FINAL
UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN FOR PHASE I REMEDIAL INVESTIGATION OF PER-AND POLYFLUOROALKYL SUBSTANCES, NIAGARA FALLS AIR RESERVE STATION NIAGARA FALLS, NEW YORK

PREPARED FOR:

UNITED STATES ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
2 Hopkins Plaza
Baltimore, Maryland 21201

PREPARED BY:

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DoD Contract Number: W912DR19D0005/Delivery Order: W912DR22F0247

September 2023

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*EA Engineering, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC who does business as EA Science and Technology in the State of New York

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Final
Uniform Federal Policy
Quality Assurance Project Plan
For
Phase I Remedial Investigation of
Per- and Polyfluoroalkyl Substances
at the Niagara Falls Air Reserve Station

Niagara Falls, New York

Prepared for:

U.S. Army Corps of Engineers, Baltimore District
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EA Project No. 634250247

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
%	Percent
%	Percent recovery
%RSD	Percent relative standard deviation
AEC	Anion exchange capacity
AFCEC	Air Force Civil Engineering Center
AFFF	Aqueous film-forming foam
AHA	Activity Hazard Analysis
amsl	Above mean sea level
amu	Atomic mass unit(s)
ANG	Air National Guard
APP	Accident Prevention Plan
ARNG	Army National Guard
ARW	Air Refueling Wing
ASD	Assistant Secretary of Defense
ASL	Aerostar SES LLC
ASP	Associate Safety Professional
ASTM	ASTM International
AKTW	Attack Wing
B.A.	Bachelor of Arts
bgs	Below ground surface
B.S.	Bachelor of Science
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C	Carbon
CA	Corrective Action
CAS	Chemical Abstracts Service
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMQ/OE	Certified Manager of Quality/Organizational Excellence
cm/sec	Centimeter(s) per second
CPOC	Contaminant(s) of potential concern
CPR	Cardiopulmonary resuscitation
CQCS	Contractor Quality Control Supervisor
CSM	Conceptual site model

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

CSP	Certified Safety Professional
DL	Detection Limit
DO	Dissolved oxygen
DoD	Department of Defense
DoE	Department of Energy
DOT	Department of Transportation
DPT	Direct push technology
DQCR	Daily Quality Control Report
DQI	Data quality indicators
DQO	Data quality objective
DUA	Data usability assessment
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
EIS	Extracted Internal Standard
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Resources Program Information Management System
FOSA	Fluorooctane sulfonamides
FOSAA	Perflurorooctane sulfonamidoacetic acids
FPTA	Fire Protection Training Area
FS	Feasibility Study
ft	Foot (feet)
FTA	Fire Training Area
FTCA	Fluorotelomer carboxylic acids
GPS	Global Positioning System
HA	Health Advisory
HAZWOPER	Hazardous waste operations and emergency response
HDPE	High-density polyethylene
HDR EOC	HDR Environmental, Operations and Construction, Inc.
HFPO-DA	Hexafluoropropylene oxide – dimer acid
HHRA	Human health risk assessment
HPLC	High-performance liquid chromatography
HQ	Hazard Quotient
HTRW	Hazardous, toxic, and radioactive waste
ICAL	Initial calibration
ICB	Initial calibration blank
ICP	Inductively coupled plasma
ICV	Initial calibration verification

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

ID	Identification
IDW	Investigation-derived waste
IDQTF	Intergovernmental Data Quality Task Force
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISC	Instrument Sensitivity Check
IDQTF	Intergovernmental Data Quality Task Force
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISC	Instrument Sensitivity Check
KO	Contracting Officer
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate.
LC/MS/MS	Liquid chromatography/tandem mass spectrometry
LLLCS	Low-Level Laboratory Control Standard
LOD	Limit of detection
LOQ	Limit of quantification
M	Million
MB	Method blank
MD	Matrix Duplicate
MDL	Method detection limit
mL	Milliliter(s)
mm	Millimeter(s)
MPC	Measurement performance criteria
M.S.	Master of Science
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not applicable
ND	Non-detect
NELAP	National Environmental Laboratory Accreditation Program
NFARS	Niagara Falls Air Reserve Station
ND	Non-detect
NELAP	National Environmental Laboratory Accreditation Program
NEtFOSAA	N-ethyl perfluorooctane sulfonamidoacetic acid
NFP	Niagara Frontier Publications (NFP) 2012
NMeFOSAA	N-methyl perfluorooctane sulfonamidoacetic acid
ng/L	Nanogram(s) per liter
No.	Number

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
oz	Ounce(s)
PA	Preliminary Assessment
PAL	Project action limit
PDF	Portable document format
PDT	Project delivery team
PE	Professional Engineer
PFAA	Perfluoroalkyl acid
PFAS	Per- and polyfluoroalkyl substances
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutane sulfonate
PFCA	Perfluoroalkyl carboxylic acids
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFDS	Perfluorodecane sulfonate
PFHpA	Perfluoroheptanoic acid
PFHpS	Perfluoroheptane sulfonate
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonate
PFNA	Perfluorononanoic acid
PFNS	Perfluorononane sulfonate
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PFOSA	Perfluorooctanesulfonamide
PFPeA	Perfluoropentanoic acid
PFPeS	Perfluoropentansulfonic acid
PFSA	Perfluoroalkyl sulfonic acids
PFTeDA	Perfluorotetradecanoic acid
PFTriDA	Perfluorotridecanoic acid
PFUnA	Perfluoroundecanoic acid
PG	Professional Geologist
PhD	Doctor of Philosophy
PID	Photoionization detector
PM	Project Manager
PMP	Project Management Professional
POC	Point of contact

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

ppt	Part(s) per trillion
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QCP	Quality Control Plan
QL	Quantitation limit
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial investigation
RL	Reporting Limit
RML	Regional Management Level
RPD	Relative percent difference
RPM	Restoration Program Manager
RSD	Relative standard deviation
RSL	Regional Screening Level
SAIC	Science Applications International Corporation
SD	Sample Duplicate
SERDP	Strategic Environmental Research and Development Program
SI	Site Inspection
SL	Screening Level
SLERA	Screening level ecological risk assessment
SOP	Standard operating procedure
SOW	Statement of Work
SPLP	Synthetic Precipitation Leaching Procedure
SSHP	Site Safety and Health Plan
STR	Senior Technical Reviewer
su	Standard unit(s)
TBD	To be determined
TDS	Total dissolved solids
TO	Task Order
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TPP	Technical project planning
UCL	Upper confidence limit
UFP	Uniform Federal Policy
µg/kg	Micrograms per kilogram

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

USACE	U.S. Army Corps of Engineers
WMP	Waste Management Plan

1. INTRODUCTION

This Uniform Federal Policy (UFP) −Quality Assurance Project Plan (QAPP) was prepared to support Phase I Remedial Investigation (RI) activities to delineate the impact of per- and polyfluoroalkyl substances (PFAS) in identified aqueous film-forming foam (AFFF) release areas at Niagara Falls Air Reserve Station (NFARS) in Niagara Falls, New York (**Figure 1-1**). EA Engineering P.C. and its affiliate EA Science and Technology (EA) has prepared this UFP-QAPP under Contract Number (No.) W912DR19D0005 with the U.S. Army Corps of Engineers (USACE) Baltimore District, Task Order (TO) No. W912DR22F0247 for the Air Force Civil Engineering Center (AFCEC). Services covered under this UFP-QAPP are defined in the Statement of Work (SOW) dated 15 June 2022 and include completion of a Phase I RI under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that characterizes environmental conditions and defines the nature and extent of PFAS contaminants.

NFARS is an Air Force Reserve Command military installation located in Niagara Falls, New York, approximately 15 miles north of the City of Buffalo. The installation, which adjoins the Niagara Falls International Airport, encompasses approximately 550 acres. NFARS was established in November 1942 and operated by the Aerospace Defense Command, with numerous groups active on the installation between 1946 and 1971. In 1971, the installation was transferred to the Air Force (AF) Reserves command, and the 914th Tactical Airlift Group (later called the 914th Tactical Airlift Wing) became the installation host.

In 1970, the U.S. Air Force (USAF) began using AFFF firefighting agents containing perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) to extinguish petroleum fires during firefighting activities and training exercises, and consequently these products were stored, maintained, used, and disposed of on the NFARS installation. The historical use of AFFF at NFARS has resulted in the environmental release of PFAS compounds (specifically PFOA, PFOS, and perfluorobutane sulfonate [PFBS]) based on preliminary assessments and site investigations completed at the installation in 2018.

Due to their persistence, bioaccumulation potential, and toxicity, PFAS may potentially impact human health and the environment. Although manufacturers have reformulated AFFF to eliminate PFOS, USAF maintains a significant inventory of PFOS-based AFFF. As part of ongoing efforts, USAF is actively removing PFOS-based AFFF from their inventory and replacing it with formulations based on shorter carbon chains, which may be less persistent and less prone to bioaccumulation in the environment.

The Phase I RI includes site characterization activities to delineate the nature and extent of PFAS resulting from historical AFFF releases at NFARS. For the purposes of this Phase I RI, delineation is defined as the lateral and vertical extent of PFAS in all impacted media. At the conclusion of Phase I RI activities, the data should be sufficient to:

- Develop a comprehensive understanding of the vertical and lateral extent of PFAS in soil, groundwater, sediment, and surface water

- Determine the source strength of residual PFAS in soil within unsaturated source zones

- Develop and/or refine conceptual site models (CSMs) using validated environmental data to describe hydrogeological conditions and identify migration pathways and potential receptors.

- Facilitate a Phase II (Human Health Risk Assessment, Environmental Risk Assessment, and Phase II Report) if warranted.

The UFP-QAPP was prepared in accordance with the UFP for QAPPs (Intergovernmental Data Quality Task Force [IDQTF] 2005), using optimized UFP-QAPP Worksheets in accordance with IDQTF guidance (IDQTF 2012). The UFP-QAPP format fulfills the requirements of the U.S. Environmental Protection Agency's (EPA's) guidance documents QA/R-5 (EPA 2001) and QA/G-4 (EPA 2006).

This UFP-QAPP provides the strategy for conducting the Phase I RI, defines the sampling objectives and methods that will be used, and includes the project organization, data quality objective (DQO) process, the project schedule, the CSM for PFAS at NFARS, project quality objectives, and techniques that may be applied to sites and decision criteria.

Meeting minutes for project planning sessions are included in **Appendix A**. Standard operating procedures (SOPs) for field activities are included in **Appendix B**; field forms to be used during implementation of the RI are included as **Appendix C**; an Accident Prevention Plan (APP) that identifies hazards associated with this work is provided as **Appendix D**; a Waste Management Plan that provides the framework for the handling of wastes generated during the RI is provided as **Appendix E**; a Quality Control Plan (QCP) that describes procedures to ensure quality control during the defined scope of work is included as **Appendix F**; laboratory certifications and SOPs are included in **Appendix G**.

All personnel involved in field work will be required to review this UFP-QAPP and associated SOPs prior to performing field work.

1.1 BACKGROUND

PFAS are classified as emerging environmental contaminants based on increasing regulatory interest, potential risk to human health and the environment, and evolving regulatory standards. In 2014, EPA added the first PFAS compound perfluorobutane sulfonate (PFBS), to the Regional Screening Level (RSL) and Regional Management Level (RML) lists. EPA subsequently issued Drinking Water Health Advisories for PFOA and PFOS in May 2016 (EPA 2016a, 2016b). Additional compounds including hexafluoropropylene oxide dimer acid (HFPO-DA, or GenX), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS) were later added to the RSL and RML lists in May 2022 (ASD 2022).

In 2016, Aerostar SES LLC (ASL), under contract to USACE, performed a preliminary assessment at NFARS to determine locations of potential environmental release of perfluorinated compounds

(ASL 2016). The preliminary assessment identified known or suspected AFFF release areas warranting a subsequent site inspection to determine the presence or absence of PFAS. ASL then conducted screening-level site inspections (SIs) at known or suspected AFFF release areas at NFARS in 2017. The 2018 SI Report identified historical AFFF releases with PFAS compounds (specifically PFOA, PFOS, and PFBS) present in on-site and downgradient environmental media (ASL 2018). Based on the results of SI, seven sites (**Figure 1-2**) are being carried forward to the next phase (RIs) following the CERCLA process:

- Site FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
- Site SS850P: AFFF Area 2 Hanger 850
- Site SS706P: AFFF Area 3 Building 706
- Site SS700P: AFFF Area 4 Building 700, Outfall 4
- Site SS015P: AFFF Area 5 Blue Angels Crash Site
- Site SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
- Site SS316P: AFFF Area 8 Hulby Street

In 2019, subsequent to the SI, the Department of Defense (DoD) adopted Screening Levels (SLs) for PFOS, PFOA, and PFBS in soil and groundwater, as described in a memorandum from the Office of the Assistant Secretary of Defense (ASD) titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 15 September 2021 (ASD 2021). The SLs were modified in 2022 when HFPO-DA, PFNA, and PFHxS were added to the RSL and RML lists, as described in a memorandum from the Office of the Assistant Secretary of Defense (ASD) titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022).

This Phase I RI will be performed following the ASD policy. SLs to be used during the RI are provided in UFP-QAPP Worksheet #15.

1.2 PURPOSE AND SCOPE OF WORK

The overall goal of this project is to conduct an RI at identified areas at NFARS where AFFF was historically stored, used, and/or released, in compliance with CERCLA, as amended; the National Contingency Plan (40 Code of Federal Regulations Part 300); and in compliance with AFCEC and USACE requirements and guidance for field investigations including specific requirements for sampling environmental media for PFAS.

This UFP-QAPP provides instruction and guidance to support the collection, analysis, and reporting of data generated under this TO to ensure that data are scientifically valid, legally defensible, and meet the established quality assurance (QA) and quality control (QC) objectives. This document has been developed to address the data acquisition, management, sampling locations, sample analysis, installation information, and DQOs.

The list of 40 PFAS compounds that will be reported during the execution of this TO is included in Worksheet #15. PFAS samples will be analyzed using EPA Method 1633 in accordance with the Quality Systems Manual (QSM) for Environmental Laboratories Version 5.4 (DoD 2021) or a more recent version for which the laboratory is accredited. Note that EPA Method 1633 is currently a draft method; however, the most recent version of the method at the time of analysis will be used.

1.3 PLAN ORGANIZATION

This UFP-QAPP is organized with the original 37 worksheets consolidated into optimized UFP-QAPP worksheets (IDQTF 2012). The UFP-QAPP is intended to provide the problem definition, approach to resolving the problem, and QA/QC activities, to ensure that the data collected are usable. The table of contents of this document presents a listing of all the UFP-QAPP worksheets. The crosswalk identifying the Optimized UFP-QAPP worksheets compared with earlier EPA QAPP guidance (EPA 2001, 2002a) is provided in **Table 1-1**.

Appendices to this UFP-QAPP, provided as separate tabs, are as follows:

- Appendix A – Project Planning Session Meeting Minutes
- Appendix B – Field Standard Operating Procedures
- Appendix C – Field Forms
- Appendix D – Accident Prevention Plan
  - Attachment A – Activity Hazard Analyses
  - Attachment B – Occupational Safety and Health Administration Form 300 and 300A
  - Attachment C – Resumes and Certifications
  - Attachment D – Safety Field Forms
  - Attachment E – Site Safety and Health Plan
  - Attachment F – Safety Data Sheets
- Appendix E – Waste Management Plan
- Appendix F – Quality Control Plan
- Appendix G – Laboratory Standard Operating Procedures and Certificates

Table 1-1. Crosswalk: Uniform Federal Policy-Quality Assurance Project Plan Workbook to 2106-G-05 QAPP

Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
1 and 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 and 5	Project Organization and Quality Assurance Project Plan Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, and 8	Personnel Qualifications and Sign-Off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	CSM	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	Quality Assurance Project Plan elements for evaluating existing data
14 and 16	Project Tasks and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits (PALs) and Laboratory Specific Detection/Quantitation Limits (QLs)	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 and 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field Quality Control	2.3.5	Quality Control Requirements
21	Field Standard Operating Procedures	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical Standard Operating Procedures	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 and 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, and 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

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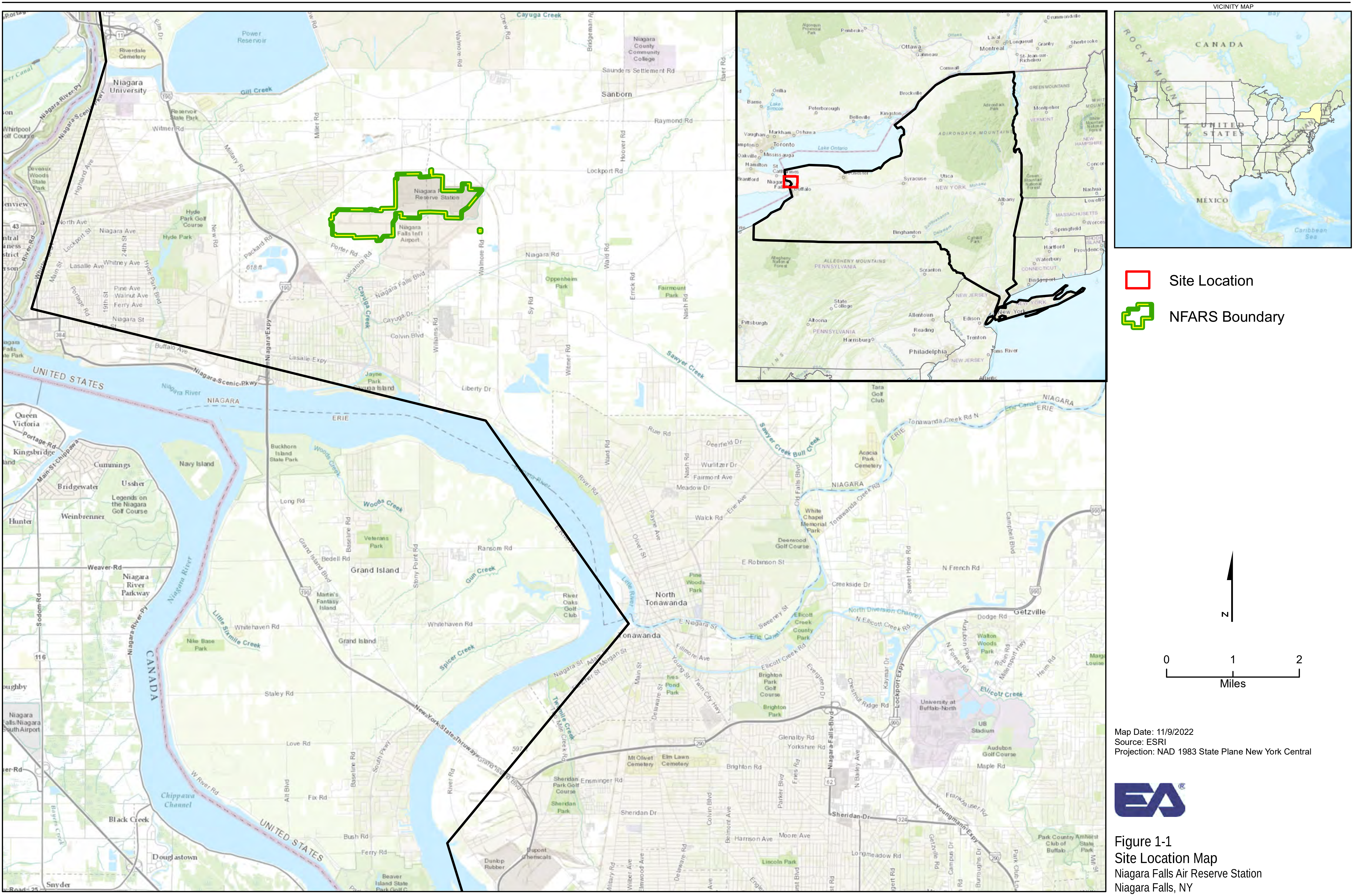
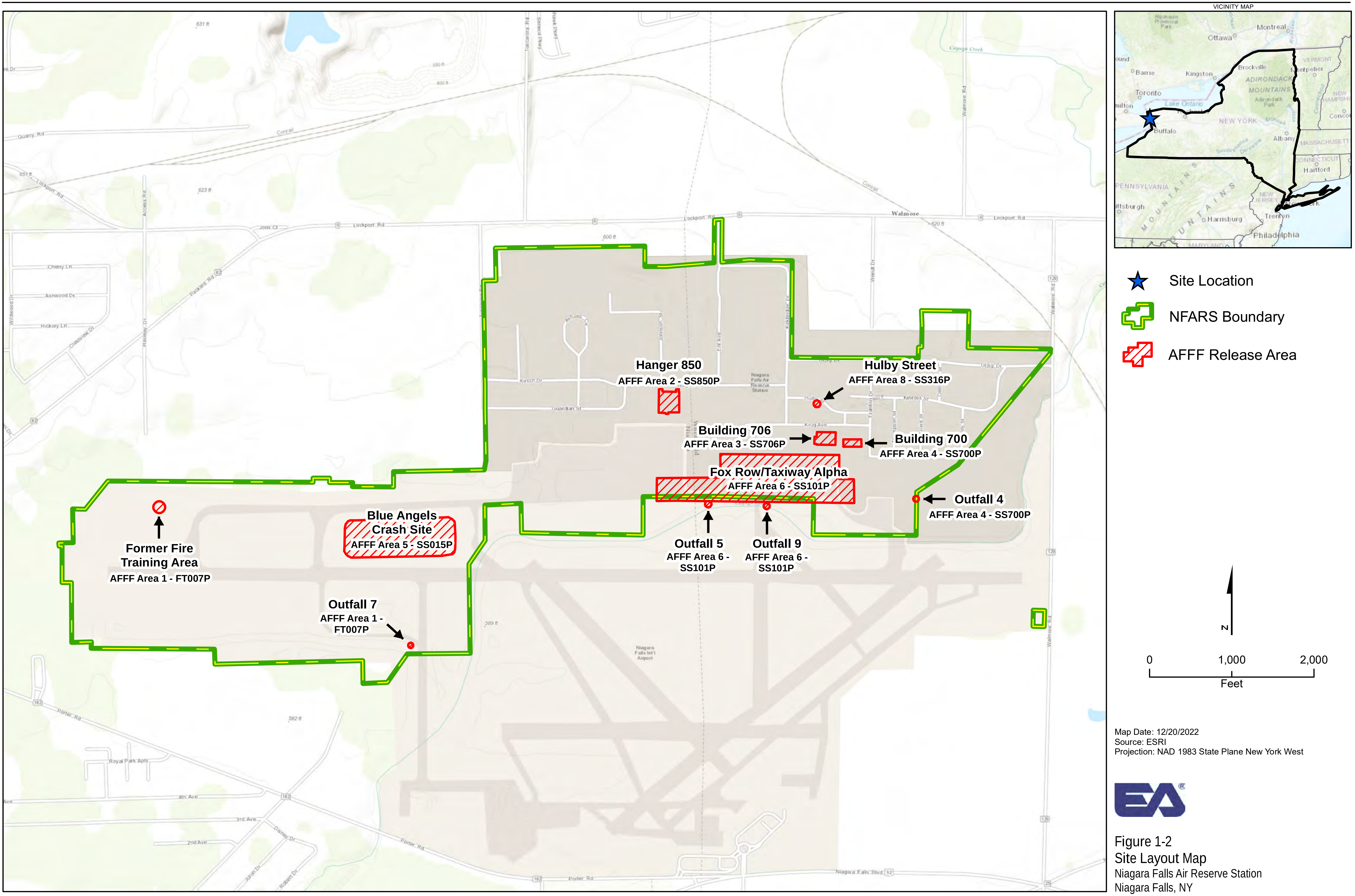


Map Date: 11/9/2022
Source: ESRI
Projection: NAD 1983 State Plane New York Central

Figure 1-1
Site Location Map
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\Figure 1-1 Site Location Map.mxd



Map Date: 12/20/2022
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 1-2
Site Layout Map
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 1-2 Site Layout Map.mxd

UFP-QAPP Worksheets #1 & #2: Title and Approval Page

Contractor Name:	EA Engineering, Science, and Technology, Inc., PBC
Contract Number:	W912DR-19-D-0005
Work Assignment Number:	Task Order W912DR22F0247
Document Title:	Uniform Federal Policy Quality Assurance Project Plan, Phase I Remedial Investigation of Per- And Polyfluoroalkyl Substances at the Niagara Falls Air Reserve Station
Project Lead:	U.S. Army Corps of Engineers – Baltimore District
Preparation Date:	December 2022
Project Lead Signature/Date:	
Printed Name/Title:	Dennis Powers / USACE Interim Technical Manager
Project Lead Signature/Date:	
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Signature/Date:	
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Investigative Organization Signature/Date:	
Printed Name/Title:	Robert Casey, PMP / EA Project Manager
Other Approval Signature/Date:	Donald
Printed Name/Title:	Donald Conan, PE, PG / EA Senior Technical Reviewer
Other Approval Signature/Date:	Samantha Saalfield
Printed Name/Title:	Samantha Saalfield, PhD / EA Project Chemist

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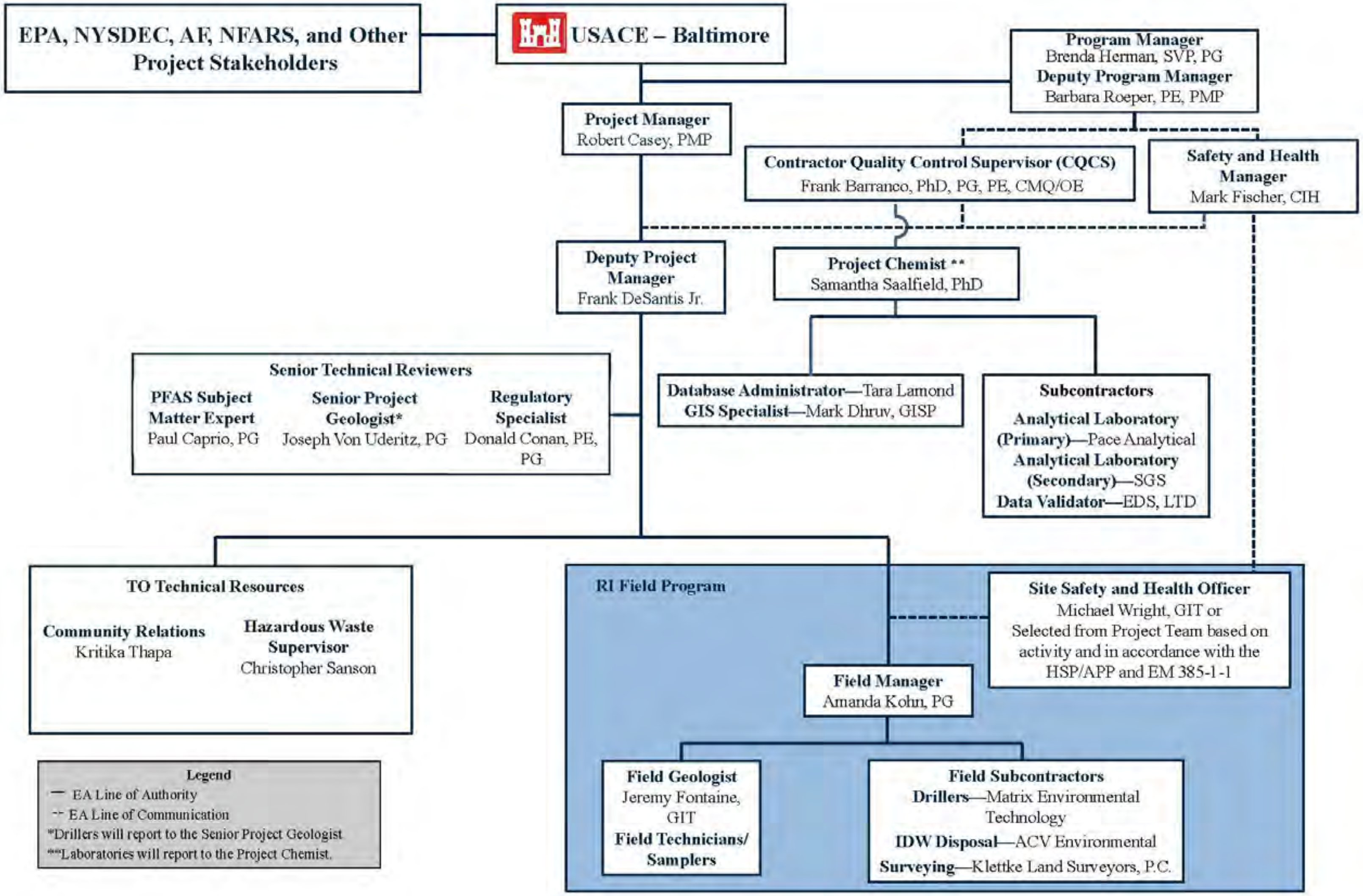
UFP-QAPP Worksheets #3 & #5: Project Organization and QAPP Distribution List



Note: The AFCEC Restoration Program Manager (RPM) is the key project interface between the project team and external stakeholders/regulators.

Document Name/Type	A	B	C	D	E
Draft UFP-QAPP	1 electronic	1 electronic	1 electronic		
Draft Final UFP-QAPP	1 electronic	1 electronic	1 electronic	1 electronic	1 electronic
Final UFP-QAPP	2 CDs 2 hard copies	1 CD 1 hard copy	1 CD	1 CD 1 hard copy	1 CD 1 hard copy

A	USACE Project Manager CENAN-PPMD-E Thomas Heins 914 ARW NFIAP Bldg 700 Niagara Falls, NY 14304 Phone: 716-236-2049 Mobile: 917-275-3373 Thomas.R.Heins@usace.army.mil USACE Interim Technical Manager CENAB-ENE-M Dennis Powers 2 Hopkins Plaza Baltimore, MD 21201 Phone: 410-962-4454 Dennis.J.Powers@usace.army.mil
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D	NYSDEC Attn: Steve Moeller 700 Delaware Avenue, Buffalo, NY 14209 716-851-7220
E	NYSDOH Attn: James Sullivan Empire State Plaza Corning Tower Room 1787 Albany, New York 12237 (518) 402-5584

UFP-QAPP Worksheets #4, #7, and #8: Personnel Qualifications and Sign-Off Sheet

This worksheet identifies key project personnel for each organization performing tasks defined in this UFP-QAPP and summarizes their title or role, qualifications (e.g., training and experience), any specialized training, licenses, certifications, or clearances required by the project. The qualifications of USACE personnel are under the purview of the DoD and will not be outlined in this UFP-QAPP. In addition, federal and state stakeholders' qualifications are under the purview of their respective agencies and will not be presented in this UFP-QAPP. The table in this worksheet summarizes the responsibilities and provides a space for the signatures of key personnel to the site covered in this UFP-QAPP. Signatures on the sign-off sheet indicate personnel have read, and agree to implement this UFP-QAPP, as written. Certification and training records for identified personnel are maintained by the organization's human resources department and are available on request.

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Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Organization: EA (Contractor)				
Brenda Herman, PG	EA Program Manager	**Undergraduate Course Work** • Bachelor of Science (B.S.); Biology; University of Delaware; 1984 **Graduate Course Work** • Master of Science (M.S.); Geology; University of Delaware; 1989 Ms. Herman is a Professional Geologist (PG) with 33 years of experience managing and conducting environmental projects for the DoD. Ms. Herman has been the Program Manager for several Indefinite Delivery/Indefinite Quantity contracts with USACE–Baltimore, Norfolk, and Omaha districts, as well as Aberdeen Proving Ground and Fort Belvoir. These contracts have covered hazardous, toxic, and radiological waste and Military Munitions Response Program investigation and removals; natural resources; compliance; and technology services.	**Registrations/Certification** • PG—Tennessee; 2000 **Specialized Training** • Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Responses (HAZWOPER) • USACE Construction Quality Management for Contractors • EA Project Manager (PM) Training • Wharton Class, Essentials of Management	Brenda Herman 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Barbara Roeper, PE, PMP	EA Deputy Program Manager	**Undergraduate Course Work** • B.S.; Chemical Engineering; Bucknell University; 1988 **Graduate Course Work** • M.S.; Environmental Engineering; Johns Hopkins University; 1999 Ms. Roeper is a Professional Engineer (PE) with 34 years of experience and working knowledge of environmental compliance, waste management, site investigation, and remediation requirements under federal and state regulations. She has a key role in soil and groundwater investigation tasks, remediation projects, environmental compliance, and underground storage tank/aboveground storage tank compliance program development. In addition, her experience includes feasibility studies, Resource Conservation and Recovery Act (RCRA) facility investigations and corrective actions, design of groundwater remediation systems and wastewater treatment systems, groundwater and surface water modeling, and RCRA permit application preparation. She has worked closely with the EPA and state and local agencies. Her project management experience includes oversight of construction projects and field collection of samples, cost estimation, site safety and health management, subcontractor management, negotiation with regulators, and interaction with the public.	**Registrations/Certification** • PE- New York (No.099506); 2018 • PE- D.C. (No. PE923113); 2021 • PE- Pennsylvania (No. PE075505); 2008 • PE -Delaware (No. 14765); 2006 • PE -Maryland (No. 23130); 1998 • Project Management Professional (PMP) (No. 1267810); 2009 **Specialized Training** • OSHA HAZWOPER 40-hour Training and 8-hour refresher • OSHA 8-hour Hazardous Waste Operations Supervisory • EA PM Training • Cardiopulmonary resuscitation (CPR) and First Aid Certified	Barbara C. Roeper 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Robert Casey, PMP	EA Project Manager	**Undergraduate Course Work** • B.S.; Environmental Science; Humboldt State University, 2001 Mr. Casey is a PMP with 22 years of experience supporting and 15+ years managing hazardous, toxic, and radioactive waste (HTRW) projects under various federal regulations as well as following guidance provided by DoD and New York State Department of Environmental Conservation (NYSDEC). He has had an 18-year relationship with NYSDEC, including 10 years as Deputy Program Manager for EA's Standby Engineering Contract with NYSDEC for a range of HTRW work, including supporting several PFAS projects directly for NYSDEC. He has served as Deputy PM on a $7.6 Million (M)+ PFAS SI project for Army National Guard (ARNG) installations nationwide, and as senior technical reviewer (STR) for EA's 8-year Performance Based Remediation contract at NFARS.	**Registrations/Certifications** • USACE Construction Quality Management Certified; 2006, 2011 **Specialized Training** • OSHA 40-hour HAZWOPER Training; 2001 • OSHA 8-hour Hazardous Waste Site and Supervisor's Training; 2006 • OSHA 8-hour Competent Person Training for Trenching and Shoring Construction; 2006 • The Remediation Course, Princeton Groundwater, Inc.; April 2011 • Contaminant Chemistry and Monitored Natural Attenuation Workshop Series, Northwest Environmental Training Center; July 2009 • Advanced Tools for In Situ Remediation, Long Island Groundwater Institute; April 2009 • Emerging Contaminants Symposium, Central New York Association of Professional Geologists, October 2016 • National Forum on Vapor Intrusion, EPA • EA Supervisor Training; 2017 • Association of Vapor Intrusion Professionals 2022 • Project Management Institute; 2010 • EA Project Manager Training; 2007	13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Frank DeSantis Jr.	EA Deputy Project Manager	**Undergraduate Course Work** • B.S.; Environmental and Forest Biology; State University of New York College of Environmental Science and Forestry; 2000 Mr. DeSantis has 19 years of experience in the biological and environmental fields, including Phase I and Phase II assessments in support of the Army Operational Range Assessment Program, remedial action–operation and long-term management activities in support of USAF and Army Environmental Command environmental programs; site characterizations and pre-design investigations in support of USAF performance-based remediation programs; and RIs and Feasibility Studies (FSs) and remedial design for NYSDEC. He has provided project management for preliminary site assessments, site characterizations, RI/FS, and remedial design/remedial actions. He served as the investigation manager for an RI/FS of a metals impacted tidal marsh at Camp Smith, New York. He understands the New York guidance (e.g., Division of Environmental Remediation -10: Technical Guidance for SI and Remediation) and promulgated remedial regulations (e.g., Title 6, New York Codes Rules and Regulations, Part 375, Soil Clean-up Objectives) at sites with metal contaminants showing migration via surface water and sediment deposition.	**Specialized Training** • OSHA 40-hour HAZWOPER Training • OSHA 8-hour HAZWOPER Refresher; Annually • OSHA 8-hour Hazardous Waste Operations Supervisor Training • 30-hour Construction Safety and Health • Permit Required Confined Space Training • Safe-Capture: Chemical Immobilization of Wildlife • CPR and First Aid Training; Biannually	13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Paul Caprio, PG	EA PFAS Subject Matter Expert	**Undergraduate Course Work** • B.S.; Geology; 1979 Mr. Caprio has 40+ years of experience in management, design, implementation, and interpretation of RI/FSs and other types of hazardous waste site characterization and remediation projects. He has served as Senior Technical Resource for $40M+ of PFAS-related TOs, including the ARNG PFAS SIs nationwide, serves as the Director of EA's Chemicals and Contaminants of Emerging Concern group, and leads EA's internal PFAS Technical Working Group. He stays current with evolving PFAS regulations, analytical methods, and remedial technologies through his active involvement in Interstate Technology and Regulatory Council's (ITRC's) PFAS technical working group and PFAS-related Strategic Environmental Research and Development Program (SERDP) projects.	**Registrations/Certifications** • Professional Geologist—Pennsylvania (1995, No. 002495G) **Specialized Training** • OSHA 40-hour HAZWOPER Training • OSHA 8-hour HAZWOPER Refresher; Annual • OSHA 8-hour Site Supervisor Course • Federal Contracts Management Training • CPR and First Aid Training	Paul Caprio 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Joseph Von Uderitz, PG	EA Senior Project Geologist	**Undergraduate Course Work** • B.S.; Environmental Studies and Geology; Alfred University; 2001 Mr. Von Uderitz is a PG with 18 years of experience in environmental site assessment and remediation. His primary responsibilities are oversight of field activities including preparing work plans, scheduling, and overseeing implementation of work plans. Oversight includes Contractor QC responsibilities of the installation and operations of treatment systems, as well as installation of monitoring and recovery wells, and development, gauging, and sampling of wells. He maintains product recovery, dual phase extraction systems, and catalytic oxidizer systems at various locations. Additionally, he has experience with construction activities and associated safety and health concerns, site inspections to evaluate work conditions for potential job site hazards, ensuring proper selection and use of personal protective equipment, use of monitoring equipment, and safety and health compliance. Provides daily health and safety briefings for personnel on multiple construction sites. Provides technical review and assisted in preparation of safety procedures for Site Safety and Health Plans (SSHPs) and APPs.	**Registrations/Certifications** • PG- Pennsylvania; 2015 (PG005197) • PG- New York; 2017 (No. 000144-1) **Specialized Training** • OSHA HAZWOPER 40-hour Training • OSHA 8-hour HAZWOPER Refresher; annually • OSHA 8-hour HAZWOPER Supervisor Training; 2020 • OSHA 30-hour Construction Safety and Health Training • Level 1 Anti-Terrorism Awareness Training; 2016 • EA PM Training; 2012 • USACE Construction Quality Management for Contractors Worker • The Mine Safety and Health Administration Training • 40-hour Radiation Worker I Training • Excavation Safety Training (Trenching/Shoring) • Association of Reciprocal Safety Councils Training • Permit-Required Confined Space Entrant • Permit-Required Confined Space Attendant • Permit-Required Confined Space Supervisor • General Radiation Worker Training CPR and First Aid Certified; Bi-annually	J. VonUderitz 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Donald Conan, PE, PG	EA Regulatory Specialist	**Undergraduate Course Work** • B.S. Civil & Environmental Engineering, Clarkson University; 1987 Mr. Conan is a PE with more than 30 years as an Environmental /Civil Engineer and Project Manager. As a Senior Engineer in EA's Syracuse, New York office, Mr. Conan is responsible for managing the engineering staff in the Syracuse office, and the technical oversight of environmental restoration projects under various federal and state programs. His broad experience includes conducting site assessments related to hazardous waste and petroleum contamination and the remediation activities associated with these projects.	**Registrations/Certifications** • PE- New York; 1998 (075666-1) • PE- Florida; 1994 (48066) • PE- Maine; 1998 (8729) • PG- New York; 2018 (000144-1) **Specialized Training** • OSHA 40-hour HAZWOPER Training; 1992 • OSHA 8-hour Hazardous Waste Operations Supervisory; 1999 • OSHA HAZWOPER 8-hour Refresher Training; annual • OSHA 30-hour Construction Safety and Health; 2011 • USACE Construction Quality Management for Contractors; 2017 • University of Wisconsin, Designing Air-Based In Situ Soil and Groundwater Remediation Systems • U.S. Navy Northern Division, Data Quality Objectives/Assessment Workshop • American Public Works Association, Public Works Construction Inspection • Ductile Iron Pipe Research Association, Basic Corrosion Short Course • New York State Department of Environmental Conservation Soil Vapor Intrusion Training; 2005 • Activated Carbon – Application, Principles and Practices; PACS Laboratory, Pittsburgh, Pennsylvania; 2015 • USACE Construction Quality Management for Contractors; 2017	Donald Co 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Frank Barranco, PhD, PG, PE, CMQ/OE	EA Contractor Quality Control Supervisor (CQCS)	**Undergraduate Course Work** • Bachelor of Arts (B.A.); Geology; Duke University; 1984 **Graduate Course Work** • M.S.; Geology; University of Texas Arlington; 1988 • Doctor of Philosophy (PhD); Environmental Science and Engineering; Colorado School of Mines; 1998 Dr. Barranco has 33 years of consulting experience and serves as Director of the Quality Management Program, implementing company-wide QA/QC policies, guidance documents, and SOPs. He has 12 years as Corporate Quality Officer responsible for QC for federal projects covering investigation, design, remediation, long-term management, and construction at Formerly Used Defense Sites, Formerly Utilized Sites Remedial Action Program, Defense Environmental Restoration Program, Installation Restoration Program (IRP), Superfund, Base Realignment and Closure, etc. under CERCLA, RCRA, and other regulations. Dr. Barranco has 2,000+ hours of training in Quality Management, HTRW, sustainability, DQO development, contaminant transport, and environmental engineering.	**Registrations/Certification** • PE- Maryland; 2012 (No. 43120) • PG- Tennessee (No. 005603) • PG- New York; 2019 (No. 001202-1) • Certified Manager of Quality/Organization Excellence (CMQ/OE) (No. 53424) **Specialized Training** • OSHA 40-hour HAZWOPER Training • OSHA 8-hour Hazardous Waste Operations Supervisor Training • CQM Training • CPR and First Aid Training; Bi-annually	Frank D Barranco, Jr. 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Samantha Saalfield, PhD	EA Project Chemist	**Undergraduate Course Work** • B.A.; Geology/Chemistry; 2004 **Graduate Course Work** • PhD; Earth Sciences; Dartmouth College; 2009 Dr. Saalfield has 15 years of environmental chemistry experience on environmental projects under CERCLA, RCRA, and other federal, state, and local regulations. She has developed/approved data quality objectives DQOs and UFP-QAPPs. She has directed/supported Chemical Data Quality for site characterization, RI, and Remedial Confirmation Sampling task orders.	**Specialized Training** • OSHA 40-hour HAZWOPER Training; 2009 • OSHA 8-hour HAZWOPER Refresher; annually • Confined Space Training; 2014 • INNOV-X Systems Radiation Safety and Operations Training for Field XFR analyzers • Interstate Technology and Regulatory Council’s Incremental Sampling Methodology Training • DoD QSM v.5 Training • PM Training; 2013 • CPR and First Aid Training; Bi-annually	Samantha Saalfield 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Mark Fischer CIH	EA Safety and Health Manager	**Undergraduate Course Work** • B.S.; Environmental Science; 1998 Mr. Fisher is a Certified Industrial Hygienist (CIH) with 33 years of experience applying and implementing occupational health and safety and environmental regulations and guidance to environmental cleanup, construction, and industrial operation programs and projects. Mr. Fisher performed quality assurance reviews of numerous U.S. Army Corps of Engineers (USACE) projects undergoing the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Resource Conservation and Recovery Act (RCRA) cleanup for occupational health and safety and perimeter air monitoring concerns. He developed engineering regulations, manual, pamphlets, and other guidance directly related to protecting occupational health and air monitoring for all USACE programs.	**Registrations/Certifications** • Certified Industrial Hygienist (CIH)—No. 6764CP (1995) **Specialized Training** • OSHA 40-hour HAZWOPER Training • OSHA 8-hour HAZWOPER Refresher; annually • OSHA 30-hour Construction Safety Training	Mark J. Fisher, CIH 13 September 2023

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Organization: Pace Analytical – Gulf Coast Laboratory, Baton Rouge, Louisiana				
Marie Levy	Project Manager	On file with the laboratory	Not applicable	On file with the laboratory
Wally Washington	Quality Assurance Manager	On file with the laboratory	Not applicable	On file with the laboratory
Organization: Environmental Data Services, Ltd. (Data Validation)				
Diane Waldschmidt	Principal Chemist and Program Manager	On file with EDS, Ltd.	Not applicable	On file with EDS, Ltd.

Notes:
Signature approval maintained in project file.

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UFP-QAPP Worksheet #6: Communication Pathways

This worksheet documents specific issues (communication drivers) that will trigger the need for formal (documented) communication with other project personnel or stakeholders. Its purpose is to ensure there are procedures in place for providing notifications, obtaining approvals, and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, approvals to proceed from one Definable Feature of Work to the next, field changes, emergencies, non-conformances, and stop-work orders. Discussion with stakeholders in the decision process will be aided by the submittal of monthly progress reports detailing activities at Air National Guard (ANG) installations.

Communication Drivers	Responsible Entity	Name	Phone Number	Role/Procedure (Timing, pathways, etc.)
Modifications to Program	USACE PM	Tom Heins	917-936-6273	Primary points of contact (POCs) for USACE. Responsible for executing the contract and overseeing the contractual and administrative aspects of the Contract; ensure Contractor compliance with contractual requirements, monitor and manage Contractor performance including PMP, Integrated Master Schedule, etc.; respond to inquiries from NFARS and AFCEC; assist NFARS and AFCEC in planning, programming, budget, and execution of funding for this Contract and out-years.
	USACE Interim Technical PM	Dennis Powers	410-962-4454	
Modifications of Contractual Responsibilities	USACE Contracting Officer (KO)	Leigha Arnold Brooks	443-749-2022	Fully responsible for execution of this Contract on behalf of the USAF; all contracting, work/invoice approval/authorization; official line of communication with the Contractor concerning legal and contractual matters. The KO is the only person with authority to negotiate and enter into contracts and to obligate funds.
Installation Interface	AFCEC Base Restoration Program Manager (RPM)	Lindsay Mairs	716-236-3125	Ensure AF requirements relating to execution of RIs for PFAS compounds are fully met; facilitate regulatory interactions to achieve regulatory acceptance/concurrence; provide access for Contractor's services at the project sites; ensure review of deliverables by AFCEC/CZTE, PFAS Support Team and, as appropriate, AF legal; facilitate the processing of Contractor's site access/badges with base agencies; facilitate the processing/approval of dig permits with base agencies; respond to inquiries from a variety of sources to include congressional inquiries, public inquiries, media inquiries, and other federal government inquiries, as appropriate

Communication Drivers	Responsible Entity	Name	Phone Number	Role/Procedure (Timing, pathways, etc.)
Installation Interface	AFCEC PM	Melvin Alli	210-925-6636	Plan, program, budget, and execute funding for this contract and out-years; respond to inquiries from a variety of sources to include congressional inquiries, public inquiries, media inquiries, and other federal government inquiries, as appropriate.
Contractual modification and/or program performance	EA Program Manager	Brenda Herman	410-527-2474	Communicates with USACE KO and other USACE personnel at the programmatic level regarding overall performance.
Manage all project phases/overall technical leads	EA PM	Robert Casey	315-565-6550	Primary POC responsible for implementing work specified in the SOW; responsible for the day-to-day coordination with stakeholders. Reports to Program Manager. POC with USACE on TO-specific matters; directs project scheduling, risk management, estimating, safety, quality, and cost control, and procurement of equipment, materials, and supplies; manages subcontractors; reviews scoping documents, work plans, deliverables, and cost/performance reports for consistency and accuracy; manages/executes TO IAW SOW; work plans; and federal, state, and local regulations; schedules and chairs kickoff meetings and project status review meetings with USACE and other stakeholders; leads communication with stakeholders, as necessary and as directed.
Project Safety	EA Health & Safety Manager	Mark Fischer	443-541-4132	Communicates with EA PM regarding safety issues. Reviews and approves safety plans, audits fieldwork to ensure compliance with APP, and exercises stop-work authority, if needed. Directs overall health and safety compliance; ensures compliance with OSHA regulations, EA policy, and USACE procedures outlined in EM 385-1-1.
Project QA/QC and Corrective Actions	EA CQCS	Frank Barranco	410-329-5137	Communicates with EA PM regarding QC/QA issues; reviews and approves corrective action plans; directs and oversees overall QA/QC policies; participates in project and program reviews and quality audits to ensure quality work products are delivered to clients; ensures quality performance and compliance with federal and state regulations, EA policy, and USACE procedures; audits fieldwork to ensure compliance with UFP-QAPP.

Communication Drivers	**Responsible Entity**	**Name**	**Phone Number**	**Role/Procedure** (Timing, pathways, etc.)
Modifications to Analytical Corrective Actions	EA Project Chemist	Samantha Saalfield, PhD	410-527-2491	Approves and monitors implementation of UFP-QAPP, including identification of laboratory and analytical methods. Serves as direct liaison with analytical laboratory QC personnel; ensures that corrective action is implemented on chemistry-related issues; has overall responsibility for chemical data quality and ensures that data meet DQOs; approves or rejects data validation reports and analytical data packages.
Laboratory Corrective Actions and QA Modifications	Pace Analytical Gulf Coast Laboratory QA Manager	Wally Washington	225-769-4900	Reports project nonconformance issues within 1 week to the Laboratory PM in person or by phone, or email.
Modifications to Eurofins analytical responsibilities	Pace Analytical Gulf Coast Laboratory Project Manager	Marie Levy	225-678-1833	Report project nonconformance issues within 1 week to the Project Chemist by phone, or email
Modification to data validation responsibilities	Data Validation Project Manager (EDS, Ltd.)	Diane Waldschmidt	412-408-3288	Report project nonconformance issues within 1 week to the Project Chemist by phone, or email.
Regulatory Agency Interface	New York State Department of Environmental Conservation PM	Steven Moeller	716-851-7220	Communicate technical approaches, schedule, and decisions directly to regulatory agencies' representative(s) on an as-needed basis, documented via phone records and emails. Facilitate/support setup of project planning meeting(s) with regulator, USACE and AFCEC, document distribution and comment/response process.
	New York State Department of Health	Jim Sullivan	518-402-5584	

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UFP-QAPP Worksheet #9: Project Planning Session Summary

This worksheet is used to document project planning sessions and is used to provide a concise record of participants, key decisions or agreements reached, and action items. If a planning session occurs after this UFP-QAPP has been finalized, and the session results in a change to this UFP-QAPP, this worksheet will be amended accordingly.

TECHNICAL PROJECT PLANNING MEETING NO. 1

Title: NFARS Phase I RI of PFAS
Meeting Location: Microsoft Teams meeting
Date of Session: 27 October 2022

Participants:

Attendees	Organization/TO Role
Steven Moeller	NYSDEC- Project Manager
Jim Sullivan	NYSDOH
Lindsay Mairs	AFCEC-Restoration Program Manager
Tom Heins	USACE – New York District – Project Manager
Alison Hines	USACE – Baltimore District – Technical PM
Genna Rohleder	USACE – Project Geologist
Kiera Hearn	USACE – Project Chemist
Bob Casey	EA – Project Manager
Frank DeSantis	EA – Deputy Project Manager
Amanda Kohn	EA – Field Task Manager
Joe Von Uderitz	EA – Senior Project Geologist

The purpose of the meeting was to introduce the project team, discuss the AFFF sites moving forward to RI, and present the Phase I RI approach and schedule. Meeting minutes were provided to participants and provided in **Appendix A**.

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UFP-QAPP Worksheet #10: Conceptual Site Model

This Phase I RI is being conducted to delineate the vertical and lateral extent of PFAS compounds in soil, groundwater, sediment, and surface water resulting from historical AFFF releases at NFARS. AFFF release areas and outfalls that provide locations to monitor stormwater discharge for all release events that have occurred at NFARS were investigated in the SI phase (Aerostar SES LLC 2018). The following table presents the seven areas that have been determined to have an AFFF release and that require additional investigation in the Phase I RI.

EESOH-MIS ID	AFFF Area (s)
FT007P	AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
SS850P	AFFF Area 2 Hanger 850
SS706P	AFFF Area 3 Building 706
SS707P	AFFF Area 4 Building 700, Outfall 4
SS015P	AFFF Area 5 Blue Angels Crash Site
SS101P	AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9
SS316P	AFFF Area 8 Hulby Street

Note: EESOH-MIS = Enterprise Environmental, Safety, and Occupational Health Management Information System (US Air Force)

This worksheet presents available information for NFARS and describes the CSM. Information from the Phase I RI sampling efforts will be used to further develop and refine the CSM to identify migration and exposure pathways from identified PFAS source areas.

INSTALLATION LOCATION

NFARS is located in Niagara County, New York, approximately 6 miles east of the city of Niagara Falls and 15 miles north of the city of Buffalo. The installation, which adjoins the Niagara Falls International Airport, encompasses approximately 550 acres. The installation is fenced with controlled access.

INSTALLATION BACKGROUND AND USAGE

In 1928, the city of Niagara Falls invested $70,000 to establish the Niagara Falls International Airport. Its 150 acres was used for private, single-engine planes. During World War II, the United States Army Air Forces assumed control of the airport and upgraded its facilities to be used as an Army Air Force base. NFARS was fully established in November 1942 and operated by the Aerospace Defense Command.

After the war, the Air Force, ANG, and Navy used the runways. The 107th Fighter Interceptor Group of the New York ANG were assigned to the NFARS in 1946, the same year the installation was designated as a United States Naval Air Station. Following the conclusion of World War II, NFARS became the home site for the original Camp Bell military installation. Along with this designation, NFARS also served as the home station for Bell Aerospace, who manufactured the Bell X-1A experimental aircraft. In 1947, General Chuck Yeager tested the Bell aircraft at NFARS before breaking the sound barrier at Edwards Air Force Base, California. Additionally, NFARS was home to the original Bell helicopter and the Bell Rocket Belt prototype. In 1952, the Air Force branch was established there with the activation of the 76th Air Base Squadron. In 1971, the installation was transferred to the Air Force Reserves command, and the 914th Tactical Airlift Group (now called the 914th Air Refueling Wing [ARW]) became the installation host. NFARS is now also home to the 107th Attack Wing (ATKW) of the New York ANG, the 277th Quartermaster Company, Buffalo Military Entrance Processing Station, the 2nd Squadron 101st Cavalry, the 865th Combat Surgical Hospital, and the 1982nd Forward Surgical Team (ASL 2016).

The airport has been used for freight, charter flights, and periodic commercial flights and is the alternate landing facility for flights at the Buffalo-Niagara International Airport. The Niagara Frontier Transportation Authority has owned the airport since 1970. The runways, taxiways, and aircraft parking at the NFARS are used by the 914th ARW. The 107th ATKW does not currently have aircraft and does not use the runways, taxiways, or aircraft parking areas. In general, the western one-third of the Air Reserve Station is devoted to the facilities of the 107th ATKW.

ENVIRONMENTAL SETTING

Climate

The climate at NFARS is characterized as humid continental with hot to warm summers and cold winters. The average annual precipitation is approximately 35 inches and the average annual snowfall is 77 inches. The average annual temperature in the NFARS area is approximately 48 degrees Fahrenheit (°F). The average annual high temperature is approximately 57°F, and the average annual low temperature is approximately 38°F (US Climate Data 2017).

Topography

NFARS falls within the Lake Tonawanda plain, part of the Erie-Ontario Lowlands physiographic province, which is characterized by lake plains associated with Lake Ontario to the north and Lake Erie to the southwest. The Niagara River, which drains the water from Lake Erie into Lake Ontario, is located approximately 3.5 miles northwest of the NFARS. The Lake Tonawanda plain is characterized by generally flat terrain with beach ridges and moraines forming areas of low relief. The ground surface in the area of NFARS slopes gradually from 600 ft above mean sea level (amsl) along the northernmost boundary to 585 ft amsl along the southern boundary.

Hydrology

NFARS is located within the Erie-Niagara Drainage Basin and is part of the Niagara Tonawanda Creek Watershed. Surface water at NFARS primarily flows through a system of ditches and underground storm drains that discharge into Cayuga Creek, which is the largest surface water body on the installation (**Figure 10-1**). Beginning north of NFARS in the town of Lewiston, Cayuga Creek flows south through NFARS and the city of Niagara Falls before joining Bergholtz Creek. Bergholtz Creek then joins Little River before discharging into the Niagara River, five miles upstream of Niagara Falls (ASL 2016).

Cayuga Creek enters NFARS from the northeastern quadrant and parallels the aircraft aprons and runway along the eastern and southern boundaries of NFARS before exiting the installation to the south. An unnamed tributary, and several on-site and off-site drainage ditches flow generally south through the northwestern corner of the installation and join Cayuga Creek near the eastern portion of the airfield. During the original construction of the airfield, Cayuga Creek was diverted and channelized. In 2011, a portion of Cayuga Creek was realigned during airfield safety improvements in the area east of Outfall 4.

Geology

The unconsolidated subsurface deposits (i.e., overburden) at the installation consist of a relatively thin veneer of Pleistocene-age fine-grained glaciolacustrine and till deposits (Cadwell, et al. 1986), with localized deposits of glaciofluvial or recent coarser-grained alluvium. Overburden thickness throughout NFARS ranges from approximately 3 ft near Cayuga Creek to nearly 18 ft in the northwestern portion of the installation. The overburden is comprised of three main types of material: reworked topsoil/fill, lacustrine deposits, and glacial till. Near Hanger 850, a distinct and apparently laterally discontinuous, well-graded sand layer, exists between the glaciolacustrine deposits and till. Near Cayuga Creek, recent fluvial deposits directly overlie the fractured bedrock in areas where the glacial deposits have been eroded. **Figure 10-2** provides a generalized representative surface geology and surface soil map of the site and surrounding area.

Bedrock underlying the relatively thin cover of overburden is Middle Silurian Lockport dolostone, which consists of gray to brownish gray, fine to coarse grained, massive- to thinly-bedded dolostone. Regionally, the Lockport Dolostone consists of four formations. In the locale of NFARS the Guelph Formation, the uppermost unit is not present. Underlying the Guelph Formation, the Eramosa Formation is present in the area of NFARS; however, it is missing the upper 10–20 ft. The Eramosa Formation is a dolomite and is described as a biostromal, bituminous, medium- to massive-bedded dolomite. Below the Eramosa Formation lies the Upper Goat Island Formation, which is a light to dark gray, medium- to thin-bedded argillaceous dolomite with thin shale partings and locally present vugs. (Brett et al. 1995). A generalized representative cross section of the subsurface is provided in **Figure 10-3.**

Previous work conducted at NFARS has noted that the upper 10 ft of the Lockport Dolostone is highly weathered and more heavily fractured than that below and contains mainly horizontal bedding plane fractures with localized high angle vertical fracturing. Fracture concentrations vary heavily based on location. Vertical fractures become narrower and less connected with depth (Science Applications International Corporation [SAIC] 1991). Regionally, the bedrock dips gently to the south, with fracture sets oriented east-northeast. Other features of the Lockport Formation observed during previous work include fossil coral and algal structures; stylolites; vugs; and secondary mineralization of calcite, dolomite, fluorite, galena, and gypsum (EA 2010).

Hydrogeology

Hydro-stratigraphic units at the installation include overburden (typically 4–7 ft of saturated unconsolidated materials), shallow bedrock (the upper 5–15 ft of closely-fractured and hence more permeable bedrock), and the deep bedrock (the less fractured, more competent bedrock).

Groundwater exists within the overburden at approximately 4–10 ft bgs. The glaciolacustrine or till layers may locally perch groundwater or act as a confining layer; however, no regional, continuous confining unit is present between the overburden and shallow bedrock.

The principal water-bearing zones in the Lockport dolostone are weathered bedrock and horizontal fractures near stratigraphic contacts. Groundwater exists in the Lockport Dolomite under artesian, semi-confined, and unconfined conditions. Unconfined water table conditions exist in bedrock in areas where the fractured upper part of the rock is hydraulically connected to an overlying unconsolidated layer capable of transporting water. No “low permeability layer” occurs between the overburden and bedrock. Groundwater within the overburden and shallow bedrock transmissive zone occurs under water table, confined and artesian conditions. At some locations groundwater occurs at elevations within the overburden and shallow bedrock transmissive zone indicating a water table condition. At other locations the groundwater level is within the overlying lacustrine material or above the ground surface (e.g., near Cayuga Creek) indicating confined or artesian conditions.

Regional groundwater flow in the area of NFARS is south to southwest. Locally, flow directions vary based on proximity to the Cayuga Creek and seasonal water level fluctuation (EA 2010). Local flow directions have been observed to the east, southeast, south, and southwest at various previously investigated sites. Groundwater movement may also be locally influenced by anthropogenic features, such as pumping wells, sumps, building foundations, sewer lines, etc.

Due to the limited saturated thickness of the overburden and relatively low permeability (e.g., 10^{-5} to 10^{-2} centimeters per second [cm/sec]), groundwater flow is relatively slow. In the underlying bedrock, most groundwater flow is within secondary porosity features (i.e., along horizontal bedding planes, vertical fractures, and joints), particularly in the upper 5–15 ft where these openings may be weathered and/or expanded by dissolution. Estimates of base-wide hydraulic conductivity determined by aquifer testing range from 2.2×10^{-7} to 2.3×10^{-2} cm/sec for the overburden, 1.3×10^{-5} to 3.2×10^{-2} cm/sec for the shallow bedrock, and 4.3×10^{-6} to 8.1×10^{-3} cm/sec for the deep bedrock (E&E 1996). In fractured bedrock, the hydraulic conductivity is highly dependent on the spacing of fractures and the size of the opening (aperture). Hydraulic conductivity in fractures can be several orders of magnitude greater than that of the bedrock matrix. Due to the closely fractured nature of the shallow bedrock, groundwater flow in the upper portion of the bedrock may resemble flow through a porous medium. Near vertical fractures that are open, pronounced changes in water level may be apparent.

Ecological Setting

Potential ecological habitat areas at the site consist primarily of open fields around office buildings, hangers, and runways. These developed areas, characterized by buildings, mowed lawns, and impermeable roads and parking lots, provide limited to low quality habitat. This habitat is not considered to be of ecological importance, because it is suitable habitat for only a few individuals of common wildlife species that are habituated to humans. Cayuga Creek provides some higher quality habitat, with riparian vegetation growing along the banks.

CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USE

Land use in the area surrounding NFARS is varied. The area to the north, east, and west of the installation is primarily rural/agricultural use with some commercial use properties, while the area to the south comprises commercial and industrial use properties. Given the past and current land use, the reasonably ascertainable future land use is industrial (for military/airfield use).

The population both on and off the installation primarily relies on public water supply provided by the Niagara County Water District. Drinking water for the city of Niagara Falls and the county of Niagara is obtained from the upstream west branch of the Niagara River. Surface water intakes are located slightly more than 8 miles to the south of NFARS and upstream of the Cayuga Creek entry to the Niagara River (ASL 2016).

There are no identified surface water intakes or downstream fisheries adjacent to the surface water migration path 15 miles downstream of NFARS. Cayuga Creek and its tributaries are not used for drinking or industrial water. Cayuga Creek is an impaired creek and is classified as a Class C stream, indicating that it has water quality suitable for noncontact activities such as recreation and fishing (ASL 2016). However, the New York State Department of Health's "Health Advice on Eating Sportfish and Game" (April 2018) specifically advises against eating any fish from Cayuga Creek due to impacts by dioxin.

The New York and New England Carbonate Rock Aquifer is a principal aquifer that underlies a considerable portion of the southern half of Niagara County. Three bedrock aquifers are contained within this principal aquifer. These include the Lockport aquifer occurring in the Lockport Dolomite formation; the Camillus aquifer occurring in the Camillus Shale and the Syracuse formations; and the limestone aquifer occurring in the Onondaga Limestone, Akron Dolomite, and the Bertie Limestone formations. All three bedrock aquifers yield small to moderate quantities of water and are not used for significant public withdrawals of water.

Groundwater use in the area of NFARS is both industrial and domestic in nature. According to the NYSDEC water well locator and the U.S. Geological Survey National Water Information System, there are no public water wells within 4 miles of this location, although several private wells exist. The SI identifies nine wells designated for commercial or domestic use within 4 miles downgradient of the installation to the south and southwest (ASL 2018), as presented in the table below.

Well Number	Use	Depth	Source	Location
NI1237	Commercial	Unknown	Provided by NYSDEC	North of Niagara River
NI1242	Commercial	200	NY Well Database and NYSDEC	North of Niagara River
NI1248	Domestic	200	NY Well Database and NYSDEC	North of Niagara River
NI1251	Domestic	200	NY Well Database and NYSDEC	North of Niagara River
NI1259	Commercial	Unknown	Provided by NYSDEC	North of Niagara River
NI1270	Commercial	Unknown	Provided by NYSDEC	North of Niagara River
E2770	Domestic	58	NY Well Database and NYSDEC	South of Niagara River
E3085	Domestic	68	NY Well Database and NYSDEC	South of Niagara River
E3139	Domestic	Unknown	Provided by NYSDEC	South of Niagara River

Wells NI1242, NI1248, and NI1251 are approximately 3.5 miles southwest and downgradient of the installation (ASL 2018). These wells are installed in bedrock to a depth of 200 ft bgs, are likely geologically isolated from the surficial aquifer due to their depth. Well NI1237 is a commercial well of an unknown depth installed near Well NI1242. Well NI1259 is a commercial-use well that is installed immediately adjacent to NI1251 (a domestic-use well). The depths of Wells NI1237 and NI1259 are unknown. The domestic-use well next to NI1259 indicates that this well is not used for potable water and the area of NI1237 is heavily industrialized, suggesting that it is also unlikely to be used for potable water. Although commercial-use well NI1270 is within 4 miles of the installation boundary, it is greater than 4 miles from any of the AFFF areas investigated during the SI. **Figure 10-4** provides the locations of these wells in relation to the NFARS boundary and the surrounding 4 mile radius.

Wells E2770, E3085, and E3139 are all located to the south of NFARS on Grand Island. All three are designated for domestic use. Their geographic location, on the south side of Niagara River, suggests that they are hydraulically isolated from any potential contamination at NFARS.

PREVIOUS INVESTIGATIONS

The following subsections present previous investigations that addressed PFAS in environmental media at NFARS.

2016 Preliminary Assessment (Aerostar SES LLC 2016)

The PA for PFAS, at NFARS was conducted in February 2016 by ASL under contract to the USACE Savannah District (ASL 2016). The objective of the PA was to identify locations at NFARS where PFAS may have been released to the environment and to conduct an initial assessment of possible migration pathways and receptors of potential contamination. The PA recommended eight locations that warranted an SI to determine the presence or absence of PFAS (**Table 10-1**):

- FT007/FPTA No. 3/Site 9
- Hangar 850
- Building 706
- Building 700 (Former Fire Station)
- Blue Angels Crash Site
- Fox Row/Taxiway Alpha
- Outfalls 004, 005, 007, and 009
- Hulby Street

Note that no AFFF release events have occurred at the specific locations of outfalls 004, 005, 007, and 009. These four outfalls provide stormwater drainage for all other suspected release events that have occurred at NFARS, including sites potentially impacted by AFFF.

2018 Site Inspection (Aerostar SES LLC 2018)

The subsequent SI was conducted in August 2017 by ASL, under contract to the USACE Savannah District. The eight locations recommended for SI in the PA were identified as AFFF Areas 1 through 8 as summarized in the table below and detailed in **Table 10-1.**

AFFF Area	PA Location
1	FT007/FPTA No. 3/Site 9
2	Hangar 850
3	Building 706
4	Building 700 (Former Fire Station)
5	Blue Angels Crash Site
6	Fox Row/Taxiway Alpha
7	Outfalls 004, 005, 007, and 009
8	Hulby Street

ASL conducted screening-level SIs at each AFFF area to determine the presence or absence of PFOA, PFOS, and PFBS in the environment at those areas. The objectives of the SIs were to:

- Determine if a confirmed release of PFOS, PFOA, or PFBS has occurred at the areas selected for inspection

- Determine if PFOS and PFOA are present in groundwater or surface water at the inspection areas at concentrations exceeding the EPA lifetime health advisory (HA) for drinking water at the time of the SI (70 ng/L for combined concentrations of PFOA and PFOS)

- Determine if PFBS is present in soil, sediment, groundwater, or surface water at the inspection areas at concentrations exceeding generic RSLs at the time of the SI

- Determine if PFOA and PFOS are present in soil or sediment at the inspection areas at concentrations exceeding screening levels at the time of the SI

- Identify potential receptor pathways with potential impacts to human health.

The SI activities included the following. Investigation of PFOS, PFOA, or PFBS into the shallow bedrock was outside the scope of the SI.

- Advancement of a total of 22 soil borings to depths ranging from 2 to 20 feet (ft) below ground surface (bgs) (top of Lockport Dolostone) using direct-push technology (DPT) methods. One surface soil and one subsurface soil sample was collected from each of the 22 borings.

- Installation of temporary wells at 21 soil boring locations, with wells screened in glacial deposits. Collection of groundwater samples from 19 of 21 temporary wells (2 temporary wells did not produce water) and 3 existing monitoring wells

- Collection of 7 sediment and co-located surface water samples

- Off-site laboratory analysis by Maxxam Analytics International Corporation of Mississauga, Ontario, Canada for 18 PFAS compounds (including PFBS, PFOA, and PFOS) using modified EPA Method 537.

- Comparison of PFBS, PFOA, and PFOS analytical results to screening levels

    - Soil, sediment, groundwater, and surface PFBS analytical results were compared to published EPA RSLs at the time of the SI (May 2018) (130,000 micrograms per kilogram [µg/kg] for soil and sediment, and 40,000 ng/L for groundwater and surface water)

    - PFOA and PFOS soil and sediment analytical results were compared to screening levels calculated using the EPA Regional Screening Level Calculator (126 µg/kg for both PFOA and PFOS).

    - Groundwater and surface water PFOA and PFOS analytical results were compared the EPA HA of 70 ng/L for the combined concentrations of PFOA and PFOS.

PFBS, PFOA, and/or PFOS concentrations in soil, groundwater, sediment, and/or surface water exceeded SI screening levels at each AFFF area (**Table 10-1**). Note that no AFFF release events have occurred at the specific locations of outfalls 004, 005, 007, and 009. These four outfalls provide stormwater drainage for all other suspected release events that have occurred at NFARS, including sites potentially impacted by AFFF.

2019 West End Electrical Project PFAS Sampling (EA 2020)

A supplemental investigation was conducted by EA in 2019 to evaluate PFAS concentrations in soil and groundwater that may be encountered within potential limits of excavations completed as part of the proposed West End Tactical Air Navigation System electrical feed repairs (West End Project). The West End Project was executed as part of the DoD's military construction (or MilCon) program. Project work was located in and adjacent to the current and former FTA at NFARS. The objective of this supplemental investigation was to gather data on existing site conditions as they relate to potential PFAS-impacted soil and groundwater to support soil excavation sequencing, handling, and backfilling requirements.

Supplemental investigation activities included the following. Groundwater was not encountered in soil borings during this event; therefore, groundwater sampling was not conducted.

- Advancement of a total of 17 soil borings to depths of 4 ft bgs (proposed depth of the conduit trench) using direct-push technology (DPT) methods. One surface soil sample immediately beneath vegetation and one subsurface soil sample at the proposed depth of excavation was collected from each of the 17 borings.

- Off-site laboratory analysis by GEL Laboratories, LLC located in Charleston, South Carolina for 19 PFAS compounds (including PFBS, PFOA, and PFOS) using modified EPA Method 537.

- Comparison of PFBS, PFOA, and PFOS analytical results to screening criteria developed by the EPA and the New York State Department of Environmental Conservation (NYSDEC) (1 µg/kg, equivalent to 1 part per billion) for PFOA and PFOS)

In surface soil samples, all 19 target analytes were detected at a concentration greater than the reporting limit (RL) in at least 1 sample. Concentrations of PFOS in surface soil samples exceeded 1 µg/kg in 16 of 17 samples and concentrations of PFOA in surface soil samples exceeded 1 µg/kg in 9 of 17 samples. The total concentrations of PFAS in surface soil ranged from 0.578 to 1,052 µg/kg and the greatest concentrations were observed in samples collected from SB-07, SB-09, SB-13, and SB-14, which are located in an area between the former and current FTA.

In subsurface soil samples, 15 analytes of the 19 target analytes were detected at a concentration greater than the RL in at least 1 sample. Concentrations of PFOS in subsurface soil samples exceeded 1 µg/kg in 10 of 17 samples and concentrations of PFOA in subsurface soil samples exceeded 1 µg/kg in 6 of 17 samples. The total concentrations of PFAS in subsurface soil ranged from 0.391 to 253.4 µg/kg and the greatest concentrations were observed in samples collected from SB-05, SB-09, SB-13, SB-14 and SB-15, which are adjacent to the current FTA.

PFAS SOURCE AREAS

PFAS source areas at NFARS include seven AFFF areas investigated during the SI (Aerostar SES LLC 2018):

- AFFF Area 1 (FT007/FPTA No. 3/Site 9)
- AFFF Area 2 (Hanger 850)
- AFFF Area 3 (Building 706)
- AFFF Area 4 (Building 700 [Former Fire Station])
- AFFF Area 5 (Blue Angels Crash Site)
- AFFF Area 6 (Fox Row/Taxiway Alpha)
- AFFF Area 8 (Hulby Street)

These source areas have been recommended for further investigation during the Phase I RI. For the purpose of this RI investigation, outfall locations investigated during the SI as AFFF Area 7 (Outfalls 004,005, 007, and 009) have been combined with suspected attributable release areas. Per the SI, PFAS exceedances in surface water at Outfall 007 are likely attributed to AFFF Area 1 (FT007/FPTA No. 3/Site 9) and possibly AFFF Area 5 (Blue Angels Crash Site); exceedances in surface water at Outfall 004 are likely attributed to AFFF Area 4 (Building 700 [Former Fire Station]); and exceedances in sediment at Outfall 009 is likely attributed to attributable to AFFF Area 4 (Building 700 [Former Fire Station]), AFFF Area 3 (Building 706), and/or AFFF Area 6 (Fox Row/Taxiway Alpha) releases.

Source areas and associated outfall locations being investigated under this RI have been designated as follows:

- Site FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
- Site SS850P: AFFF Area 2 Hanger 850
- Site SS706P: AFFF Area 3 Building 706
- Site SS700P: AFFF Area 4 Building 700, Outfall 4
- Site SS015P: AFFF Area 5 Blue Angels Crash Site
- Site SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
- Site SS316P: AFFF Area 8 Hulby Street

The following table presents a crosswalk of locations that were identified in the PA, investigated in the SI, and carried forward to the Phase I RI.

Locations Identified During 2016 PA Aerostar SES LLC)	2018 SI AFFF Areas (Aerostar SES LLC 2018)	RI Site ID and Name
FT007/Fire Protection Training Area (FPTA) No. 3/Site 9	AFFF Area 1	FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
Hangar 850	AFFF Area 2	SS850P: AFFF Area 2 Hanger 850
Building 706	AFFF Area 3	SS706P: AFFF Area 3 Building 706
Building 700 (Former Fire Station)	AFFF Area 4	SS707P: AFFF Area 4 Building 700, Outfall 4
Blue Angels Crash Site	AFFF Area 5	SS015P: AFFF Area 5 Blue Angels Crash Site
Fox Row/Taxiway Alpha	AFFF Area 6	SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9
Outfalls 004, 005, 007, and 009	AFFF Area 7	Not applicable. Outfalls have been combined with suspected attributable release areas.
Hulby Street	AFFF Area 8	SS316P: AFFF Area 8 Hulby Street

PREVIOUS INVESTIGATION RESULTS

In 2019, subsequent to the SIs, DoD adopted SLs for soil and groundwater, as described in a memorandum from the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 15 September 2021 (ASD 2021). The ASD SLs applied to three compounds: PFOS, PFOA, and PFBS. In May 2022, EPA added five additional compounds to the RSL and RML including PFOS, PFOA, HFPO-DA and its ammonium salt (also referred to as GenX chemicals), PFNA, and PFHxS. In July 2022, DoD issued a revised memorandum from the ASD clarifying technical guidance on the investigation of PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA (GenX) accounting for the May 2022 EPA screening levels (ASD 2022).

The most recent ASD calculated RSL values for PFOS, PFOA, PFBS, HFPO-DA, PFNA, and PFHxS will be used for evaluating detected constituents during implementation of this RI. The most recent ASD calculated RSL values are presented in the tables below.

ASD Calculated RSL Values

Analyte	Residential Scenario Screening Levels Calculated Using EPA RSL Calculator (HQ = 0.1)		Industrial/Commercial Composite Worker Screening Levels Calculated Using EPA RSL Calculator (HQ = 0.1)
	Soil (µg/kg)	Tapwater (ng/L)	Soil (µg/kg)
PFOS	13	4	160
PFOA	19	6	250
PFBS	1,900	601	25,000
PFNA	19	6	250
PFHxS	130	39	1,600
HFPO-DA	23	6	350

A re-screening of the 2018 SI and 2019 West End Electrical Project PFAS analytical data was conducted during preparation of this UFP-QAPP to identify PFOS, PFOA, PFBS, PFNA, and PFHxS compounds detected at concentrations above the most recent ASD calculated RSL values. HFPO-DA were not analyzed during these previous investigations. **Tables 10-2 to 10-8** present PFAS analytical results as compared to the most recent ASD calculated RSL values:

- Table 10-2: 2018 Site Inspection Surface Soil Analytical Results
- Table 10-3: 2018 Site Inspection Subsurface Soil Analytical Results
- Table 10-4: 2018 Site Inspection Groundwater Analytical Results
- Table 10-5: 2018 Site Inspection Surface Water Analytical Results
- Table 10-6: 2018 Site Inspection Sediment Analytical Results
- Table 10-7: 2019 West End Electrical Project PFAS Sampling Surface Soil Analytical Results
- Table 10-8: 2019 West End Electrical Project PFAS Sampling Subsurface Soil Analytical Results

A summary of the historical PFAS analytical results for each site being investigated during this Phase I RI is presented below.

FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7

Site FT007P includes a former FTA on the west side of NFARS, approximately 400 ft east of the current FTA and 770 ft north of the main runway, and Outfall 007 which serves as a location to monitor stormwater drainage for release events that have occurred at the former FTA.

The former FTA was active beginning in the early 1960s through the late 1990s. The former FTA has been inactive since 1997 and is currently maintained as part of the area around the main runway. The area is well vegetated and surrounded by open, well maintained, grassed areas.

The operational history of the former FTA includes the use of AFFF and dry chemicals to put out training fires ignited with JP-4 and other flammable liquids. The volume of AFFF used is unknown. Beginning in 1979, JP-4 was the only accelerant used to ignite training fires. Previously, unknown mixtures of combustibles were likely used. Training operations were conducted at the site between 20 and 30 times per year. The training area consisted of a large, oval pit with a low earthen berm that drains into an intermittent stream to the north of the pit (Portage, Inc. 2012). During its active-use period, the site did not have a functional containment system. There is no record of a retention pond for the collection of excess liquids.

The former FTA was investigated and monitored under the IRP. Soil sampling from previous investigations found metal contaminants within regional background ranges, with elevated nickel and vanadium levels. Groundwater sampling found similar results for metals, along with benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH). The BTEX and TPH constituents appeared to be migrating off-site, volatilizing or biodegrading between investigations (SAIC 1991). The extent of contamination for soil and groundwater was found to be generally limited (USAF 1994) and the site was ultimately recommended for No Further Action (E&E 1999).

2018 SI Investigation Activities

Three soil borings (NIGRA01-001 to NIGRA01-003) were advanced to refusal/top of the Lockport Dolostone in the vicinity of the former fire training pit during the 2018 SI. Depth to refusal ranged from 9.25 ft bgs at NIGRA01-001 to 10 ft bgs at NIGRA01-002 and NIGRA01-003. The water table interface during soil boring advancement was encountered at NIGRA01-001 at 8.15 ft bgs and at NIGRA01-002 at 8.8 ft bgs. Water was not encountered at NIGRA01-003. Temporary wells were installed at each boring location and screened in overburden (glacial deposits) at 3.8-8.8 ft bgs (NIGRA01-001), 4.2-9.2 ft bgs (NIGRA01-002), and 0-10 ft bgs (NIGRA01-003).

Surface soil samples were collected from 0-0.5 ft bgs, subsurface soil samples were collected from just above the water table interface, and groundwater samples were collected from each temporary well. Two co-located surface water and sediment samples were collected from the drainage canals surrounding the former fire training area. Surface water and sediment were also collected from Outfall 007. Sampling locations and results exceeding applicable ASD calculated RSL values are shown in **Figures 10-5 through 10-13**.

PFAS was detected in surface soil, groundwater, surface water, and sediment at the former FTA and in surface water and sediment at Outfall 007 as presented in **Tables 10-2 through 10-8** and summarized below.

2018 SI Surface Soil Results

15 of 18 target analytes, including PFOS, PFHxS, PFOA, PFNA, and PFBS, were detected in at least one SI surface soil sample collected from the former FTA at concentrations greater than RLs. Concentrations of PFOS exceeded both the ASD calculated residential soil RSL (13 µg/kg) and the ASD calculated industrial/commercial composite worker soil RSL (160 µg/kg) in each of the

three surface soil samples, with estimated concentrations ranging from 1,600 to 4,000 µg/kg. Additionally, concentrations of PFHxS and PFOA exceeded the ASD calculated residential soil RSLs of 130 µg/kg and 19 µg/kg at NIGRA01-001 (estimated concentrations of 410 and 62 µg/kg, respectively) and NIGRA01-002 (estimated concentrations of 250 and 39 µg/kg, respectively). PFNA exceeded the ASD calculated residential soil RSL of 19 µg/kg at NIGRA01-002 only (estimated concentration of 20 µg/kg). Concentrations of PFBS were below the ASD calculated residential soil RSL of 1,900 µg/kg.

2018 SI Subsurface Soil Results

PFOS was detected in two of the three subsurface soil samples collected from the former FTA, at concentrations greater than RLs: NIGRA01-002 (estimated 0.92 µg/kg) and NIGRA01-003 (estimated 0.37 µg/kg). Neither of these concentrations exceed the current ASD calculated residential soil RSL of 13 µg/kg. PFOS was not detected above RLs in NIGRA01-001.

2018 SI Groundwater Results

12 of 18 target analytes, including PFBS, PFHxS, PFOS, PFOA, and PFNA, were detected in SI groundwater samples at concentrations greater than the RLs in at least one groundwater sample collected from the former FTA. Concentrations exceeded the ASD calculated tapwater RSLs for PFBS (601 ng/L), PFHxS (39 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) at each of the three groundwater samples collected, with concentrations as follows:

- PFBS: 26,000 ng/L at NIGRA01-001, 30,000 ng/L at NIGRA01-002, and 31,000 ng/L at NIGRA01-003

- PFHxS: 870,000 ng/L at NIGRA01-001, 790,000 ng/L at NIGRA01-002, and 750,000 ng/L at NIGRA01-003

- PFOS: 910,000 ng/L at NIGRA01-001, 330,000 ng/L at NIGRA01-002, and 1,200,000 ng/L at NIGRA01-003

- PFOA: 110,000 ng/L at each sample location.

Additionally, concentrations of PFNA exceeded the ASD calculated tapwater RSL (6 ng/L) at NIGRA01-001 (estimated 7,700 ng/L) and NIGRA01-003 (14,000 ng/L).

2018 SI Surface Water Results

10 of 18 target analytes, including PFBS, PFHxS, PFNA, PFOS, and PFOA, were detected in at least one surface water sample collected from the former FTA at concentrations greater than the RLs. Estimated concentrations exceeded the ASD calculated tapwater RSLs for PFBS (601 ng/L), PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) in both surface water samples collected, with concentrations as follows:

- PFBS: estimated 740 ng/L at NIGRA01-004 and estimated 1,600 ng/L at NIGRA01-005

- PFHxS: estimated 8,700 ng/L at NIGRA01-004 and estimated 20,000 ng/L at NIGRA01-005

- PFNA: estimated 97 ng/L at NIGRA01-004 and estimated 370 ng/L at NIGRA01-005

- PFOS: estimated 7,200 ng/L at NIGRA01-004 and estimated 21,000 ng/L at NIGRA01-005

- PFOA: estimated 1,100 ng/L at NIGRA01-004 estimated 3,300 ng/L at NIGRA01-005

12 of 18 target analytes, including PFHxS, PFNA, PFOS, and PFOA, were detected in surface water collected from Outfall 007 at concentrations greater than the RLs. PFHxS, PFNA, PFOS, and PFOA concentrations exceeded ASD calculated tapwater RSLs, with concentrations at Outfall 007 as follows:

- PFHxS: estimated 1,500 ng/L
- PFNA: estimated 35 ng/L
- PFOS: estimated 2,800 ng/L
- PFOA: estimated 210 ng/L

The reported concentration of PFBS at Outfall 007 was below the ASD calculated tapwater RSL.

2018 SI Sediment Results

15 of 18 target analytes, including PFBS, PFOS, PFHxS, PFNA, and PFOA, were detected in at least one sediment sample collected from the former FTA at concentrations greater than the RLs. Concentrations of PFBS were below the ASD calculated residential soil RSL (1,900 µg/kg). Concentrations of PFOS exceeded both the ASD calculated residential soil RSL (13 µg/kg) and the ASD calculated industrial/commercial composite worker soil RSL (160 µg/kg) in both sediment samples, with estimated concentrations of 3,100 µg/kg at NIGRA01-004 (7,500 µg/kg in the duplicate sample collected at NIGRA01-004) and 1,200 µg/kg at NIGRA01-005. Additionally, concentrations at NIGRA01-004 exceeded the ASD calculated residential RSLs for PFHxS (130 µg/kg), PFNA (19 µg/kg), and PFOA (19 µg/kg) as follows:

- PFHxS: estimated 340 µg/kg in the parent sample and estimated 760 µg/kg in the duplicate sample collected at NIGRA01-004

- PFNA: estimated 20 µg/kg in the parent sample and estimated 69 µg/kg in the duplicate sample collected at NIGRA01-004

- PFOA: estimated 57 µg/kg in the parent sample and estimated 140 µg/kg in the duplicate sample collected at NIGRA01-004

While 3 of 18 target analytes, including PFHxS, PFOS, and PFOA, were detected in sediment from Outfall 007 at concentrations greater than the RLs, concentrations were below the ASD calculated residential soil RSLs.

2019 West End Electrical Project Surface Soil Results

PFOS concentrations in 2019 surface soil samples exceeded the ASD calculated residential soil RSL (13 µg/kg) and ASD calculated industrial/commercial composite worker soil RSL (160 µg/kg) at three locations in the vicinity of the former FTA, including SS07 west of the former FTA (938 µg/kg), SS13 south of the former FTA (163 µg/kg) and SS14 southwest of the former FTA (411 µg/kg). Additionally, PFOS was reported in surface soil at concentrations above the ASD calculated residential soil RSL at six additional locations surrounding the former FTA, including SS05 (26.6 µg/kg), SS09 (147 µg/kg), SS10 (estimated 69.4 µg/kg), SS11 (14.1 µg/kg), SS12 (29.5 µg/kg), and SS15 (25.5 µg/kg).

While PFBS, PFHxS, PFNA, and PFOA were reported in surface soil at multiple locations, concentrations were below ASD calculated residential soil RSLs.

2019 West End Electrical Project Subsurface Soil Results

PFOS concentrations in 2019 subsurface soil samples exceeded the ASD calculated residential soil RSL (13 µg/kg) at five locations in the vicinity of the former FTA, including SB03 (16 µg/kg), SB05 (61.3 µg/kg), SB09 (147 µg/kg), SB14 (42.9 µg/kg in the parent sample and 43.9 µg/kg in the duplicate sample), and SB15 (73 µg/kg). Additionally, PFOA was reported at a concentration above the ASD calculated residential soil RSL (19 µg/kg) at SB09 (20.5 µg/kg). While PFBS, PFHxS, and PFNA were reported in subsurface soil at multiple locations, concentrations were below ASD calculated residential soil RSLs.

SS850P: AFFF Area 2 Hanger 850

Hangar 850 is an aircraft maintenance hangar south of Wagner Drive with ramp access to Delta Row. Hangar 850 has an AFFF fire suppression system in a mechanical room on the northwest side of the building. The mechanical room contains one 2,500-gallon aboveground storage tank of 3% AFFF with a working capacity of 2,300 gallons.

Hangar 850 has had multiple releases of AFFF. The largest spill occurred in 2010 when a lightning strike short-circuited the fire suppression system control panels. The release was approximately 48,000 gallons of AFFF concentrate and water mixed. AFFF released during this event was mostly contained inside of the hangar, though a small amount was observed to have discharged into the sanitary and storm sewers. NFARS personnel responded to the release immediately and conducted a cleanup action resulting in the removal and proper disposal of residual AFFF. The NYSDEC concurred that the spill had been properly addressed.

According to NFARS spill records, several other smaller spills have occurred at Hangar 850. In 1995, approximately 10 gallons were released from the mechanical room door. In 1996, approximately 2,100 gallons of AFFF concentrate were released into the hangar due to system overpressure. NYSDEC was notified, and the spill was contained and removed with a vacuum truck. This spill was verified not to have entered the stormwater system. In 2013, during a water test of the firefighting system at Hangar 850, approximately 5,000 gallons of 0.5% AFFF were released. During this release, nearby storm drains were plugged, and the sluice gates were closed. The hangar doors were also closed with most of the material being removed via vacuum truck. Very little residual foam was noted on the apron south of the hangar. The releases discussed above create a total spill volume of approximately 2,135 gallons of AFFF concentrate.

Prior to the 2018 SI, no previous groundwater investigations had been conducted at Building 850. Directly east of Building 850 at IRP Site 12, a removal action was conducted in 2015 to remove chlorinated volatile organic compounds from the soil. Approximately 75 cubic yards of soil were removed from an 8.5-ft-deep excavation (Versar 2016).

2018 SI Investigation Activities

Four soil borings (NIGRA02-001 to NIGRA02-004) were advanced to refusal/top of the Lockport Dolostone around Hangar 850 during the 2018 SI. Depth to refusal was 20 ft bgs at each location. The water table interface during soil boring advancement was encountered at 12 ft bgs at NIGRA02-001 to 15 ft bgs at NIGRA02-002 and NIGRA02-003. Temporary wells were installed at each boring location and screened in overburden (glacial deposits at 8.9 to 18.9 ft bgs (NIGRA02-001), 9.3 to 19.3 ft bgs (NIGRA02-002), 9.7 to 19.7 ft bgs (NIGRA021-003), and 9.7 to 19.7 ft bgs (NIGRA02-004).

Surface soil samples were collected from 0-0.5 ft bgs, subsurface soil samples were collected from just above the water table interface, and groundwater samples were collected from each temporary well. One surface water sample and co-located sediment sample was collected from an unnamed tributary east of Hangar 850. Sampling locations and results exceeding applicable ASD calculated RSLs are shown in **Figure 10-7** and **Figures 10-9 through 10-13**.

PFAS was detected in surface soil, groundwater, and sediment at Hanger 850 as presented in **Tables 10-2 through 10-8** and are summarized below.

2018 SI Surface Soil Results

Each of the 18 target analytes, including PFOS, PFHxS, PFNA, PFOA, and PFBS, were detected in at least one surface soil sample collected from Hanger 850 at concentrations greater than the RLs. Concentrations of PFOS exceeded the ASD calculated residential soil RSL (13 µg/kg) at NIGRA02-002 (estimated 38 µg/kg) and NIGRA02-003 (estimated 70 µg/kg). While PFHxS, PFNA, and PFOA were detected at concentrations greater than the RL in each of the three surface soil samples collected from Hanger 850, and while PFBS was detected at concentrations greater than the RL at NIGRA02-002 and NIGRA02-003, concentrations were below ASD calculated residential soil RSLs.

2018 SI Subsurface Soil Results

PFAS were not detected in subsurface soil collected from Hanger 850 at concentrations greater than the RLs.

2018 SI Groundwater Results

10 of 18 target analytes, including PFOS, PFHxS, PFNA, PFOA, and PFBS, were detected in at least one groundwater sample collected from Hanger 850 at concentrations greater than the RLs. Concentrations of PFOS exceeded the ASD calculated tapwater RSL (4 ng/L) in each of the four groundwater samples collected, with concentrations ranging from an estimated 7.2 ng/L at NIGRA02-003 to 58 ng/L at NIGRA02-002. Additionally, concentrations of PFHxS and PFNA at NIGRA02-002 (120 ng/L and 36 ng/L) exceeded the ASD calculated tapwater RSLs of 39 ng/L and 6 ng/L, and the concentrations of PFOA at NIGRA02-002 (400 ng/L) and NIGRA02-003 (estimated 6.2 ng/L) exceeded the ASD calculated tapwater RSL of 6 ng/L. While PFBS was detected in groundwater from NIGRA02-002 (estimated 13 ng/L) and NIGRA02-003 (estimated 24 ng/L), concentrations were below the ASD calculated tapwater RSL of 601 ng/L.

2018 SI Surface Water Results

1 of 18 target analytes, perfluoropentanoic acid, was detected in the surface water sample collected from Hanger 850 at a concentration than the RL (NIGRA02-005, estimated concentration of 11 ng/L). There is no ASD calculated tapwater RSL for perfluoropentanoic acid.

2018 SI Sediment Results

2 of 18 target analytes, PFOS and perfluoroundecanoic acid, were detected in the sediment sample collected from Hanger 850 at concentrations greater than the RLs (NIGRA02-005). The PFOS concentration (estimated 1.1 μg/kg) was below the ASD calculated residential soil RSL of 13 μg/kg. Perfluoroundecanoic acid was detected at an estimated concentration of 0.27 μg/kg. There are no ASD calculated soil RSLs for perfluoroundecanoic acid.

Site SS706P: AFFF Area 3 Building 706

Building 706 is a former aircraft maintenance hangar that has been demolished and is now only a foundation (ASL 2016). According to the building plans, the mechanical room was on the western side of the building. No records were found regarding the size of the AFFF system. Most of the area surrounding former Building 706 is paved. The remaining footprint of the building is immediately east of Hangar 707 along Krug Avenue. Directly south of the building footprint is Fox Row.

According to Air Reserve Station spill records, only one release of AFFF occurred at former Building 706. In 1995, 216 gallons of AFFF concentrate mixed with approximately 798 gallons of water spilled onto the ramp west side of the building. The spill occurred due to the failure of personnel to pre-rinse a truck prior to an operational test (ASL 2016). No removal actions were taken at the time.

2018 SI Investigation Activities

Two soil borings (NIGRA03-001 and NIGRA03-002) were advanced to refusal/top of the Lockport Dolostone during the 2018 SI. Depth to refusal was 6 ft bgs at each location. The water table interface during soil boring advancement was encountered at 6 ft bgs at NIGRA03-001 to 4 ft bgs at NIGRA03-002. Temporary wells were installed at each boring location and screened in overburden (glacial deposits at 0.7-5.7 ft bgs).

Surface soil samples were collected from 0-0.5 ft bgs, surface water samples were collected from just above the water table interface, and groundwater samples were collected from each temporary well. Sampling locations and results exceeding applicable ASD calculated soil RSLs are shown in **Figure 10-7** and **Figures 10-9 through 10-13**. PFAS was detected in surface soil, subsurface soil, and groundwater at Building 706.

2018 SI Surface Soil Results

11 of 18 target analytes, including PFHxS, PFNA, PFOS, and PFOA, were detected in at least one surface soil sample collected from Building 706 at concentrations greater than the RLs. PFHxS, PFNA, PFOS, and PFOA concentrations reported in both surface soil samples collected from Building 706 were below ASD calculated residential soil RSLs. PFBS was not detected above the RL in either of the two surface soil samples collected.

2018 SI Subsurface Soil Results

3 of 18 target analytes, including PFOS and PFOA, were reported in at least one subsurface soil sample collected from Building 706 at sconcentration greater than the RLs. PFOS concentrations reported at NIGRA03-001 and NIGRA03-002, and PFOA reported at NIGRA03-002 were below the ASD calculated residential soil RSLs. PFBS, PFHxS, and PFNA were not detected above the RL in either of the two subsurface soil samples collected.

2018 SI Groundwater Results

9 of 18 target analytes, including PFOS, PFOA, PFHxS, and PFBS, were detected in at least one groundwater sample collected from Building 706 at concentrations greater than the RLs. Concentrations of PFOS exceeded the ASD calculated tapwater RSLs (4 ng/L) at NIGRA03-001 (29 ng/L) and NIGRA03-002 (estimated 140 ng/L), while concentrations of PFOA exceeded the ASD calculated tapwater RSLs (6 ng/L) at NIGRA03-001 (estimated 11 ng/L) and NIGRA03-002 (estimated 21 ng/L). Additionally, the concentration of PFHxS at NIGRA03-002 (estimated 160 ng/L) exceeded the ASD calculated tapwater RSL of 39 ng/L. Concentrations of PFHxS reported at NIGRA03-001 and PFBS reported at NIGRA03-002 and PFHxS at NIGRA03-001 were below ASD calculated tapwater RSLs. PFNA were not detected above the RL in either of the two groundwater samples collected.

SS700P: AFFF Area 4 Building 700, Outfall 4

SS700P includes building 700 is the former fire station that now houses the Air Reserve Station Explosive Ordnance Disposal and Bioenvironmental units, and Outfall 004 which serves as a location to monitor stormwater drainage for release events that have occurred at Building 700. Building 700 is north of Otis Drive and west of Franklin Drive. Use of the building as a fire station ended in 2005 and 2006. The building formerly contained a 1,000-gallon tank used for AFFF storage that is now housed at the current fire station (ASL 2016).

In 2007, a spill of 3 to 5 gallons of AFFF was documented at the south-side ramp area. Spray testing was also conducted in the grassy area to the south/southeast of the building. Records located by ASL were unclear as to the precise location; however, it was situated between the former fire station and FPTA 01. During interviews conducted for the PA, current fire chief and assistant fire chief did not have knowledge or records of the volume of AFFF released during each testing event at the undocumented spray test area.

2018 SI Investigation Activities

Three soil borings (NIGRA04-001 through NIGRA04-003) were advanced to refusal/top of the Lockport Dolostone during the 2018 SI. Depth to refusal was 7.82 ft bgs at NIGRA04-001, 4 ft bgs at NIGRA04-002, and 5.5 ft bgs at NIGRA04-003. The water table interface was not recorded on soil boring logs. Temporary wells were installed at each boring location and screened in overburden (glacial deposits at 2.7-7.8 ft bgs at NIGRA04-001, 1.2-3.7 ft bgs at NIGRA04-002, and 0.4-5.4 ft bgs at NIGRA04-003.

Surface soil samples were collected from 0-0.5 ft bgs, and surface water samples were collected from just above the water table interface. Groundwater samples were collected from NIGRA04-001 and NIGRA04-003 only. Groundwater was not sampled at well NIGRA04-002 as the well was dry. Co-located surface water and sediment samples were collected from Outfall 004. Sampling locations and results exceeding applicable ASD calculated RSLs are shown in **Figure 10-7** and **Figures 10-9 through 10-13**. PFAS was detected in surface soil, subsurface soil, and groundwater at Building 700 and in surface water and sediment at Outfall 004.

2018 SI Surface Soil Results

15 of 18 target analytes, including PFOS, PFHxS, PFOA, PFNA, and PFBS, were detected in at least one surface soil sample collected from Building 700 at concentrations greater than the RLs. Concentrations of PFOS exceeded both the ASD calculated residential soil RSL (13 µg/kg) and the ASD calculated industrial industrial/commercial composite worker soil RSL (160 µg/kg) in each of the three surface soil samples, with estimated concentrations ranging from 410 to an estimated 780 µg/kg. PFHxS and PFOA were reported in each surface soil sample at concentrations below the ASD calculated residential soil RSL. While PFNA was detected at NIGRA04-003 (estimated 0.78 µg/kg) and in the duplicate sample collected from NIGRA04-001 (2 µg/kg), and while PFBS was detected at NIGRA04-002 (1.5 µg/kg) and NIGRA04-003

(estimated 0.55 µg/kg), concentrations were below ASD calculated residential soil RSLs (19 µg/kg for PFNA and 1,900 µg/kg for PFBS).

2018 SI Subsurface Soil Results

12 of 18 target analytes, including PFOS, PFHxS, PFOA, PFNA, and PFBS, were reported in at least one subsurface soil collected from Building 700 at concentrations greater than the RLs. Concentrations of PFOS exceeded both the ASD calculated residential soil RSL (13 µg/kg) and the ASD calculated industrial industrial/commercial composite worker soil RSL (160 µg/kg) at NIGRA04-002 (230 µg/kg), while PFOS at NIGRA04-001 (estimated 50 µg/kg in the parent sample and estimated 89 µg/kg in the duplicate sample) exceeded the ASD calculated residential soil RSL only.

PFHxS and PFOA were detected in each subsurface soil sample at concentrations below the ASD calculated residential soil RSLs of 130 µg/kg and 19 µg/kg. Additionally, PFNA concentrations detected at NIGRA04-003 (estimated 0.35 µg/kg) and NIGRA04-001 (estimated 0.26 µg/kg in the parent sample and estimated 0.44 µg/kg in the duplicate), and PFBS concentrations detected at NIGRA04-003 (estimated 0.35 µg/kg) and in the duplicated collected from NIGRA04-001 (estimated 0.26 µg/kg), were below ASD calculated residential soil RSLs (19 µg/kg for PFNA and 1,900 µg/kg for PFBS).

2018 SI Groundwater Results

12 of 18 target analytes, including PFBS, PFHxS, PFNA, PFOS, and PFOA, were detected in at least one groundwater sample collected from Building 700 at concentrations greater than the RLs. Concentrations in each of the three groundwater samples collected exceeded the ASD calculated tapwater RSLs for PFBS (601 ng/L), PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L), with concentrations as follows:

- PFBS: 950 ng/L at NIGRA04-001, 940 ng/L at NIGRA04-002, and 650 µg/L at NIGRA04-003
- PFHxS: 7,300 ng/L at NIGRA04-001, 6,800 ng/L at NIGRA04-002, and 4,600 ng/L at NIGRA04-003
- PFNA: estimated 160 ng/L at NIGRA04-001, estimated 150 ng/L at NIGRA04-002, and 30 ng/L at NIGRA04-003
- PFOS: 22,000 ng/L at NIGRA04-001, 25,000 ng/L at NIGRA04-002, and 2,100 ng/L at NIGRA04-003
- PFOA: 1,100 ng/L at NIGRA04-001 and NIGRA04-002, and 470 ng/L at NIGRA04-003.

2018 SI Surface Water Results

12 of 18 target analytes, including PFHxS, PFNA, PFOS, PFOA, and PFBS, were detected in surface water collected from Outfall 004 at concentrations greater than the RLs. Estimated concentrations exceeded the ASD calculated tapwater RSLs for PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) with concentrations as follows:

- PFHxS: estimated 940 ng/L
- PFNA: estimated 19 ng/L
- PFOS: estimated 1,900 ng/L
- PFOA: estimated 160 ng/L

While PFBS was reported in surface water from Outfall 004 (estimated 80 ng/L), the concentration was below the ASD calculated tapwater RSL of 601 ng/L.

2018 SI Sediment Results

14 of 18 target analytes, including PFOS, PFHxS, PFNA, and PFOA, were detected in sediment collected from Outfall 004 at concentrations greater than the RLs. The reported concentration of PFOS (estimated 54 µg/kg) exceeded the ASD calculated residential soil RSL of 13 µg/kg. While PFHxS, PFNA, and PFOA were detected in sediment from Outfall 004 (estimated 4.1 µg/kg, estimated 0.51 µg/kg, and estimated 1 µg/kg, respectively), concentrations were below the ASD calculated tapwater RSLs (130 µg/kg for PFHxS, 19 µg/kg for PFNA, and 19 µg/kg for PFOA). PFBS was not detected in sediment at Outfall 004 at a concentration above the RL.

SS015P: AFFF Area 5 Blue Angels Crash Site

A fatal Blue Angels crash was a one-time incident involving a plane crash that resulted in a fire. The crash occurred on the airfield during the 1985 Western New York International Air Show and involved two A-4F Skyhawks that collided midair. One of the planes crashed outside of the perimeter fence on the eastern side of the Air Reserve Station after the pilot ejected; the other plane crashed in a grassy area just north of the main east/west runway (10L/28R) and south of Taxiway Alpha. During the emergency response, an unknown volume of AFFF was dispensed to extinguish the fire (ASL 2016).

2018 SI Investigation Activities

Three soil borings (NIGRA05-001 through NIGRA05-003) were advanced to refusal/top of the Lockport Dolostone during the 2018 SI. Depth to refusal was 7 ft bgs at NIGRA05-001, 3.65 ft bgs at NIGRA05-002, and 6.5 ft bgs at NIGRA05-003. The water table interface was encountered at depths of 2.5 ft bgs at NIGRA05-002 to 5.5 ft bgs at NIGRA05-003. Temporary wells were installed at each boring location and screened in overburden (glacial deposits at 2-7 ft bgs at NIGRA05-001, 1.15-3.65 ft bgs at NIGRA05-002, and 1.4-6.4 ft bgs at NIGRA05-003.

Surface soil samples were collected from 0-0.5 ft bgs, and surface water samples were collected from just above the water table interface. Groundwater samples were collected at NIGRA05-001 and NIGRA05-003. Temporary well NIGRA05-002 was dry throughout the sampling effort. Sampling locations and results exceeding applicable ASD calculated RSLs are shown in **Figure 10-7** and **Figures 10-10 through 10-13**. PFAS was detected in surface soil and subsurface soil at NIGRA05-001 and in groundwater at both NIGRA05-001 and NIGRA05-003.

2018 SI Surface Soil Results

9 the 18 target analytes, including PFOS, PFBS, PFHxS, PFNA, and PFOA, were detected in surface soil collected from NIGRA05-001at concentrations greater than the RLs. The concentration of PFOS at NIGRA05-001 (180 µg/kg) exceeded both the ASD calculated residential soil RSL (13 µg/kg) and the ASD calculated industrial industrial/commercial composite worker soil RSL (160 µg/kg). While PFBS, PFHxS, PFNA, and PFOA were detected at concentrations greater than the MDLs, concentrations were below ASD calculated residential soil RSLs (1,900 µg/kg for PFBS, 130 µg/kg for PFHxS, 19 µg/kg for PFNA, and 19 µg/kg for PFOA).

PFHxS was the only target analyte detected in surface soil at NIGRA05-003, with the estimated concentration of 0.92 µg/kg reported below the ASD calculated residential soil RSL (1,600 µg/kg). PFAS was not detected in surface soil at NIGRA05-002.

2018 SI Subsurface Soil Results

9 of 18 target analytes, including PFBS, PFHxS, PFOS, and PFOA, were detected in subsurface soil collected from NIGRA05-001 at concentrations greater than the RLs. PFBS, PFHxS, PFOS, and PFOA concentrations were below ASD calculated residential soil RSLs (1,900 µg/kg for PFBS, 130 µg/kg for PFHxS, 13 µg/kg for PFOS, and 19 µg/kg for PFOA). PFAS was not detected in surface soil at NIGRA05-002 or NIGRA05-003.

2018 SI Groundwater Results

9 of 18 target analytes, including PFHxS, PFNA, PFOS, and PFOA, were detected in at least one groundwater sample collected from the Blue Angels Crash Site at concentrations greater than the RLs. Concentrations at NIGRA05-001 exceeded the ASD calculated tapwater RSLs for PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) as follows:

- PFHxS: 2,200 ng/L PFNA: 40 ng/L PFOS: estimated 1,000 ng/L PFOA: 170 ng/L

Additionally, the concentration of PFOS at NIGRA05-003 (estimated 25 ng/L) exceeded the ASD calculated tapwater RSL. While PFHxS was detected above the RL at NIGRA05-003 (estimated 20 ng/L), the concentration was below the ASD calculated tapwater RSL (39 ng/L).

SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9

The Fox Row/Taxiway Alpha area is a heavily used paved area for both vehicles and aircraft. Outfalls 005 and 009 provide locations to monitor stormwater drainage for all release events that have occurred at the Fox Row/Taxiway Alpha area.

Several AFFF releases occurred in the Fox Row/Taxiway Alpha area. During an exercise in May 2010, a fire truck departed from Fox Row and accidentally released AFFF from an open valve. Spill records show that approximately 25 gallons of concentrate were released. Although the spill response team tried to hold water back from the stormwater system by closing the sluice gate, water foamed as it was slowly released to the outfalls (ASL 2016). Other AFFF releases have occurred from Hangar 850, Building 706, and other buildings that border this area.

2018 SI Investigation Activities

Four soil borings (NIGRA06-001 through NIGRA06-004) were advanced to refusal/top of the Lockport Dolostone during the 2018 SI. Depth to refusal was 20 ft bgs at NIGRA06-001, 12.5 ft bgs at NIGRA06-002, 9 ft bgs at NIGRA06-003, and 2 ft bgs at NIGRA06-004. The water table interface was encountered at depths of 2 ft bgs at NIGRA06-001 to 12.5 ft bgs at NIGRA06-002. Temporary wells were installed at three borings NIGRA06-001, NIGRA06-002, and NIGRA06-003 and screened in overburden glacial deposits (9.9-19.9 ft bgs at NIGRA06-001, 2-8.5 ft bgs at NIGRA06-002, and 2.5-9 ft bgs at NIGRA06-003). A temporary well was not installed at boring NIGRA06-004.

Surface soil samples were collected from 0-0.5 ft bgs, and surface water samples were collected from just above the water table interface. Groundwater samples were collected from three temporary wells (NIGRA06-001, NIGRA06-002, and NIGRA06-003), one previously existing overburden well (MW7-2, screened from 4 to 7 ft bgs), and two previously existing bedrock wells (MW7-1D, screened from 9.1 to 11.6 ft bgs and MW-3D, screened from 11.1 to 16.1 ft bgs). Note that bedrock groundwater was not collected at any of the other AFFF areas investigated during the SI.

Co-located surface water and sediment samples were collected at Outfalls 005 and 009. Sampling locations and results exceeding applicable ASD calculated RSLs are shown in **Figure 10-7** and **Figures 10-9 through 10-13**. PFAS was detected in surface soil at each soil boring location, in subsurface soil at NIGRA06-004 only, in groundwater at 5 of 6 sampling locations (MW7-1D, MW7-2, MW7-3D, NIGRA06-002, and NIGRA06-003), and in surface water and sediment at Outfalls 005 and 009.

2018 SI Surface Soil Results

11 of 18 target analytes, including PFOS, PFHxS, PFNA, and PFOA, were detected in at least one surface soil sample collected from Fox Row/Taxiway Alpha at concentrations greater than the RLs. Concentrations of PFOS exceeded the ASD calculated residential soil RSL (13 µg/kg) at NIGRA06-001 (17 µg/kg in the parent sample and 33 µg/kg in the duplicate sample), NIGRA06-

002 (33 µg/kg), and NIGRA06-004 (53 µg/kg). PFHxS, PFNA, and PFOA concentrations detected in surface soil at each of the 4 sample locations were below ASD calculated residential soil RSLs (130 µg/kg for PFHxS, 19 µg/kg for PFNA, and 19 µg/kg for PFOA).

2018 SI Subsurface Soil Results

PFAS was not detected in subsurface soil collected from NIGRA06-001, NIGRA06-002, or NIGRA06-003.

7 of 18 target analytes, including PFHxS, PFNA, PFOS, and PFOA, were detected in subsurface soil collected from NIGRA06-004 at concentrations greater than the RLs. However, concentrations were below ASD calculated residential soil RSLs (130 µg/kg for PFHxS, 19 µg/kg for PFNA, 13 µg/kg for PFOS, and 19 µg/kg for PFOA).

2018 SI Overburden Groundwater Results

10 of 18 target analytes, including PFBS, PFHxS, PFNA, PFOS, and PFOA, were detected in at least one overburden groundwater sample collected from Fox Row/Taxiway Alpha at concentrations greater than the RLs.

Concentrations at overburden well MW7-2 exceeded the ASD calculated tapwater RSLs for PFBS (601 ng/L), PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) as follows:

- PFBS: estimated 1,400 ng/L
- PFHxS: estimated 28,000 ng/L
- PFNA: estimated 720 ng/L
- PFOS: estimated 45,000 ng/L
- PFOA: estimated 3 µg/L

Additionally, concentrations of PFOS at NIGRA06-002 (estimated 10 ng/L) and NIGRA06-003 (estimated 61 ng/L), PFHxS at NIGRA06-003 (estimated 46 ng/L), and PFOA at NIGRA06-003 (estimated 6.1 ng/L) exceeded ASD calculated tapwater RSLs.

While PFBS, PFHxS, and PFOA were detected in groundwater collected from NIGRA06-002, and while PFBS was detected in groundwater collected from NIGRA06-003, concentrations were below ASD calculated tapwater RSLs. Additionally, while PFHxS was detected in the duplicate sample collected from NIGRA06-001, the concentration was below the ASD calculated tapwater RSL. PFAS was not detected in the parent sample collected from NIGRA06-001.

2018 SI Bedrock Groundwater Results

11 of 18 target analytes, including PFBS, PFHxS, PFNA, PFOS, and PFOA, were detected in at least one bedrock groundwater sample collected from Fox Row/Taxiway Alpha at concentrations greater than the RLs.

Concentrations at bedrock well MW7-1D exceeded the ASD calculated tapwater RSLs for PFBS (601 ng/L), PFHxS (39 ng/L), PFNA (6 ng/L), PFOS (4 ng/L), and PFOA (6 ng/L) as follows:

- PFBS: estimated 3,400 ng/L
- PFHxS: estimated 69,000 ng/L
- PFNA: estimated 860 ng/L
- PFOS: estimated 49,000 ng/L
- PFOA: estimated 5,000 ng/L

Additionally, PFAS concentrations at bedrock well MW7-3D exceeded the ASD calculated tapwater RSLs, including PFHxS (83 ng/L), PFOS (81 ng/L), and PFOA (estimated 8.8 ng/L).

While PFBS was detected in groundwater collected from bedrock well MW7-3D, the concentration was below the ASD calculated tapwater RSL.

2018 SI Surface Water Results

6 of 18 target analytes, including PFOS, PFOA, and PFHxS, were detected in surface water collected from Outfall 005 at concentrations greater than the RLs. Concentrations exceeded the ASD calculated tapwater RSLs for PFOS (4 ng/L) and PFOA (6 ng/L), with concentrations of 12 ng/L and 7.5 ng/L, respectively. While PFHxS was detected in surface water from Outfall 005, the concentration was were below the ASD calculated tapwater RSL.

Additionally, 8 of 18 target analytes, including PFOS, PFOA, PFHxS, and PFBS, were detected in surface water collected from Outfall 009 at concentrations than the RLs. PFAS concentrations exceeded the ASD calculated tapwater RSLs for PFOS (4 ng/L), PFOA (6 ng/L), and PFHxS (39 ng/L), with concentrations as follows:

- PFHxS: estimated 40 ng/L
- PFOS: estimated 49 ng/L
- PFOA: estimated 13 ng/L

While PFBS was detected in surface water from Outfall 009, the concentration was below the ASD calculated tapwater RSL (1,900 µg/kg).

2018 SI Sediment Results

4 of 18 target analytes, including PFHxS, PFOS, and PFOA, were detected in sediment collected from Outfall 005 at concentrations greater than the RLs. However, detected concentrations of PFHxS, PFOS, and PFOA were below ASD calculated residential soil RSLs (1,900 µg/kg for PFHxS, 13 µg/kg for PFOS, and 19 µg/kg for PFOA). PFBS and PFNA were not detected in sediment from Outfall 005.

12 of 18 target analytes, including PFOS, PFHxS, PFNA, and PFOA, were detected in sediment collected from Outfall 009 at concentrations greater than the RLs. PFOS detected in sediment at

Outfall 009 (estimated 160 µg/kg) exceeded the ASD calculated residential soil RSL (13 µg/kg) and met the ASD calculated industrial/commercial composite worker soil RSL (160 µg/kg). While PFHxS, PFNA, and PFOA were also detected in sediment from Outfall 009, concentrations were below ASD calculated residential soil RSLs (1,900 µg/kg for PFHxS, 19 µg/kg for PFNA, and 19 µg/kg for PFOA).

SS316P: AFFF Area 8 Hulby Street

In 1987, a 4-gallon spill of AFFF was reported to have occurred on the southern side of the street across from Building 316, the Emergency Management Building. There is an open field directly across from the building that has historically been used for emergency training exercises. In the spill report for the event, it was reported that burn pans were dumped on the side of the road and that an exercise was being conducted. No removal action was conducted for this spill (ASL 2016). The field is currently unoccupied.

2018 SI Investigation Activities

Three soil borings (NIGRA08-001 through NIGRA08-003) were advanced to refusal/top of the Lockport Dolostone during the 2018 SI. Depth to refusal was 10 ft bgs at NIGRA08-001 and NIGRA08-002, and 11 ft bgs at NIGRA08-003. The water table interface was encountered at a depth of 9 ft bgs. Temporary wells were installed at each of the three borings and screened in overburden glacial deposits (4.7-9.7 ft bgs at NIGRA08-001, 5-10 ft bgs at NIGRA08-002, and 5.8-10.8 ft bgs at NIGRA08-003).

Surface soil samples were collected from 0-0.5 ft bgs, and surface water samples were collected from just above the water table interface. Groundwater samples were collected from each of the three temporary wells. Sampling locations and results exceeding applicable ASD calculated RSLs are shown in **Figure 10-7** and **Figures 10-9 through 10-13**. PFAS was detected in surface soil and subsurface soil at each boring location, and in groundwater at NIGRA08-001 and NIGRA08-002.

2018 SI Surface Soil Results

7 the 18 target analytes, including PFHxS, PFNA, PFOS, and/or PFOA, were detected in at least one surface soil sample collected from Hulby Street at concentrations greater than the RLs. However, estimated concentrations of PFHxS, PFNA, PFOS, and/or PFOA in each surface soil sample collected from Hulby Street were below ASD calculated residential soil RSLs (1,900 µg/kg for PFHxS, 19 µg/kg for PFNA, 13 µg/kg for PFOS, and 19 µg/kg for PFOA).

2018 SI Subsurface Soil Results

1 the 18 target analytes, PFOS, was detected in each subsurface soil sample collected from Hulby Street at a concentration greater than the RL. However, the PFOS concentrations were below the ASD calculated residential soil RSL (13 µg/kg).

2018 SI Groundwater Results

7 of 18 target analytes, including PFOS, PFOA, PFHxS, and PFBS were detected in at least one groundwater sample collected from Hulby Street at concentrations greater than the RLs. Concentrations of PFOS at NIGRA08-001 (estimated 15 ng/L) and NIGRA08-002 (100 ng/L) exceeded the ASD calculated tapwater RSL of 4 ng/L, while the concentration of PFOA at NIGRA08-001 (7.7 ng/L) exceeded the ASD calculated tapwater RSL of 6 ng/L.

While estimated concentrations of PFHxS were reported at NIGRA08-001 and NIGRA08-002, and while PFBS was reported at NIGRA08-001, concentrations were below the ASD calculated tapwater RSLs (39 ng/L for PFHxS and 601 ng/L for PFBS). PFNA was not detected above the RL in groundwater at NIGRA08-003.

PFAS CONTAMINANTS OF POTENTIAL CONCERN

PFAS Contaminants of Potential Concern (COPCs) for this RI are those PFAS compounds that were reported at concentrations above ASD calculated RSLs during previous investigations. COPCs in each media at each site are as follows:

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
  - Surface Soil: PFHxS, PFNA, PFOS, PFOA
  - Subsurface Soil: PFOS
  - Groundwater: PFBS, PFHxS, PFNA, PFOS, PFOA
  - Surface Water: PFBS, PFHxS, PFNA, PFOS, PFOA
  - Sediment: PFHxS, PFNA, PFOS, PFOA

- SS850P: AFFF Area 2 Hanger 850
  - Surface Soil: PFOS
  - Subsurface Soil: None
  - Groundwater: PFHxS, PFNA, PFOS, PFOA
  - Surface Water: None
  - Sediment: None

- SS706P: AFFF Area 3 Building 706
  - Surface Soil: None
  - Subsurface Soil: None
  - Groundwater: PFHxS, PFOS, PFOA
  - Surface Water: Not applicable (no hydrologic features present)
  - Sediment: Not applicable (no hydrologic features present)

- SS700P: AFFF Area 4 Building 700, Outfall 4
  - Surface Soil: PFOS
  - Subsurface Soil: PFOS
  - Groundwater: PFBS, PFHxS, PFNA, PFOS, PFOA

  - Surface Water: PFHxS, PFNA, PFOS, PFOA
  - Sediment: PFOS

- SS015P: AFFF Area 5 Blue Angels Crash Site
  - Surface Soil: PFOS
  - Subsurface Soil: None
  - Groundwater: PFHxS, PFNA, PFOS, PFOA
  - Surface Water: Not applicable (not sampled)
  - Sediment: Not applicable (not sampled)

- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
  - Surface Soil: PFOS
  - Subsurface Soil: None
  - Groundwater: PFBS, PFHxS, PFNA, PFOS, PFOA
  - Surface Water: PFHxS, PFOS, PFOA
  - Sediment: PFOS

- SS316P: AFFF Area 8 Hulby Street
  - Surface Soil: None
  - Subsurface Soil: None
  - Groundwater: PFOS, PFOA
  - Surface Water: Not applicable (not sampled)
  - Sediment: Not applicable (not sampled)

PFAS-SPECIFIC FATE AND TRANSPORT CONSIDERATIONS

PFAS have a high solubility and are thus mobile; however, they are retarded by sorption on organic carbon due to hydrophobic effects. Distribution coefficients (K_d) can be estimated by employing the organic carbon partition coefficient (K_{oc}) multiplied by the fraction of organic carbon (f_{oc}). For points of reference, Log K_{oc} of 2.06 and 2.57 have been measured for PFOA and PFOS, respectively. This places PFOA and PFOS at similar levels of retardation as many chlorinated solvents (e.g., trichloroethylene). The retardation factor for a given solute can be determined from K_d and soil physical properties. Generally, longer chain PFAS (e.g., PFOS and PFOA) will sorb (due to hydrophobic effects) and be more strongly retarded than shorter chain compounds (e.g., PFBS).

Some PFAS are cationic (positively charged) or zwitterionic (mixed charges), influencing their fate and transport in the environment through electrostatic interactions with mineral matter. Cationic and zwitterionic PFAS tend to be less mobile in quartz-dominated media than anionic perfluoroalkyl acids (PFAAs) and so they can potentially be retained longer in source zones.

PFAS are not particularly volatile, though certain ionic species of PFAS (e.g., ionized PFOA and not the salt) can have Henry's constants that illustrate a particular affinity to air interfaces.

Finally, and of primary significance to the transport and transformation of PFAS, compounds including PFOS and PFOA can be generated over time in the subsurface by abiotic and biological transformation of precursors via oxidation processes. Commonly, precursors, such as fluorotelomers and other polyfluorinated precursors will, with time and distance of migration, abiotically and/or biologically transform to become PFAAs, like PFOA and PFOS, that act as persistent "dead end" daughter products. PFAAs have not generally illustrated a tendency to be biodegraded. This general recalcitrance to degradation and high degree of mobility often leads to long PFAA plumes.

NFARS-SPECIFIC MIGRATION PATHWAYS

Surface water and groundwater migration routes at and in the vicinity of NFARS are largely regulated by flow pathways (and barriers to flow) associated with facility infrastructure and subsurface geology. Where infiltration is limited by impervious surfaces, surface water runoff follows the drainage and stormwater management infrastructure, with discharge to Cayuga Creek. Migration pathway considerations for NFARS are as follows. Specific considerations for each site being investigated under this Phase I RI are presented in the subsections below.

- Surface water primarily flows through a system of drainage ditches and underground storm drains, which all discharge into Cayuga Creek, the only major surface water body on the base. Cayuga Creek enters at the northeastern installation boundary and flows along the eastern and southern boundaries before exiting the installation and eventually discharging to Little River, a tributary to Niagara River.

- The soils throughout NFARS are moderately drained, have slow permeability in the subsoil, and have a seasonally high water table of 6 to 12 inches below surface. Soils are saturated, ponded, or flooded long enough during the growing season to develop anaerobic conditions (HDR Environmental, Operations and Construction, Inc. [HDR EOC], 2012).

- Overburden is primarily comprised of reworked topsoil/fill, lacustrine deposits, and glacial till ranging from 3-18 ft in depth. The fine-grained nature of the unconsolidated till and lacustrine deposits results in low hydraulic conductivities, which leads to high surface runoff and low infiltration rates. Groundwater velocities in overburden are slow due to low permeability. Water movement in overburden is restricted except in areas with sand lenses and dehydration cracking. Glaciolacustrine or till layers may locally perch groundwater or act as a confining layer.

- Bedrock below the thin overburden is comprised of fine- to coarse-grained and massive- to thinly-bedded dolostone (Lockport). No confining unit is present between the overburden and shallow bedrock, resulting in a direct hydraulic connection.

- Groundwater flow in bedrock is within secondary porosity features (i.e., along horizontal bedding planes, vertical fractures, and joints), particularly in the upper 5–15 ft where these openings may be weathered and/or expanded by dissolution. Bedrock hydraulic conductivity is dependent on spacing of fractures and size of fracture openings.

- Regional groundwater flow is to the south/southwest. Shallow groundwater flows toward nearby streams and drainages, which may be to the east, southeast south, or southwest. Groundwater movement may also be locally influenced by anthropogenic features, such as pumping wells, sumps, building foundations, sewer lines, etc.

- The majority of historical groundwater contamination for various contaminants at NFARS has been found and addressed in fractured shallow bedrock.

FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7

Surface water at the former FTA flows into a surficial drainage feature that surrounds the site. Historically, flow from this feature flowed west through what is now the current FTA. Currently it flows south of the current FTA into a canal that flows south to Cayuga Creek through Outfall 007.

Surface soil and shallow overburden at the former FTA consists of gravelly sandy lean clay to a depth of 2 ft bgs. Subsurface soil consists of high plasticity clay from 2 to 3.5 ft bgs, sandy lean clay of medium plasticity to approximately 7 ft bgs, high plasticity clay to approximately 8.15 to 8.8 ft bgs, and lean clay of medium plasticity with trace sand and gravel over bedrock. Coarser-grained sandy lean clay provides a preferential pathway for groundwater and contaminant flow. Based on water levels in temporary wells gauged on 22 August 2017, localized shallow groundwater flows south, consistent with historical groundwater flow, with likely discharge to Cayuga Creek.

SS850P: AFFF Area 2 Hanger 850

Hangar 850 is approximately 1,500 ft to the north of Cayuga Creek with the aircraft apron between. Contaminants released from Hangar 850 onto the apron will drain to the south and west reaching either Cayuga Creek or the stormwater system east of the apron. An unnamed tributary on the eastern side of Hangar 850 empties into the middle reach of Cayuga Creek.

Surface soil and shallow overburden at Hangar 850 consists of gravelly sandy lean clay to a depth of 1 ft bgs. Subsurface soil consists of high plasticity clay. A zone of sandy clay of medium plasticity was observed at NIGRA02-001 at depths of 5-6 ft, while zones of non-plastic gravelly sandy clay were observed at NIGRA02-001 at 12-18.5 ft bgs and NIGRA02-002 at 15-20 ft bgs. These coarser-grained deposits provide preferential pathways for groundwater and contaminant flow. Based on water levels in temporary wells gauged on 22 August 2017, groundwater in the uppermost water-bearing zone in Hangar 850 flows to the east/southeast toward the open unnamed tributary that discharges into Cayuga Creek.

SS706P: AFFF Area 3 Building 706

The majority of the area surrounding Building 706 is and has been paved. Surface water flows into surrounding drainage features or onto the aircraft apron. Once on the apron, surface water flows into grassed areas to the west and south.

Based on boring logs from the SI (ASL 2018), surface soil and shallow overburden at the site consists of sandy lean clay to a depth of 1 ft bgs. Subsurface soil at NIGRA03-001 consists of low plasticity clay to 6 ft bgs. Coarser-grained subsurface deposits were noted at NIGRA03-002, with sandy lean clay from 1 to 4 ft bgs, gravelly lean clay from 4 to 5 ft bgs, and gravel from 5 to 6 ft bgs. These coarser-grained deposits provide preferential pathways for groundwater and contaminant flow. Based on water levels from the temporary wells gauged on 22 August 2017, groundwater in the uppermost water-bearing zone flows south.

SS707P: AFFF Area 4 Building 700, Outfall 4

Surface water from Building 700 will flow preferentially towards the south off of the paved area. The topography in the area directs all surface water towards the Cayuga Creek. Outfall 004 provides a location to monitor stormwater drainage for all release events that have occurred at Building 700. Based on boring logs from the SI, surface soil consists of gravelly sandy lean clay to a depth of 0.5 ft bgs. Subsurface soil consists primarily of gravelly or sandy clay to gravelly sand. A lens of lean clay was noted at NIGRA04-002 from 1-2 ft bgs overlying gravelly sand with clay. Coarser-grained deposits would provide preferential pathways for groundwater and contaminant flow. Based on water levels from the temporary wells gauged on 22 August 2017, shallow groundwater flows south.

SS015P: AFFF Area 5 Blue Angels Crash Site

The Blue Angels Crash Site is well vegetated and in close proximity to an active runway. Surface drainage originating from the majority of NFARS flows preferentially towards the Cayuga Creek that bisects the facility. A southern bend in the Cayuga Creek occurs immediately east of the crash site, making it likely that AFFF reached the creek shortly after application to the crash site.

Based on boring logs from the SI, surface and shallow subsurface soil at NIGRA05-001 consists of lean clay to a depth of 5 ft bgs. Gravelly lean clay was encountered over bedrock at 5-7 ft bgs. Surface and surface and shallow subsurface soil at NIGRA05-002 and NIGRA05-003 consists of high plasticity clay to refusal/top of bedrock. Coarser gravelly lean clay observed at NIGRA05-001 would provide a preferential pathway for groundwater and contaminant flow. One of three temporary wells was dry so a localized groundwater flow direction could not be determined due to a lack of data. Groundwater elevations calculated from surrounding areas indicated that the groundwater flow is to the south-southwest.

SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9

Cayuga Creek parallels Fox Row/Taxiway Alpha and at its closest is only approximately 250 ft from the edge of the paved surface. The paved surface drains to the south and directs all surface water from the paved areas to Cayuga Creek.

Based on boring logs from the SI, surface and shallow subsurface soil consists of high plasticity clay. Coarser-grained subsurface deposits were noted over bedrock, with gravelly sandy lean clay at NIGRA06-001 at 15-20 ft bgs and NIGRA06-002 at 15-18.68 ft bgs, and gravelly lean clay was at NIGRA06-003 at 7-9 ft bgs. These coarser-grained deposits provide preferential pathways for groundwater and contaminant flow. Based on water levels gauged on 22 August 2017, groundwater flow is to the south.

SS316P: AFFF Area 8 Hulby Street

AFFF Area 8: Hulby Street is a well-vegetated open field that was previously used for training activities. The spill area was likely unpaved at the time of AFFF release and would have allowed AFFF to infiltrate into the subsurface. Several roads are in the area of the spill; though, without a definitive location, it cannot be confirmed that the release entered the stormwater system. The volume of the release makes it unlikely that it reached the Cayuga Creek.

Based on boring logs from the SI, surface soil consists of high plasticity clay at NIGRA08-001 and sandy lean clay at NIGRA08-002 and NIGRA08-003. Subsurface soil consists of high plasticity clay and lean clay, with gravelly lean clay over bedrock at each location (8-10 ft bgs at NIGRA08-001, 7-10 ft bgs at NIGRA08-001, and 9-11 ft bgs at NIGRA08-001). These coarser-grained deposits provide preferential pathways for groundwater and contaminant flow. Based on water levels gauged on 22 August 2017, groundwater flow is to the south, with discharge to Cayuga Creek.

Table 10-1. PA Locations and SI AFFF Areas

AFFF Area	Location	Description	Highest Detection in Soil (µg/kg)	Depth to Water (ft bgs)	Highest Detection in Groundwater (ng/L)	Highest Detection in Sediment (µg/kg)	Highest Detection in Surface Water (ng/L)
AFFF Area 1	FT007/FPTA No. 3/Site 9	• AFFF has been used at FT007/FPTA No. 3/Site 9 during fire training activities.	PFBS: 6.4 J PFOA: 62 J PFOS: 4,000 J	2.71-3.44	PFBS: 31,000 PFOA: 110,000 PFOS: 1,200,000 PFOA+PFOS: 1,310,000	PFBS: 11 J PFOA: 140 J PFOS: 7,500 J	PFBS: 1,600 J PFOA: 3,300 J PFOS: 21,000 J PFOA+PFOS:24,300 J
AFFF Area 2	Hangar 850	• This building is currently equipped with an AFFF system and has had several recorded AFFF releases. The largest spill occurred in 2010 when a lightning strike overpowered the fire suppression system control panels. The release was approximately 48,000 gallons of AFFF concentrate and water mixed. • In 1995, approximately 10 gallons were released from the mechanical room door. • In 1996, approximately 2,100 gallons of AFFF concentrate were released into the hangar due to system overpressure. NYSDEC was notified, and the spill was contained and removed with a vacuum truck. • In 2013, during a water test of the firefighting system at Hangar 850, approximately 5,000 gallons of 0.5% AFFF were released.	PFBS: 0.25 J PFOA: 8.8 J PFOS: 70 J	3.40-12.61	PFBS: 24 PFOA: 400 PFOS: 58 PFOA+PFOS: 458	PFBS: 0.91 R PFOA: 0.91 R PFOS: 1.1 J	PFBS: < 20 R PFOA: < 20 R PFOS: < 20 R PFOA+PFOS: < 20 R
AFFF Area 3	Building 706	• In 1995, there was a release of 216 gallons of AFFF solution onto the ramp west of Building 706. No removal actions were taken at the time.	PFBS: ND PFOA: 3.8 PFOS: 5.6	5.63-5.64	PFBS: 22 J PFOA: 21 J PFOS: 140 J PFOA+PFOS: 161 J	Not sampled	Not sampled
AFFF Area 4	Building 700	• In 2007, a spill of 3–5 gallons was documented at the south side ramp area. • There is an undocumented spray test area in the grassy area to the south/southeast of the fire station. Records located by ASL were unclear as to the precise location; however, it was situated between the former fire station and FPTA 01.	PFBS: 1.5 PFOA: 7.8 J PFOS: 780 J	4.24-4.94	PFBS: 950 PFOA: 1,100 PFOS: 25,000 PFOA+PFOS: 26,100	Not sampled	Not sampled
AFFF Area 5	Blue Angels Crash Site	• Unknown volume of AFFF used to extinguish an aircraft crash-related fire.	PFBS: 4.4 PFOA: 5.7 PFOS: 180	2.5-5.5	PFBS: 290 PFOA: 170 PFOS: 1,000 J PFOA+PFOS: 1,170 J	Not sampled	Not sampled
AFFF Area 6	Fox Row/Taxiway Alpha	• A fire truck departed from Fox Row in May of 2010 responding to an exercise while unintentionally leaking AFFF from an open valve. Spill records show that approximately 25 gallons of concentrate were released. • Other releases have occurred in the area originating from buildings such as Hangar 850 or Building 706.	PFBS: ND PFOA: 2.8 J PFOS: 53	0.93-4.74	PFBS: 3,400 J PFOA: 5,000 J PFOS: 49,000 J PFOA+PFOS: 54,000 J	Not sampled	Not sampled
AFFF Area 7	Outfalls 004, 005, 007, and 900	• No AFFF release events have occurred at the specific locations of outfalls 004, 005, 007, and 009 (Former AFFF Area 7). These four outfalls provide stormwater drainage for all other suspected release areas at NFARS. For the purpose of this RI, outfall locations (Area 7) have been combined with suspected attributable release areas.	Not sampled	N/A	Not sampled	PFBS: 0.83 J PFOA: 4.1 J PFOS: 160 J	PFBS: 100 PFOA: 210 PFOS: 2,800 J PFOA+PFOS: 3,010 J
AFFF Area 8	Hulby Street	• In 1987, a 4-gallon spill of AFFF occurred on the southern side of Hulby Street, reportedly across from Building 316, the emergency management training building.	PFBS: 0.73 R PFOA: 0.52 J PFOS: 7.9 J	4.42-8.88	PFBS: 7.7 J PFOA: 7.7 J PFOS: 100 PFOA+PFOS: 100	Not sampled	Not sampled

Notes:
J = Estimated value
µg/kg = Micrograms per kilogram
ND = Non-detect
ng/L = Nanogram(s) per liter
R = Data was rejected

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Table 10-2. 2018 Site Inspection Surface Soil Analytical Results

AFFF Area			AFFF Area 1: Former Fire Training Area (Site 9)			AFFF Area 2: Hanger 850				
Location ID			**NIGRA01-001**	**NIGRA01-002**	**NIGRA01-003**	**NIGRA02-001**	**NIGRA02-001**	**NIGRA02-002**	**NIGRA02-003**	**NIGRA02-004**
Sample Name			**NIGRA01-001-SS-001**	**NIGRA01-002-SS-001**	**NIGRA01-003-SS-001**	**NIGRA02-001-SS-001**	**NIGRA02-001-SS-901**	**NIGRA02-002-SS-001**	**NIGRA02-003-SS-001**	**NIGRA02-004-SS-001**
Parent Sample ID							**NIGRA02-001-SS-001_08/16/2017**			
Sample Date			**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/16/2017**	**8/16/2017**	**8/17/2017**	**8/17/2017**	**8/17/2017**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	µg/kg	**33 J**	**10 J**	< 6.6 U	**5.3 J**	**24 J**	**5.9 J**	< 0.62 R	< 0.65 R
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 59 R	< 6.9 R	< 6.6 U	**1.4 J**	**0.93 J**	**3.1 J**	< 0.62 R	< 0.65 R
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 59 R	**6.4 J**	**2.6 J**	< 0.62 U	**0.23 J**	< 0.69 R	**0.25 J**	**0.2 J**
Perfluorobutanoic acid	NSL	µg/kg	< 59 R	**5.5 J**	< 6.6 U	**1**	**1.2**	**1.1 J**	**1 J**	**0.61 J**
Perfluorodecanesulfonic acid	NSL	µg/kg	< 59 R	< 6.9 R	**11**	**0.32 J**	< 0.55 U	< 0.69 R	< 0.62 R	**1.5 J**
Perfluorodecanoic acid	NSL	µg/kg	**14 J**	**4.4 J**	< 4.4 U	**1.7**	**2**	**9.8 J**	< 0.42 R	**0.82 J**
Perfluorododecanoic acid	NSL	µg/kg	< 59 R	< 6.9 R	< 6.6 U	< 0.62 U	**0.41 J**	**1.7 J**	< 0.62 R	< 0.65 R
Perfluoroheptanoic acid	NSL	µg/kg	< 59 R	**3.6 J**	< 6.6 U	**2.4**	**2.1**	**1.1 J**	**0.7 J**	**0.82 J**
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**410 J**	**250 J**	**55**	**5.4**	**5.3**	**0.42 J**	**4.5 J**	**1.2 J**
Perfluorohexanoic acid	NSL	µg/kg	**27 J**	**25 J**	**4.9 J**	**8.1**	**8.6**	**3.1 J**	**1.7 J**	**1.3 J**
Perfluorononanoic acid (PFNA)	19	µg/kg	< 59 R	**20 J**	**2.6 J**	**3.7**	**4**	**3.3 J**	**1.2 J**	**0.57 J**
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	**540 J**	**24 J**	**20**	< 0.62 U	< 0.55 U	**0.39 J**	**0.34 J**	< 0.65 R
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**4,000 J**	**1,600 J**	**1,700**	**12**	**13**	**38 J**	**70 J**	**3.4 J**
Perfluorooctanoic acid (PFOA)	19	µg/kg	**62 J**	**39 J**	**5.6 J**	**8.8 J**	**8.5**	**3 J**	**2.1 J**	**3.6 J**
Perfluoropentanoic acid	NSL	µg/kg	< 59 R	**12 J**	**2.2 J**	**5.7**	**5.9**	**5.5 J**	**2.9 J**	**1.9 J**
Perfluorotetradecanoic acid	NSL	µg/kg	< 39 R	< 4.6 R	< 4.4 U	< 0.42 U	< 0.37 U	**0.9 J**	< 0.42 R	< 0.44 R
Perfluorotridecanoic acid	NSL	µg/kg	**24 J**	< 4.6 R	**1.9 J**	< 0.42 U	< 0.37 U	**0.88 J**	< 0.42 R	< 0.44 R
Perfluoroundecanoic acid	NSL	µg/kg	< 59 R	**5.1 J**	**8.4 J**	**0.45 J**	**0.46 J**	**4.1 J**	< 0.62 R	< 0.65 R

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
ID = Identification
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection

Detected results are **bolded.**

Values exceeding the ASD calculated residential soil RSL are shaded gray.

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Table 10-2. 2018 Site Inspection Surface Soil Analytical Results Continued

AFFF Area			**AFFF Area 3: Building 706**		**AFFF Area 4: Building 700**				**AFFF Area 5: Blue Angels Crash Site**		
Location ID			**NIGRA03-001**	**NIGRA03-002**	**NIGRA04-001**	**NIGRA04-001**	**NIGRA04-002**	**NIGRA04-003**	**NIGRA05-001**	**NIGRA05-002**	**NIGRA05-003**
Sample Name			**NIGRA03-001-SS-001**	**NIGRA03-002-SS-001**	**NIGRA04-001-SS-001**	**NIGRA04-001-SS-901**	**NIGRA04-002-SS-001**	**NIGRA04-003-SS-001**	**NIGRA05-001-SS-001**	**NIGRA05-002-SS-001**	**NIGRA05-003-SS-001**
Parent Sample ID						**NIGRA04-001-SS-001_08/15/2017**					
Sample Date			**8/14/2017**	**8/14/2017**	**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/22/2017**	**8/22/2017**	**8/22/2017**
Analyte	**ASD Calculated Residential Soil RSL**[1]	**Unit**									
PFAS (EPA 537.1)											
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.66 U	< 0.66 U	**2.8 J**	**0.59 J**	**0.32 J**	< 0.66 U	< 0.72 U	< 0.72 U	< 0.57 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.66 UJ	**0.57 J**	**6.9 J**	**2.1 J**	< 0.66 UJ	< 0.66 UJ	< 0.72 U	< 0.72 U	< 0.57 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.66 U	< 0.66 U	< 6.0 U	< 0.66 U	**1.5**	**0.55 J**	**4.4**	< 0.72 U	< 0.57 U
Perfluorobutanoic acid	NSL	µg/kg	**0.55 J**	**0.5 J**	**2.5 J**	**1.9**	**0.96 J**	**0.82 J**	**1.1 J**	< 0.72 U	< 0.57 U
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.66 U	< 0.66 U	**6.7 J**	**5.8**	**4**	**3.3**	< 0.72 U	< 0.72 U	< 0.57 U
Perfluorodecanoic acid	NSL	µg/kg	**1.8**	**2.2**	< 4.0 U	**1.6**	< 0.44 U	< 0.44 U	< 0.48 U	< 0.48 U	< 0.38 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.66 U	< 0.66 U	< 6.0 U	< 0.66 U	< 0.66 U	< 0.66 U	< 0.72 U	< 0.72 U	< 0.57 U
Perfluoroheptanoic acid	NSL	µg/kg	**0.81 J**	**1.4**	**4.3 J**	**2.3**	< 0.66 U	**0.6 J**	**3.6**	< 0.72 U	< 0.57 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**0.46 J**	**0.76 J**	**15**	**13**	**29**	**21**	**56**	< 0.72 U	**0.92 J**
Perfluorohexanoic acid	NSL	µg/kg	**0.6 J**	**0.8 J**	< 6.0 U	**2.2**	**2**	**1.5**	**8.8**	< 0.72 U	< 0.57 U
Perfluorononanoic acid (PFNA)	19	µg/kg	**1.4**	**2.9**	< 6.0 U	**2**	< 0.66 U	**0.78 J**	**2.8**	< 0.72 U	< 0.57 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.66 U	< 0.66 U	**42 J**	**29 J**	**2.6**	**0.59 J**	< 0.72 U	< 0.72 U	< 0.57 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**2.3**	**5.6**	**780 J**	**480 J**	**440**	**410**	**180**	< 0.72 U	< 0.57 U
Perfluorooctanoic acid (PFOA)	19	µg/kg	**2.2**	**3.8**	**7.8 J**	**6.3**	**2.3**	**1.2**	**5.7**	< 0.72 U	< 0.57 U
Perfluoropentanoic acid	NSL	µg/kg	**1.1 J**	**1.2**	**5.5 J**	**3.7**	**1.3**	**1.4**	**3.7**	< 0.72 U	< 0.57 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.44 U	< 0.44 U	< 4.0 U	< 0.44 U	< 0.44 U	< 0.44 U	< 0.48 U	< 0.48 U	< 0.38 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.44 U	< 0.44 U	< 4.0 U	< 0.44 U	< 0.44 U	< 0.44 U	< 0.48 U	< 0.48 U	< 0.38 U
Perfluoroundecanoic acid	NSL	µg/kg	**0.7 J**	**0.87 J**	< 6.0 U	**0.98 J**	**0.36 J**	< 0.66 U	< 0.72 U	< 0.72 U	< 0.57 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
ID = Identification
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-2. 2018 Site Inspection Surface Soil Analytical Results Continued

AFFF Area			AFFF Area 6: Fox Row/Taxiway Alpha					AFFF Area 8: Hulby Street		
Location ID			NIGRA06-001	NIGRA06-002	NIGRA06-002	NIGRA06-003	NIGRA06-004	NIGRA08-001	NIGRA08-002	NIGRA08-003
Sample Name			NIGRA06-001-SS-001	NIGRA06-002-SS-001	NIGRA06-002-SS-901	NIGRA06-003-SS-001	NIGRA06-004-SS-001	NIGRA08-001-SS-001	NIGRA08-002-SS-001	NIGRA08-003-SS-001
Parent Sample ID					NIGRA06-002-SS-001_08/16/2017					
Sample Date			8/16/2017	8/16/2017	8/16/2017	8/16/2017	8/17/2017	8/14/2017	8/14/2017	8/14/2017
Analyte	ASD Calculated Residential Soil RSL[1]	Unit								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	µg/kg	**0.23 J**	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.58 UJ	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.58 U	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorobutanoic acid	NSL	µg/kg	**0.33 J**	**0.71 J**	< 0.71 U	**0.58 J**	< 0.66 U	**0.51 J**	**0.29 J**	< 0.72 R
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.58 U	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorodecanoic acid	NSL	µg/kg	< 0.39 U	**0.58 J**	< 0.47 U	< 0.51 UJ	< 0.44 U	**0.23 J**	< 0.40 R	< 0.48 R
Perfluorododecanoic acid	NSL	µg/kg	< 0.58 U	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
Perfluoroheptanoic acid	NSL	µg/kg	**0.83 J**	**1.6**	**1.1 J**	**0.58 J**	**0.55 J**	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**1.2**	**3**	**3.2**	**0.59 J**	**0.69 J**	**0.76 J**	**1.4 J**	**0.49 J**
Perfluorohexanoic acid	NSL	µg/kg	**0.76 J**	**1.4**	**1.4**	**0.79 J**	**0.73 J**	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorononanoic acid (PFNA)	19	µg/kg	**0.85 J**	**1.5**	**1.1 J**	**0.58 J**	**0.93 J**	**0.38 J**	< 0.60 R	< 0.72 R
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.58 U	< 0.68 U	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**17**	**33**	**33**	**12 J**	**53**	**5.7 J**	**7.9 J**	**0.95 J**
Perfluorooctanoic acid (PFOA)	19	µg/kg	**1.5**	**2.8 J**	**2 J**	**1.3 J**	**0.8 J**	**0.51 J**	**0.52 J**	< 0.72 R
Perfluoropentanoic acid	NSL	µg/kg	**1.4**	**1.9**	**1.7**	**1 J**	**0.91 J**	< 0.73 R	**0.3 J**	< 0.72 R
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.39 U	< 0.45 U	< 0.47 U	< 0.51 UJ	< 0.44 U	< 0.48 R	< 0.40 R	< 0.48 R
Perfluorotridecanoic acid	NSL	µg/kg	< 0.39 U	< 0.45 U	< 0.47 U	< 0.51 UJ	< 0.44 U	< 0.48 R	< 0.40 R	< 0.48 R
Perfluoroundecanoic acid	NSL	µg/kg	< 0.58 U	**0.24 J**	< 0.71 U	< 0.77 UJ	< 0.66 U	< 0.73 R	< 0.60 R	< 0.72 R

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
ID = Identification
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the EPA Residential Soil RSL are shaded gray.

Table 10-3. 2018 Site Inspection Subsurface Soil Analytical Results

AFFF Area			AFFF Area 1: Former Fire Training Area (Site 9)			AFFF Area 2: Hanger 850					AFFF Area 3: Building 706	
Location ID			**NIGRA01-001**	**NIGRA01-002**	**NIGRA01-003**	**NIGRA02-001**	**NIGRA02-001**	**NIGRA02-002**	**NIGRA02-003**	**NIGRA02-004**	**NIGRA03-001**	**NIGRA03-002**
Sample Name			**NIGRA01-001-SO-007**	**NIGRA01-002-SO-008**	**NIGRA01-003-SO-010**	**NIGRA02-001-SO-011**	**NIGRA02-001-SO-911**	**NIGRA02-002-SO-014**	**NIGRA02-003-SO-014**	**NIGRA02-004-SO-012**	**NIGRA03-001-SO-006**	**NIGRA03-002-SO-003**
Parent Sample ID							**NIGRA02-001-SO-011_08/16/2017**					
Sample Date			**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/16/2017**	**8/16/2017**	**8/17/2017**	**8/17/2017**	**8/17/2017**	**8/14/2017**	**8/14/2017**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**										
PFAS (EPA 537.1)												
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.66 UJ	< 0.60 UJ	< 0.66 UJ	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 UJ	< 0.59 UJ
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorobutanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.44 U	< 0.40 U	< 0.44 U	< 0.40 U	< 0.49 U	< 0.45 R	< 0.44 R	< 0.41 R	< 0.35 U	< 0.39 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluoroheptanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	**0.42 J**
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	0.38 J
Perfluorohexanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorononanoic acid (PFNA)	19	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	< 0.66 U	**0.92 J**	**0.37 J**	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	**0.38 J**	**0.9 J**
Perfluorooctanoic acid (PFOA)	19	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	**0.4 J**
Perfluoropentanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.44 U	< 0.40 U	< 0.44 U	< 0.40 U	< 0.49 U	< 0.45 R	< 0.44 R	< 0.41 R	< 0.35 U	< 0.39 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.44 U	< 0.40 U	< 0.44 U	< 0.40 U	< 0.49 U	< 0.45 R	< 0.44 R	< 0.41 R	< 0.35 U	< 0.39 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.66 U	< 0.60 U	< 0.66 U	< 0.59 U	< 0.74 U	< 0.68 R	< 0.67 R	< 0.62 R	< 0.53 U	< 0.59 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-3. 2018 Site Inspection Subsurface Soil Analytical Results Continued

AFFF Area			AFFF Area 4: Building 700				AFFF Area 5: Blue Angels Crash Site			
Location ID			**NIGRA04-001**	**NIGRA04-001**	**NIGRA04-002**	**NIGRA04-003**	**NIGRA05-001**	**NIGRA05-001**	**NIGRA05-002**	**NIGRA05-003**
Sample Name			**NIGRA04-001-SO-007**	**NIGRA04-001-SO-907**	**NIGRA04-002-SO-004**	**NIGRA04-003-SO-005**	**NIGRA05-001-SO-004**	**NIGRA05-001-SO-904**	**NIGRA05-002-SO-002**	**NIGRA05-003-SO-005**
Parent Sample ID				**NIGRA04-001-SO-007_08/16/2017**				**NIGRA05-001-SO-004_08/22/2017**		
Sample Date			**8/16/2017**	**8/16/2017**	**8/16/2017**	**8/16/2017**	**8/22/2017**	**8/22/2017**	**8/22/2017**	**8/22/2017**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	µg/kg	**1.7**	**1.8**	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	**3.5 J**	**6.8 J**	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.52 U	**0.26 J**	< 5.5 U	**0.35 J**	**1.1 J**	**3.4 J**	< 0.66 U	< 0.58 U
Perfluorobutanoic acid	NSL	µg/kg	< 0.52 U	< 0.62 U	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.52 U	**0.93 J**	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.35 U	< 0.41 U	< 3.7 U	< 0.43 U	< 0.36 U	< 0.37 U	< 0.44 U	< 0.39 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.52 U	< 0.62 U	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluoroheptanoic acid	NSL	µg/kg	0.41 J	**0.47 J**	< 5.5 U	**0.46 J**	**1.3 J**	**3.4 J**	< 0.66 U	< 0.58 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**1.8 J**	**2.6 J**	**50**	**4.6**	**19 J**	**44 J**	< 0.66 U	< 0.58 U
Perfluorohexanoic acid	NSL	µg/kg	**0.83 J**	**1.2**	**4.3 J**	**0.75 J**	**2.1 J**	**6.4 J**	< 0.66 U	< 0.58 U
Perfluorononanoic acid (PFNA)	19	µg/kg	**0.26 J**	**0.44 J**	< 5.5 U	**0.35 J**	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	**2.7 J**	**5.7 J**	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**50 J**	**89 J**	**230**	**11**	**1.4 J**	**4.4 J**	< 0.66 U	< 0.58 U
Perfluorooctanoic acid (PFOA)	19	µg/kg	**0.49 J**	**0.84 J**	**13**	**0.56 J**	**1.3 J**	**2.8 J**	< 0.66 U	< 0.58 U
Perfluoropentanoic acid	NSL	µg/kg	**0.49 J**	**0.65 J**	< 5.5 U	< 0.65 U	**0.94 J**	**2.2 J**	< 0.66 U	< 0.58 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.35 U	< 0.41 U	< 3.7 U	< 0.43 U	< 0.36 U	< 0.37 U	< 0.44 U	< 0.39 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.35 U	< 0.41 U	< 3.7 U	< 0.43 U	< 0.36 U	< 0.37 U	< 0.44 U	< 0.39 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.52 U	< 0.62 U	< 5.5 U	< 0.65 U	< 0.54 U	< 0.55 U	< 0.66 U	< 0.58 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-3. 2018 Site Inspection Subsurface Soil Analytical Results Continued

AFFF Area			AFFF Area 6: Fox Row/Taxiway Alpha				AFFF Area 8: Hulby Street		
Location ID			**NIGRA06-001**	**NIGRA06-002**	**NIGRA06-003**	**NIGRA06-004**	**NIGRA08-001**	**NIGRA08-002**	**NIGRA08-003**
Sample Name			**NIGRA06-001-SO-012**	**NIGRA06-002-SO-012**	**NIGRA06-003-SO-007**	**NIGRA06-004-SO-002**	**NIGRA08-001-SO-008**	**NIGRA08-002-SO-010**	**NIGRA08-003-SO-008**
Parent Sample ID									
Sample Date			**8/16/2017**	**8/16/2017**	**8/17/2017**	**8/17/2017**	**8/14/2017**	**8/14/2017**	**8/14/2017**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**							
PFAS (EPA 537.1)									
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 UJ	< 0.59 UJ	< 0.58 UJ
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorobutanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**0.34 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.50 U	< 0.46 U	< 0.38 U	< 0.47 R	< 0.44 U	< 0.39 U	< 0.39 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
Perfluoroheptanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**1.6 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorohexanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**0.32 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorononanoic acid (PFNA)	19	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**0.44 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**11 J**	**0.4 J**	**0.27 J**	**0.23 J**
Perfluorooctanoic acid (PFOA)	19	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**0.77 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluoropentanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	**0.46 J**	< 0.66 U	< 0.59 U	< 0.58 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.50 U	< 0.46 U	< 0.38 U	< 0.47 R	< 0.44 U	< 0.39 U	< 0.39 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.50 U	< 0.46 U	< 0.38 U	< 0.47 R	< 0.44 U	< 0.59 U	< 0.39 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.75 U	< 0.70 U	< 0.58 U	< 0.70 R	< 0.66 U	< 0.59 U	< 0.58 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

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Table 10-4. 2018 Site Inspection Groundwater Analytical Results

AFFF Area			AFFF Area 1: Former Fire Training Area (Site 9)			AFFF Area 2: Hanger 850				
Location ID			**NIGRA01-001**	**NIGRA01-002**	**NIGRA01-003**	**NIGRA02-001**	**NIGRA02-001**	**NIGRA02-002**	**NIGRA02-003**	**NIGRA02-004**
Sample Name			**NIGRA01-001-GW-007**	**NIGRA01-002-GW-008**	**NIGRA01-003-GW-008**	**NIGRA02-001-GW-015**	**NIGRA02-001-GW-915**	**NIGRA02-002-GW-014**	**NIGRA02-003-GW-016**	**NIGRA02-004-GW-015**
Parent Sample ID							**NIGRA02-001-GW-015_08/18/2017**			
Sample Date			**8/18/2017**	**8/18/2017**	**8/18/2017**	**8/18/2017**	**8/18/2017**	**8/21/2017**	**8/21/2017**	**8/21/2017**
Analyte	**ASD Calculated Tapwater RSL[1]**	**Unit**								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	ng/L	**8,500**	**86,000**	**75,000**	**7.5 J**	< 10 U	**350**	< 10 U	< 10 U
8:2 Fluorotelomer sulfonate	NSL	ng/L	< 6,000 U	**3,700 J**	**11,000**	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluorobutanesulfonic acid (PFBS)	601	ng/L	**26,000**	**30,000**	**31,000**	< 10 U	< 10 U	**13 J**	**24**	< 10 U
Perfluorobutanoic acid	NSL	ng/L	**24,000**	**26,000**	**36,000**	**18 J**	**18 J**	**770**	**18 J**	< 10 U
Perfluorodecanesulfonic acid	NSL	ng/L	< 6,000 U	< 6,000 U	< 60,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluorodecanoic acid	NSL	ng/L	< 4,000 U	< 4,000 U	< 4,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluorododecanoic acid	NSL	ng/L	< 5,000 U	< 5,000 U	< 5,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluoroheptanoic acid	NSL	ng/L	**27,000**	**30,000**	**21,000**	< 10 U	< 10 U	**720**	**7.9 J**	< 10 U
Perfluorohexanesulfonic acid (PFHxS)	39	ng/L	**870,000**	**790,000**	**750,000**	< 10 U	< 10 U	**120**	**38**	< 10 U
Perfluorohexanoic acid	NSL	ng/L	**230,000**	**210,000**	**210,000**	< 10 U	< 10 U	**1,800**	**62**	< 10 U
Perfluorononanoic acid (PFNA)	6	ng/L	**7,700 J**	< 40,000 U	**14,000**	< 10 U	< 10 U	**36**	< 10 U	< 10 U
Perfluorooctanesulfonamide (PFOSA)	NSL	ng/L	< 40,000 U	**4.9 J**	**22**	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluorooctanesulfonic acid (PFOS)	4	ng/L	**910,000**	**330,000**	**1,200,000**	**12 J**	**9.2 J**	**58**	**7.2 J**	**11 J**
Perfluorooctanoic acid (PFOA)	6	ng/L	**110,000**	**110,000**	**110,000**	< 10 U	< 10 U	**400**	**6.2 J**	< 10 U
Perfluoropentanoic acid	NSL	ng/L	**53,000**	**68,000**	**56,000**	**30**	**32**	**5,000**	**99**	< 10 U
Perfluorotetradecanoic acid	NSL	ng/L	< 50,000 U	< 50,000 U	< 50,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluorotridecanoic acid	NSL	ng/L	< 60,000 U	< 60,000 U	< 60,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Perfluoroundecanoic acid	NSL	ng/L	< 5,000 U	< 5,000 U	< 5,000 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated value
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R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated RSL are shaded gray.

Table 10-4. 2018 Site Inspection Groundwater Analytical Results Continued

AFFF Area			**AFFF Area 3: Building 706**		**AFFF Area 4: Building 700**			**AFFF Area 5: Blue Angels Crash Site**	
Location ID			**NIGRA03-001**	**NIGRA03-002**	**NIGRA04-001**	**NIGRA04-001**	**NIGRA04-003**	**NIGRA05-001**	**NIGRA05-003**
Sample Name			**NIGRA03-001-GW-006**	**NIGRA03-002-GW-005**	**NIGRA04-001-GW-005**	**NIGRA04-001-GW-905**	**NIGRA04-003-GW-005**	**NIGRA05-001-GW-005**	**NIGRA05-003-GW-006**
Parent Sample ID						**NIGRA04-001-GW-005_08/21/2017**			
Sample Date			**8/18/2017**	**8/16/2017**	**8/21/2017**	**8/21/2017**	**8/21/2017**	**8/22/2017**	**8/22/2017**
Analyte	**ASD Calculated Tapwater RSL[1]**	**Unit**							
PFAS (EPA 537.1)									
6:2 Fluorotelomer sulfonate	NSL	ng/L	< 20 U	**16 J**	**4,000**	**4,600**	**210**	**170**	< 20 U
8:2 Fluorotelomer sulfonate	NSL	ng/L	< 20 U	< 20 UJ	**520**	**550**	**9.9 J**	< 20 U	< 20 U
Perfluorobutanesulfonic acid (PFBS)	601	ng/L	**14 J**	**22 J**	**950**	**940**	**650**	**290**	< 20 U
Perfluorobutanoic acid	NSL	ng/L	**30**	**27 J**	**960**	**750**	**380**	**130**	< 20 U
Perfluorodecanesulfonic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U
Perfluorodecanoic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U
Perfluorododecanoic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U
Perfluoroheptanoic acid	NSL	ng/L	**21**	**39 J**	**640**	**590**	**360**	**210**	< 20 U
Perfluorohexanesulfonic acid (PFHxS)	39	ng/L	**23**	**160 J**	**7,300**	**6,800**	**4,600**	**2,200**	**20 J**
Perfluorohexanoic acid	NSL	ng/L	**580**	**75 J**	**2,000**	**2,100**	**2,100**	**630**	**6.4 J**
Perfluorononanoic acid (PFNA)	6	ng/L	< 20 U	< 20 UJ	**160 J**	**150 J**	**30**	**40**	< 20 U
Perfluorooctanesulfonamide (PFOSA)	NSL	ng/L	< 20 U	< 20 UJ	**130 J**	**120 J**	**160 J**	< 20 U	< 20 U
Perfluorooctanesulfonic acid (PFOS)	4	ng/L	**29**	**140 J**	**22,000**	**25,000**	**2,100**	**1,000 J**	**25 J**
Perfluorooctanoic acid (PFOA)	6	ng/L	**11 J**	**21 J**	**1,100**	**1,100**	**470**	**170**	< 20 U
Perfluoropentanoic acid	NSL	ng/L	**97**	**110 J**	**1,700**	**1,600**	**1,200**	**500**	**7.3 J**
Perfluorotetradecanoic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U
Perfluorotridecanoic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U
Perfluoroundecanoic acid	NSL	ng/L	< 20 U	< 20 UJ	< 200 U	< 200 U	< 20 U	< 20 U	< 20 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.
Notes:
J = Estimated value
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated RSL are shaded gray.

Table 10-4. 2018 Site Inspection Groundwater Analytical Results Continued

AFFF Area			**AFFF Area 6: Fox Row/Taxiway Alpha**							**AFFF Area 8: Hulby Street**		
Location ID			**NIGRA06-001**	**NIGRA06-001**	**NIGRA06-002**	**NIGRA06-003**	**MW7-1D**	**MW7-2**	**MW7-3D**	**NIGRA08-001**	**NIGRA08-002**	**NIGRA08-003**
Sample Name			**NIGRA06-001-GW-015**	**NIGRA06-001-GW-915**	**NIGRA06-002-GW-015**	**NIGRA06-003-GW-009**	**NIGRA06-MW7-1D-010**	**NIGRA06-MW7-2-005**	**NIGRA06-MW7-3D-014**	**NIGRA08-001-GW-011**	**NIGRA08-002-GW-010**	**NIGRA08-003-GW-009**
Parent Sample ID				**NIGRA06-001-GW-015_08/17/2017**								
Sample Date			**8/17/2017**	**8/17/2017**	**8/18/2017**	**8/21/2017**	**8/15/2017**	**8/15/2017**	**8/17/2017**	**8/16/2017**	**8/18/2017**	**8/16/2017**
Analyte	**ASD Calculated Tapwater RSL[1]**	**Unit**										
PFAS (EPA 537.1)												
6:2 Fluorotelomer sulfonate	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	**2,900 J**	**930 J**	< 10 U	< 10 UJ	**12 J**	**8.5 J**
8:2 Fluorotelomer sulfonate	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	**100 J**	< 100 R	< 20 U	< 10 UJ	< 10 U	< 10 UJ
Perfluorobutanesulfonic acid (PFBS)	601	ng/L	< 10 UJ	< 10 UJ	**11 J**	**39**	**3,400 J**	**1,400 J**	**8.5 J**	**7.7 J**	< 10 U	< 10 UJ
Perfluorobutanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	**39**	**2,600 J**	**1,200 J**	< 10 U	< 10 UJ	< 10 U	< 10 UJ
Perfluorodecanesulfonic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 U	< 10 UJ	< 10 U	< 10 UJ
Perfluorodecanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 U	< 10 UJ	< 10 U	< 10 UJ
Perfluorododecanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 U	< 10 UJ	< 10 U	< 10 UJ
Perfluoroheptanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	**13 J**	**3,200 J**	**2,000 J**	**5.7 J**	< 10 UJ	< 10 U	< 10 UJ
Perfluorohexanesulfonic acid (PFHxS)	39	ng/L	< 10 UJ	**5.2 J**	**19 J**	**46**	**69,000 J**	**28,000 J**	**83**	**36 J**	**24**	< 10 UJ
Perfluorohexanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	**22**	**58**	**11,000 J**	**4,600 J**	**14 J**	**10 J**	**9.9 J**	< 10 UJ
Perfluorononanoic acid (PFNA)	6	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	**860 J**	**720 J**	< 10 U	< 10 UJ	< 10 U	< 10 UJ
Perfluorooctanesulfonamide (PFOSA)	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 U	< 10 UJ	**6.5 J**	< 10 UJ
Perfluorooctanesulfonic acid (PFOS)	4	ng/L	< 10 UJ	< 10 UJ	**10 J**	**61**	**49,000 J**	**45,000 J**	**81**	**15 J**	**100**	< 10 UJ
Perfluorooctanoic acid (PFOA)	6	ng/L	< 10 UJ	< 10 UJ	**5.3 J**	**6.1 J**	**5,000 J**	**3,000 J**	**8.8 J**	**7.7 J**	< 10 U	< 10 UJ
Perfluoropentanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	**29**	**74**	**6,400 J**	**4,000 J**	**14 J**	< 10 UJ	< 10 U	< 10 UJ
Perfluorotetradecanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 UJ	< 10 UJ	< 10 U	< 10 UJ
Perfluorotridecanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 UJ	< 10 UJ	< 10 U	< 10 UJ
Perfluoroundecanoic acid	NSL	ng/L	< 10 UJ	< 10 UJ	< 10 U	< 10 U	< 100 R	< 100 R	< 10 U	< 10 UJ	< 10 U	< 10 UJ

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
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Detected results are **bolded.**
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Table 10-5. 2018 Site Inspection Surface Water Analytical Results

AFFF Area			**AFFF Area 1: Former Fire Training Area (Site 9)**			**AFFF Area 2: Hanger 850**	**Outfall 004**	**Outfall 009**	**Outfall 005**	**Outfall 007**
Location ID			**NIGRA01-004**	**NIGRA01-004**	**NIGRA01-005**	**NIGRA02-005**	**NIGRA07-001**	**NIGRA07-002**	**NIGRA07-003**	**NIGRA07-004**
Sample Name			**NIGRA01-004-SW-001**	**NIGRA01-004-SW-901**	**NIGRA01-005-SW-001**	**NIGRA02-005-SW-001**	**NIGRA07-001-SW-001**	**NIGRA07-002-SW-001**	**NIGRA07-003-SW-001**	**NIGRA07-004-SW-001**
Parent Sample ID				**NIGRA01-004-SW-001_08/15/2017**						
Sample Date			**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/17/2017**	**8/16/2017**	**8/16/2017**	**8/16/2017**	**8/22/2017**
Analyte	**ASD Calculated Tapwater RSL[1]**	**Unit**								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	ng/L	**250 J**	**260 J**	**1,100 J**	< 10 R	**150 J**	**10 J**	**8.4 J**	**190**
8:2 Fluorotelomer sulfonate	NSL	ng/L	< 20 R	< 20 R	< 100 R	< 10 R	**22 J**	< 10 UJ	< 10 UJ	**9.6 J**
Perfluorobutanesulfonic acid (PFBS)	601	ng/L	**740 J**	**640 J**	**1,600 J**	< 10 R	**80 J**	**5.9 J**	< 10 UJ	**100**
Perfluorobutanoic acid	NSL	ng/L	**560 J**	**540 J**	**1,700 J**	< 10 R	**85 J**	< 10 UJ	< 10 UJ	**89**
Perfluorodecanesulfonic acid	NSL	ng/L	< 20 R	< 20 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 U
Perfluorodecanoic acid	NSL	ng/L	< 20 R	< 20 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 U
Perfluorododecanoic acid	NSL	ng/L	< 20 R	< 20 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 U
Perfluoroheptanoic acid	NSL	ng/L	**480 J**	**460 J**	**1,300 J**	< 10 R	**120 J**	**9.1 J**	< 10 UJ	**170**
Perfluorohexanesulfonic acid (PFHxS)	39	ng/L	**8,700 J**	**9,400 J**	**20,000 J**	< 10 R	**940 J**	**40 J**	**12 J**	**1,500**
Perfluorohexanoic acid	NSL	ng/L	**4,500 J**	**4,700 J**	**8,700 J**	< 10 R	**350 J**	**18 J**	**14 J**	**360**
Perfluorononanoic acid (PFNA)	6	ng/L	**97 J**	**110 J**	**370 J**	< 10 R	**19 J**	< 10 UJ	< 10 UJ	**35**
Perfluorooctanesulfonamide (PFOSA)	NSL	ng/L	**37 J**	**39 J**	**100 J**	< 10 R	**16 J**	< 10 UJ	< 10 UJ	**5.7 J**
Perfluorooctanesulfonic acid (PFOS)	4	ng/L	**7,200 J**	**7,700 J**	**21,000 J**	< 10 R	**1,900 J**	**49 J**	**12 J**	**2,800 J**
Perfluorooctanoic acid (PFOA)	6	ng/L	**1,100 J**	**1,100 J**	**3,300 J**	< 10 R	**160 J**	**13 J**	**7.5 J**	**210**
Perfluoropentanoic acid	NSL	ng/L	**1,400 J**	**1,400 J**	**4,500 J**	**11 J**	**380 J**	**22 J**	**21 J**	**390**
Perfluorotetradecanoic acid	NSL	ng/L	< 200 R	< 200 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 UJ
Perfluorotridecanoic acid	NSL	ng/L	< 200 R	< 200 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 UJ
Perfluoroundecanoic acid	NSL	ng/L	< 20 R	< 20 R	< 100 R	< 10 R	< 10 UJ	< 10 UJ	< 10 UJ	< 10 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
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Detected results are **bolded.**

Values exceeding the ASD calculated RSL are shaded gray.

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Table 10-6. 2018 Site Inspection Sediment Analytical Results

AFFF Area			**AFFF Area 1: Former Fire Training Area (Site 9)**			**AFFF Area 2: Hanger 850**	**Outfall 004**	**Outfall 009**	**Outfall 005**	**Outfall 007**
Location ID			**NIGRA01-004**	**NIGRA01-004**	**NIGRA01-005**	**NIGRA02-005**	**NIGRA07-001**	**NIGRA07-002**	**NIGRA07-003**	**NIGRA07-004**
Sample Name			**NIGRA01-004-SD-001**	**NIGRA01-004-SD-901**	**NIGRA01-005-SD-001**	**NIGRA02-005-SD-001**	**NIGRA07-001-SD-001**	**NIGRA07-002-SD-001**	**NIGRA07-003-SD-001**	**NIGRA07-004-SD-001**
Parent Sample ID				**NIGRA01-004-SD-001_08/15/2017**						
Sample Date			**8/15/2017**	**8/15/2017**	**8/15/2017**	**8/17/2017**	**8/16/2017**	**8/16/2017**	**8/16/2017**	**8/22/2017**
Analyte	**ASD Calculated Residential Soil RSL**[1]	**Unit**								
PFAS (EPA 537.1)										
6:2 Fluorotelomer sulfonate	NSL	µg/kg	**18 J**	**98 J**	**9.2 J**	< 0.91 R	**0.9 J**	**2.8 J**	< 0.86 UJ	< 0.84 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 12 R	< 130 R	< 8.4 R	< 0.91 R	**1.7 J**	**2.9 J**	< 0.86 UJ	< 0.84 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	**11 J**	< 130 R	**4.5 J**	< 0.91 R	< 0.94 UJ	0.83 J	< 0.86 UJ	< 0.84 U
Perfluorobutanoic acid	NSL	µg/kg	**6.3 J**	< 130 R	**4.3 J**	< 0.91 R	< 0.94 UJ	**1.1 J**	< 0.86 UJ	< 0.84 U
Perfluorodecanesulfonic acid	NSL	µg/kg	**27 J**	**65 J**	< 8.4 R	< 0.91 R	**0.82 J**	< 2.0 UJ	< 0.86 UJ	< 0.84 U
Perfluorodecanoic acid	NSL	µg/kg	**4.2 J**	**30 J**	**2.8 J**	< 0.61 R	**0.35 J**	**0.58 J**	< 0.58 UJ	< 0.56 U
Perfluorododecanoic acid	NSL	µg/kg	< 12 R	< 130 R	< 8.4 R	< 0.91 R	**0.54 J**	< 2.0 UJ	< 0.86 UJ	< 0.84 U
Perfluoroheptanoic acid	NSL	µg/kg	**5.9 J**	< 130 R	< 8.4 R	< 0.91 R	< 0.94 UJ	**1.9 J**	< 0.86 UJ	< 0.84 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**340 J**	**760 J**	**88 J**	< 0.91 R	**4.1 J**	**13 J**	**1.1 J**	**2.1**
Perfluorohexanoic acid	NSL	µg/kg	**59 J**	**82 J**	**16 J**	< 0.91 R	**0.7 J**	**3.2 J**	< 0.86 UJ	< 0.84 U
Perfluorononanoic acid (PFNA)	19	µg/kg	**20 J**	**69 J**	**6.7 J**	< 0.91 R	**0.51 J**	**3.1 J**	< 0.86 UJ	< 0.84 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	**120 J**	**440 J**	**31 J**	< 0.91 R	**2.1 J**	**3.8 J**	< 0.86 UJ	< 0.84 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**3,100 J**	**7,500 J**	**1,200 J**	**1.1 J**	**54 J**	**160 J**	**11 J**	**11**
Perfluorooctanoic acid (PFOA)	19	µg/kg	**57 J**	**140 J**	**18 J**	< 0.91 R	**1 J**	**4.1 J**	**0.58 J**	**0.47 J**
Perfluoropentanoic acid	NSL	µg/kg	**13 J**	< 130 R	**8.4 J**	< 0.91 R	**1 J**	**4.1 J**	**1 J**	< 0.84 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 8.2 R	< 89 R	< 5.6 R	< 0.61 R	< 0.63 UJ	< 1.3 UJ	< 0.58 UJ	< 0.56 U
Perfluorotridecanoic acid	NSL	µg/kg	**16 J**	**50 J**	**1.7 J**	< 0.61 R	**0.26 J**	< 1.3 UJ	< 0.86 UJ	< 0.56 U
Perfluoroundecanoic acid	NSL	µg/kg	**29 J**	**69 J**	**4 J**	**0.27 J**	**0.39 J**	< 2.0 UJ	< 0.86 UJ	< 0.84 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated value
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R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

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Table 10-7. 2019 West End Electrical Project PFAS Sampling Surface Soil Analytical Results

Location ID			**SS01**	**SS02**	**SS03**	**SS04**	**SS05**	**SS06**	**SS07**	**SS08**	
Sample Name			**NFARS-FTA-2019-SS01**	**NFARS-FTA-2019-SS02**	**NFARS-FTA-2019-SS03**	**NFARS-FTA-2019-SS04**	**NFARS-FTA-2019-SS05**	**NFARS-FTA-2019-SS06**	**NFARS-FTA-2019-SS07**	**NFARS-FTA-2019-SS08**	**NFARS-FTA-2019-S-FD02**
Parent Sample											**NFARS-FTA-2019-SS08**
Sample Date			**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**
Analyte	**ASD Calculated Residential Soil RSL**[1]	**Unit**									
PFAS (EPA 537 MOD)											
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.934 U	< 0.819 U	< 0.833 U	< 0.824 U	**1.27**	< 0.811 U	**0.838 J**	< 0.933 U	**0.766 J**
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.922 U	< 0.806 U	< 0.872 U	< 0.813 U	< 0.799 U	< 0.801 U	<0.827 U	< 0.922 U	< 0.791 U
N-ethyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.658 U	< 0.576 U	< 0.623 U	< 0.581 U	< 0.571 U	< 0.572 U	< 0.591 U	< 0.658 U	< 0.565 U
N-methyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.790 U	< 0.691 U	< 0.748 U	< 0.697 U	< 0.685 U	< 0.686 U	< 0.709 U	< 0.790 U	< 0.678 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	**0.53**	**1.03**	**3.08**	< 0.395 U	**0.173 J**
Perfluorobutanoic acid	NSL	µg/kg	**0.608**	**0.363 J**	**0.683**	**0.264 J**	**0.694**	**0.359 J**	**2.7**	**0.409 J**	**0.349 J**
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	< 0.343 U	< 0.343 U	**3.18**	< 0.395 U	< 0.339 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.886 U	< 0.775 U	< 0.838 U	< 0.782 U	< 0.768 U	<0.769 U	**3.03**	< 0.886U	< 0.760 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.295 U	< 0.346 U	< 0.374 U	< 0.349 U	< 0.343 U	< 0.343U	**0.608**	< 0.395 U	< 0.339 U
Perfluoroheptanesulfonic acid	NSL	µg/kg	< 0.443 U	< 0.387 U	< 0.419 U	< 0.391 U	**0.383 J**	< 0.385 U	**11**	< 0.443 U	< 0.380 U
Perfluoroheptanoic acid	NSL	µg/kg	**0.329 J**	< 0.346 U	**0.553 J**	< 0.349 U	**0.76**	< 0.343 U	**4.99**	< 0.395 U	< 0.339 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**2.22**	**2.52**	**2.81**	**0.314 J**	**8.88**	**8.73**	**51.4**	**2.35**	**2.13**
Perfluorohexanoic acid	NSL	µg/kg	**0.92**	**0.505 J**	**1.24**	< 0.422 U	**2.41**	**0.299 J**	**8.25**	**0.329 J**	**0.371 J**
Perfluorononanoic acid (PFNA)	19	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	**0.31 J**	< 0.343 U	**3.52**	< 0.395 U	< 0.339 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	< 0.343 U	< 0.343 U	**1.46**	< 0.395 U	< 0.339 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**8.94**	**3.9**	**9.16**	< 0.422 U	**26.6**	**3.02**	**938**	**2.11 J**	**4.14 J**
Perfluorooctanoic acid (PFOA)	19	µg/kg	**0.597 J**	**0.451 J**	**0.744**	< 0.422 U	**1.09**	< 0.416 U	**6.18**	< 0.479 U	**0.277 J**
Perfluoropentanoic acid	NSL	µg/kg	**0.478 J**	**0.186 J**	**1.19**	< 0.349 U	**2.87**	**0.226 J**	**11.6**	**0.199 J**	**0.27 J**
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.479 U	< 0.419 U	< 0.453 U	< 0.422 U	< 0.415 U	< 0.416 U	**0.221 J**	< 0.479 U	< 0.411 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	< 0.343 U	< 0.343 U	**0.215 J**	< 0.395 U	< 0.339 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.395 U	< 0.346 U	< 0.374 U	< 0.349 U	< 0.343 U	< 0.343 U	**1.54**	< 0.395 U	< 0.339 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes**:**
J = Estimated result
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-7. 2019 West End Electrical Project PFAS Sampling Surface Soil Analytical Results Continued

Location ID			**SS09**	**SS10**	**SS11**	**SS12**	**SS13**	**SS14**	**SS15**	**SS16**	**SS17**
Sample Name			**NFARS-FTA-2019-SS09**	**NFARS-FTA-2019-SS10**	**NFARS-FTA-2019-SS11**	**NFARS-FTA-2019-SS12**	**NFARS-FTA-2019-SS13**	**NFARS-FTA-2019-SS14**	**NFARS-FTA-2019-SS15**	**NFARS-FTA-2019-SS16**	**NFARS-FTA-2019-SS17**
Parent Sample											
Sample Date			**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/13/2019**	**11/13/2019**	**11/13/2019**	**11/13/2019**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**									
PFAS (EPA 537 MOD)											
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.910 U	< 0.813 UJ	**0.392 J**	**1.9**	**17.8**	**2.12**	**8.92**	< 0.932 U	< 0.986 U
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.898 U	< 0.802 UJ	< 0.771 U	**1.46**	**17.2**	< 0.803 U	< 0.864 U	< 0.920 U	< 0.973 U
N-ethyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.641 U	< 0.873 U	< 0.551 U	< 0.503 U	< 0.529 U	< 0.574 U	< 0.617 U	< 0.657 U	< 0.695 U
N-methyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.770 U	< 0.688 UJ	< 0.661 U	< 0.604 U	< 0.634 U	< 0.688 U	< 0.741 U	< 0.789 U	< 0.834 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	**1.18**	**0.495 J**	**2.81**	**0.681**	**7.85**	**0.496 J**	**0.275 J**	< 0.394 U	< 0.417 U
Perfluorobutanoic acid	NSL	µg/kg	**1.07**	**1.73 J**	**1.88**	**1.83**	**1.76**	**2.16**	**0.452 J**	**0.452 J**	**0.373 J**
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.385 U	< 0.344 UJ	< 0.330 U	< 0.302 U	**0.168 J**	**0.491 J**	< 0.370 U	< 0.394 U	< 0.417 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.863 U	< 0.771 UJ	< 0.741 U	< 0.677 U	**0.371 J**	< 0.772 U	< 0.830 U	< 0.884 U	< 0.935 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.385 U	< 0.344 UJ	< 0.330 U	< 0.302 U	< 0.317U	< 0.344 U	< 0.370 U	< 0.394 U	< 0.417 U
Perfluoroheptanesulfonic acid	NSL	µg/kg	**2.24**	**0.794**	**0.419 J**	**0.508**	**2.76**	**3.38**	**0.259 J**	< 0.442 U	< 0.468 U
Perfluoroheptanoic acid	NSL	µg/kg	**3.79**	**0.964**	**3.1**	**3.23**	**16.1**	**1.35**	**0.624**	**0.283 J**	< 0.417 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**25.4**	**21.6 J**	**21.7**	**3.99**	**30.4**	**11.3**	**4.66**	**1.27**	**0.914**
Perfluorohexanoic acid	NSL	µg/kg	**3.34**	**4.57**	**6.83**	**6.05**	**20.5**	**3.6**	**0.908**	**0.553 J**	**0.377 J**
Perfluorononanoic acid (PFNA)	19	µg/kg	**6.24**	**1.04 J**	**0.241 J**	**0.288 J**	**3.49**	**3.7**	**0.418 J**	< 0.394 U	< 0.417 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.385 U	< 0.344 U	< 0.330 U	< 0.302 U	**0.387 J**	**0.393 J**	< 0.370 U	< 0.394 U	< 0.417 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**147**	**69.4 J**	**14.1**	**29.5**	**163**	**411**	**25.5**	**1.86**	**2.26**
Perfluorooctanoic acid (PFOA)	19	µg/kg	**11**	**3.39**	**2.73**	**3.39**	**16.9**	**4.14**	**1.41**	**0.76**	**0.287 J**
Perfluoropentanoic acid	NSL	µg/kg	**2.84**	**3.48**	**5.14**	**7.7**	**15.9**	**4.1**	**0.683**	**0.296 J**	**0.215 J**
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.466 U	< 0.417 UJ	< 0.401 U	< 0.366 U	< 0.385 U	< 0.417 U	< 0.4491 U	< 0.478 U	< 0.509 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.385 U	< 0.344 U	< 0.330 U	< 0.302 U	**0.169 J**	< 0.344 U	< 0.370 U	< 0.394 U	< 0.417 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.385 U	< 0.344 UJ	< 0.330 U	< 0.302 U	**0.344 J**	**0.219 J**	< 0.370 U	< 0.394 U	< 0.417 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated result
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-8. 2019 West End Electrical Project PFAS Sampling Subsurface Soil Analytical Results

Location ID			**SB01**	**SB02**	**SB03**	**SB04**	**SB05**	**SB06**		**SB07**	**SB08**	
Sample Name			**NFARS-FTA-2019-SB01 (2-3)**	**NFARS-FTA-2019-SB02 (3-4)**	**NFARS-FTA-2019-SB03 (3-4)**	**NFARS-FTA-2019-SB04 (3-4)**	**NFARS-FTA-2019-SB05 (2-3)**	**NFARS-FTA-2019-SB06 (3-4)**	**NFARS-FTA-2019-S-FD01**	**NFARS-FTA-2019-SB07 (2-3)**	**NFARS-FTA-2019-SB08 (3-4)**	**NFARS-FTA-2019-S-FD03**
Parent Sample									**NFARS-FTA-2019-SB06 (3-4)**			**NFARS-FTA-2019-SB08 (3-4)**
Sample Date			**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**	**11/12/2019**
Analyte	**ASD Calculated Residential Soil RSL[1]**	**Unit**										
PFAS (EPA 537 MOD)												
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.917 U	< 0.951 U	< 0.839 U	< 0.812 U	< 0.885 U	< 832 U	**0.722 J**	< 0.782 U	< 0.942 U	**1.9**
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.906 U	< 0.939 U	< 0.828 U	< 0.802 U	< 0.873 U	< 0.822 U	< 0.897 U	< 0.772 U	< 0.930 U	< 0.862 U
N-ethyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.647 U	< 0.671 U	< 0.591 U	< 0.573 U	< 0.624 U	< 587 U	< 0.641 U	< 0.552 U	< 0.664 U	< 0.616 U
N-methyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.776 U	< 0.805 U	< 0.710 U	< 0.687 U	< 0.749U	< 0.704 U	< 0.769 U	< 0.662 U	< 0.797 U	< 0.739 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	< 0.388 U	< 0.402 U	**0.206 J**	< 0.344 U	**0.535 J**	**1.53**	**1.57**	**1.9**	**0.363 J**	**0.358 J**
Perfluorobutanoic acid	NSL	µg/kg	< 0.470 U	< 0.488 U	**0.505 J**	**0.246 J**	**1.14**	< 0.427 U	**0.284 J**	**0.775**	**0.379 J**	**0.48 J**
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	< 0.355 U	< 0.344 U	< 0.374 U	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U
Perfluorodecanoic acid	NSL	µg/kg	< 870 U	< 0.902 U	< 0.796 U	< 0.771 U	< 0.839 U	< 0.789 U	< 0.862 U	< 0.742 U	< 0.894 U	< 0.828 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	< 0.355 U	< 0.344 U	< 0.374 U	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U
Perfluoroheptanesulfonic acid	NSL	µg/kg	< 0.435 U	< 0.451 U	**0.235 J**	< 0.3851 U	**0.697**	< 0.395 U	< 0.431 U	**0.286 J**	< 0.447 U	< 0.414 U
Perfluoroheptanoic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	**0.578**	< 0.344 U	**0.838**	< 0.652 U	< 0.384 U	**0.359 J**	< 0.399 U	< 0.369 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**0.755**	**0.391 J**	**3.86**	< 0.344 U	**11.4**	**2.7**	**3.64**	**8.41**	**1.79**	**1.85**
Perfluorohexanoic acid	NSL	µg/kg	< 0.470 U	< 0.488 U	**1.41**	< 0.417 U	**2.52**	< 0.427 U	< 0.466 U	**2.69**	**0.387 J**	**0.241 J**
Perfluorononanoic acid (PFNA)	19	µg/kg	< 0.388 U	< 0.402 U	**0.247 J**	< 0.344 U	**0.482 J**	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.388 U	< 0.402 U	< 0.355 U	< 0.344 U	**0.218 J**	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**0.448 J**	< 0.488 U	**16**	< 0.417 U	**61.3**	**0.387 J**	**0.661**	**8.44**	**1.6**	**0.711**
Perfluorooctanoic acid (PFOA)	19	µg/kg	< 0.470 U	< 0.488 U	**0.982**	< 0.417 U	**2.86**	< 0.427 U	< 0.466 U	**0.506**	< 0.483 U	< 0.448 U
Perfluoropentanoic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	**1.24**	< 0.344 U	**1.82**	< 0.352 U	< 0.384 U	**1.86**	**0.332 J**	**0.263 J**
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.470 U	< 0.488 U	< 0.430 U	< 0.417 U	< 0.454 U	< 0.427 U	< 0.466 U	< 0.401 U	< 0.483 U	< 0.448 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	< 0.355 U	< 0.344 U	< 0.374 U	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.388 U	< 0.402 U	< 0.355 U	< 0.344 U	< 0.374 U	< 0.352 U	< 0.384 U	< 0.331 U	< 0.399 U	< 0.369 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
J = Estimated result
NSL = No screening level available
R = Data was rejected
U = Not detected above the limit of detection
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.

Table 10-8. 2019 West End Electrical Project PFAS Sampling Subsurface Soil Analytical Results Continued

Location ID			SB09	SB10	SB11	SB12	SB13	SB14		SB15	SB16	SB17
Sample Name			NFARS-FTA-2019-SB09 (3-4)	NFARS-FTA-2019-SB10 (3-4)	NFARS-FTA-2019-SB11 (2-3)	NFARS-FTA-2019-SB12 (3-4)	NFARS-FTA-2019-SB13 (2-3)	NFARS-FTA-2019-SB14 (2-4)	NFARS-FTA-2019-S-FD04	NFARS-FTA-2019-SB15 (2-3)	NFARS-FTA-2019-SB16 (3-4)	NFARS-FTA-2019-SB17 (3-4)
Parent Sample									NFARS-FTA-2019-SB14 (2-4)			
Sample Date			11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/12/2019	11/13/2019	11/13/2019	11/13/2019	11/13/2019	11/13/2019
Analyte	ASD Calculated Residential Soil RSL[1]	Unit										
PFAS (EPA 537 MOD)												
6:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.850 U	< 0.908 U	**0.727 J**	**0.616 J**	**58**	**7.92 J**	**3.15 J**	**7.44**	< 0.926 U	**0.724 J**
8:2 Fluorotelomer sulfonate	NSL	µg/kg	< 0.839 U	< 0.896 U	< 0.786 U	< 0.762 U	**6.17**	< 0.875 U	<0.957 U	**0.514 J**	< 0.914 U	< 0.893 U
N-ethyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.600 U	< 0.640 U	< 0.561 U	< 0.544U	< 0.646 U	< 0.625 U	< 0.684 U	< 0.653 U	< 0.653 U	< 0.638 U
N-methyl perfluorooctanesulfonamidoacetic acid	NSL	µg/kg	< 0.720 U	< 0.768 U	< 0.674 U	< 0.653 U	< 0.775 U	< 0.750 U	< 0.821 U	< 0.784 U	< 0.784 U	< 0.766 U
Perfluorobutanesulfonic acid (PFBS)	1,900	µg/kg	**2.84**	**0.511 J**	**2.41**	**0.574**	**1.37**	**5.11**	**5.45**	**0.436 J**	< 0.392 U	< 0.383 U
Perfluorobutanoic acid	NSL	µg/kg	**1.86**	**0.526 J**	**0.804**	**0.713**	**1.52**	**0.973**	**1.19**	**1.16**	**0.283 J**	**0.236 J**
Perfluorodecanesulfonic acid	NSL	µg/kg	< 0.360 U	< 0.384 U	< 0.337 U	< 0.326 U	< 0.388 U	< 0.375 U	< 0.410 U	**0.276 J**	< 0.392 U	< 0.383 U
Perfluorodecanoic acid	NSL	µg/kg	< 0.807 U	< 0.861U	< 0.755 U	< 0.732 U	< 0.869 U	< 0.481 U	< 0.920 U	< 0.879 U	< 0.879 U	< 0.859 U
Perfluorododecanoic acid	NSL	µg/kg	< 0.360 U	< 0.684 U	< 0.337U	< 0.326 U	< 0.388 U	< 0.375 U	< 0.410 U	< 0.392 U	< 0.392 U	< 0.383 U
Perfluoroheptanesulfonic acid	NSL	µg/kg	**5.47**	**0.349 J**	< 0.378 U	< 0.366 U	**0.383 J**	**2.87**	**2.61**	**0.665**	< 0.439 U	< 0.429 U
Perfluoroheptanoic acid	NSL	µg/kg	**5.51**	**0.479 J**	**1.22**	< 0.326 U	**2.16**	**1.73**	**2.3**	**1.3**	< 0.392 U	< 0.383 U
Perfluorohexanesulfonic acid (PFHxS)	130	µg/kg	**50.1**	**17.8**	**11.7**	**0.296 J**	**6.78**	**64.7**	**65.1**	**9.97**	< 0.392 U	< 0.383 U
Perfluorohexanoic acid	NSL	µg/kg	**12.2**	**2.65**	**4.26**	**1.77**	**6.62**	**6.47**	**7.72**	**1.79**	< 0.475 U	< 0.464 U
Perfluorononanoic acid (PFNA)	19	µg/kg	**2.15**	< 0.384 U	< 0.337 U	< 0.326 U	**0.246 J**	< 0.375 U	**0.235 J**	**1.91**	< 0.392 U	< 0.383 U
Perfluorooctanesulfonamide (PFOSA)	NSL	µg/kg	< 0.360 U	< 0.384 U	< 0.337 U	< 0.326 U	< 0.388 U	< 0.375 U	< 0.410 U	**0.512 J**	< 0.392 U	< 0.383 U
Perfluorooctanesulfonic acid (PFOS)	13	µg/kg	**147**	**7.78**	**5.88**	**0.662**	**7.06**	**42.9**	**43.9**	**73**	< 0.475 U	< 0.464 U
Perfluorooctanoic acid (PFOA)	19	µg/kg	**20.5**	**0.956**	**1.02**	< 0.396 U	**4.09**	**2.92**	**3.3**	**3.17**	< 0.475 U	< 0.464 U
Perfluoropentanoic acid	NSL	µg/kg	**5.78**	**0.769**	**3.46**	**2.38**	**5.96**	**2.31**	**2.67**	**1.73**	< 0.392 U	< 0.383 U
Perfluorotetradecanoic acid	NSL	µg/kg	< 0.436 U	< 0.466 U	< 0.408 U	< 0.396 U	< 0.470 U	< 0.455 U	< 0.497 U	< 0.475 U	< 0.475 U	< 0.464 U
Perfluorotridecanoic acid	NSL	µg/kg	< 0.360 U	< 0.384 U	< 0.337 U	< 0.326 U	< 0.388 U	< 0.375 U	< 0.410 U	< 0.392 U	< 0.392 U	< 0.383 U
Perfluoroundecanoic acid	NSL	µg/kg	< 0.360 U	< 0.384 U	< 0.337 U	< 0.326 U	< 0.388 U	< 0.375 U	< 0.410 U	**0.647**	< 0.392 U	< 0.383 U

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Notes:
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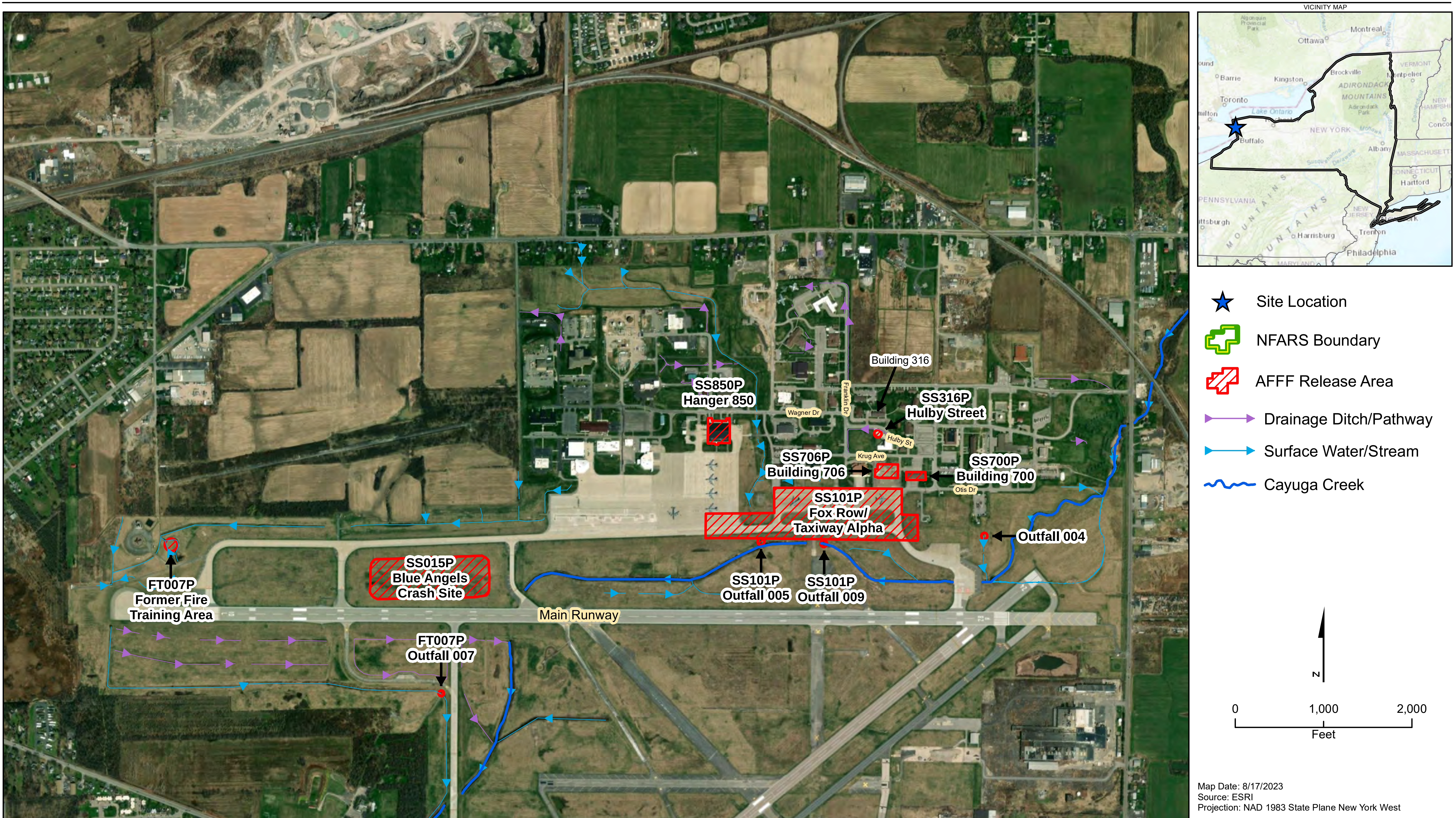
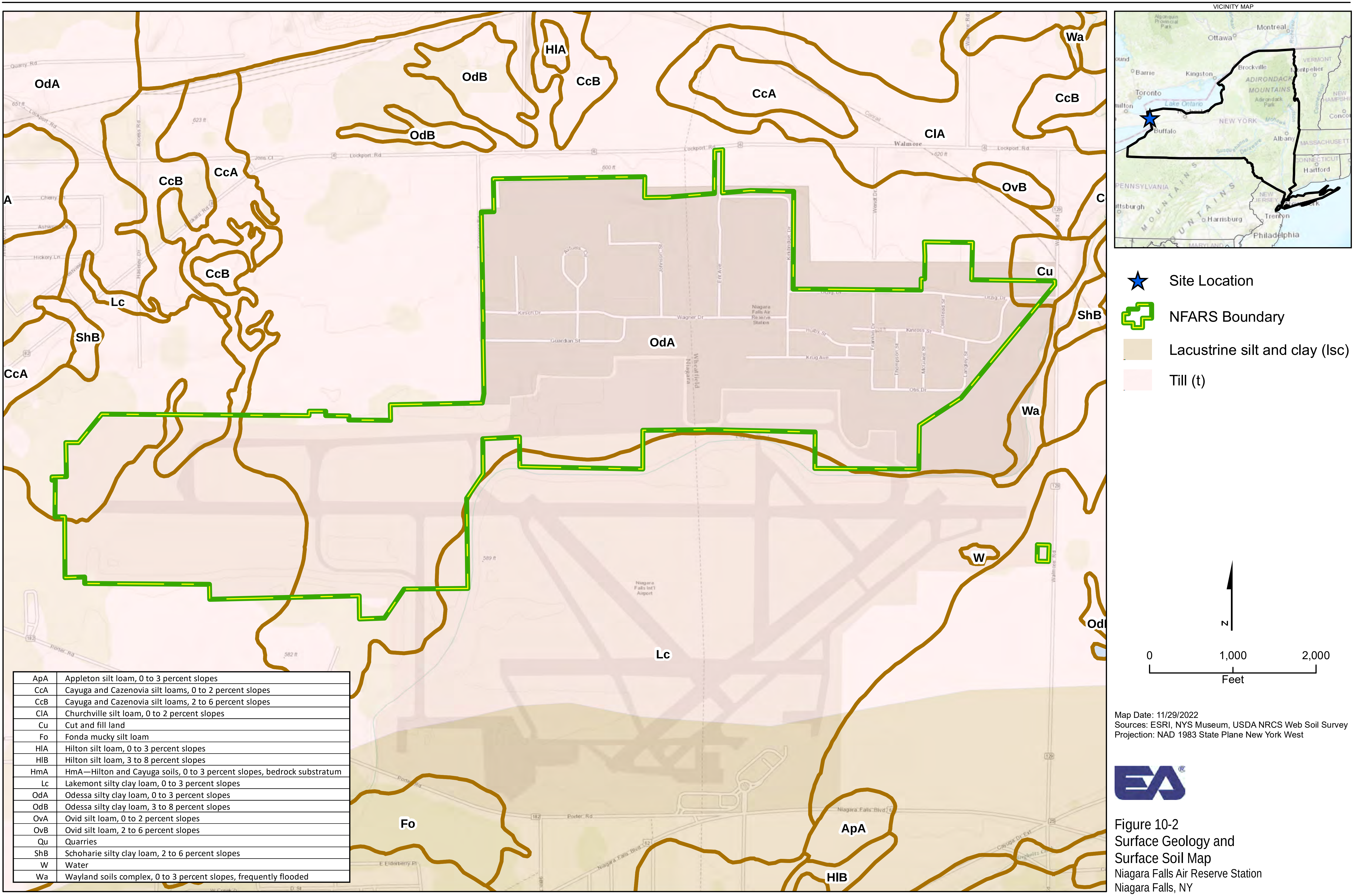
Detected results are **bolded.**
Values exceeding the ASD calculated residential soil RSL are shaded gray.



Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 10-1
Outfalls and Drainage Areas Map
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafs\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-1 Outfalls and Drainage Areas Map.mxd



ApA	Appleton silt loam, 0 to 3 percent slopes
CcA	Cayuga and Cazenovia silt loams, 0 to 2 percent slopes
CcB	Cayuga and Cazenovia silt loams, 2 to 6 percent slopes
ClA	Churchville silt loam, 0 to 2 percent slopes
Cu	Cut and fill land
Fo	Fonda mucky silt loam
HlA	Hilton silt loam, 0 to 3 percent slopes
HlB	Hilton silt loam, 3 to 8 percent slopes
HmA	HmA—Hilton and Cayuga soils, 0 to 3 percent slopes, bedrock substratum
Lc	Lakemont silty clay loam, 0 to 3 percent slopes
OdA	Odessa silty clay loam, 0 to 3 percent slopes
OdB	Odessa silty clay loam, 3 to 8 percent slopes
OvA	Ovid silt loam, 0 to 2 percent slopes
OvB	Ovid silt loam, 2 to 6 percent slopes
Qu	Quarries
ShB	Schoharie silty clay loam, 2 to 6 percent slopes
W	Water
Wa	Wayland soils complex, 0 to 3 percent slopes, frequently flooded

Map Date: 11/29/2022
Sources: ESRI, NYS Museum, USDA NRCS Web Soil Survey
Projection: NAD 1983 State Plane New York West

Figure 10-2
Surface Geology and
Surface Soil Map
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafs\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-2 Surface Geology and Surface Soil Map.mxd

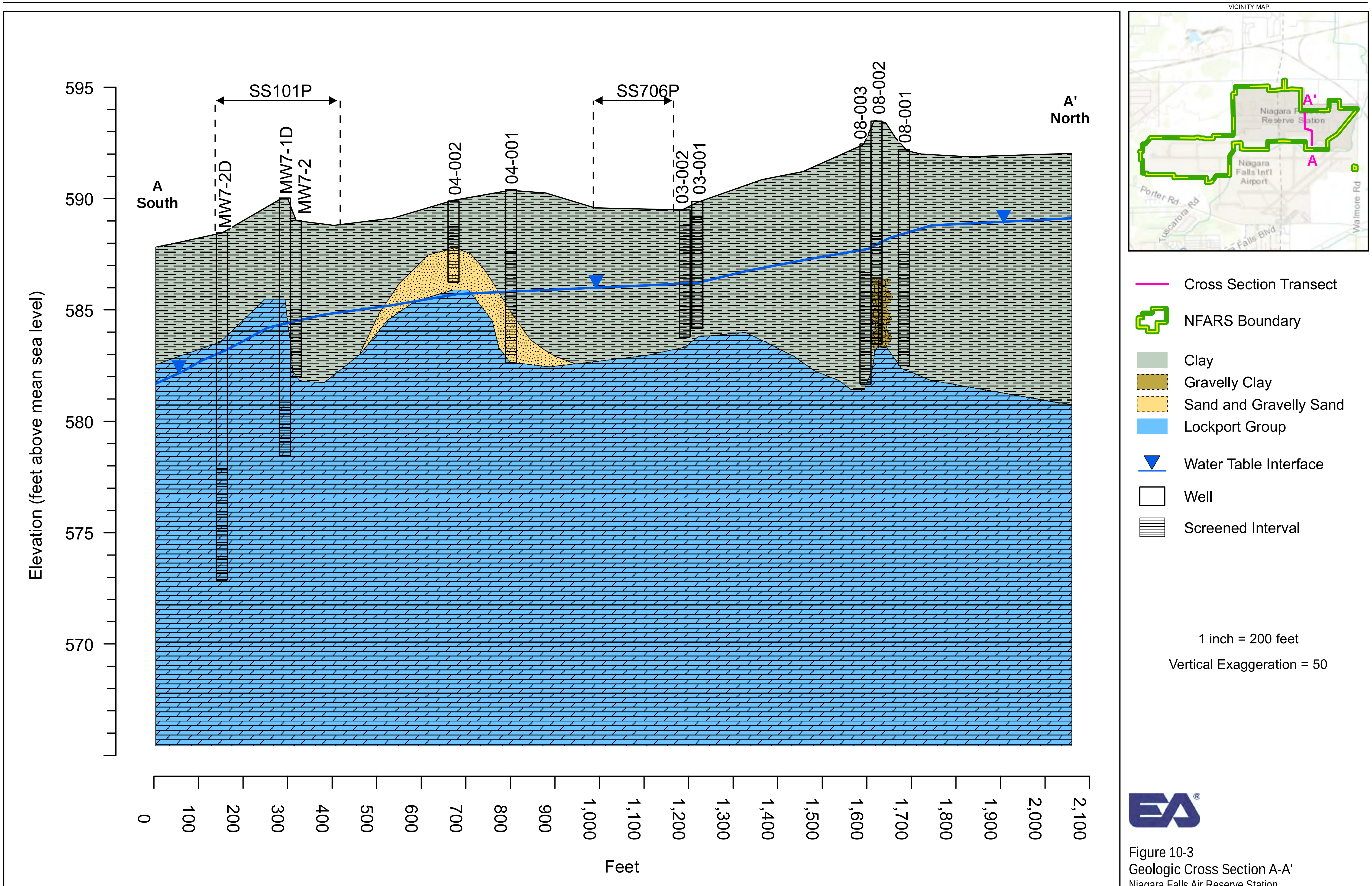
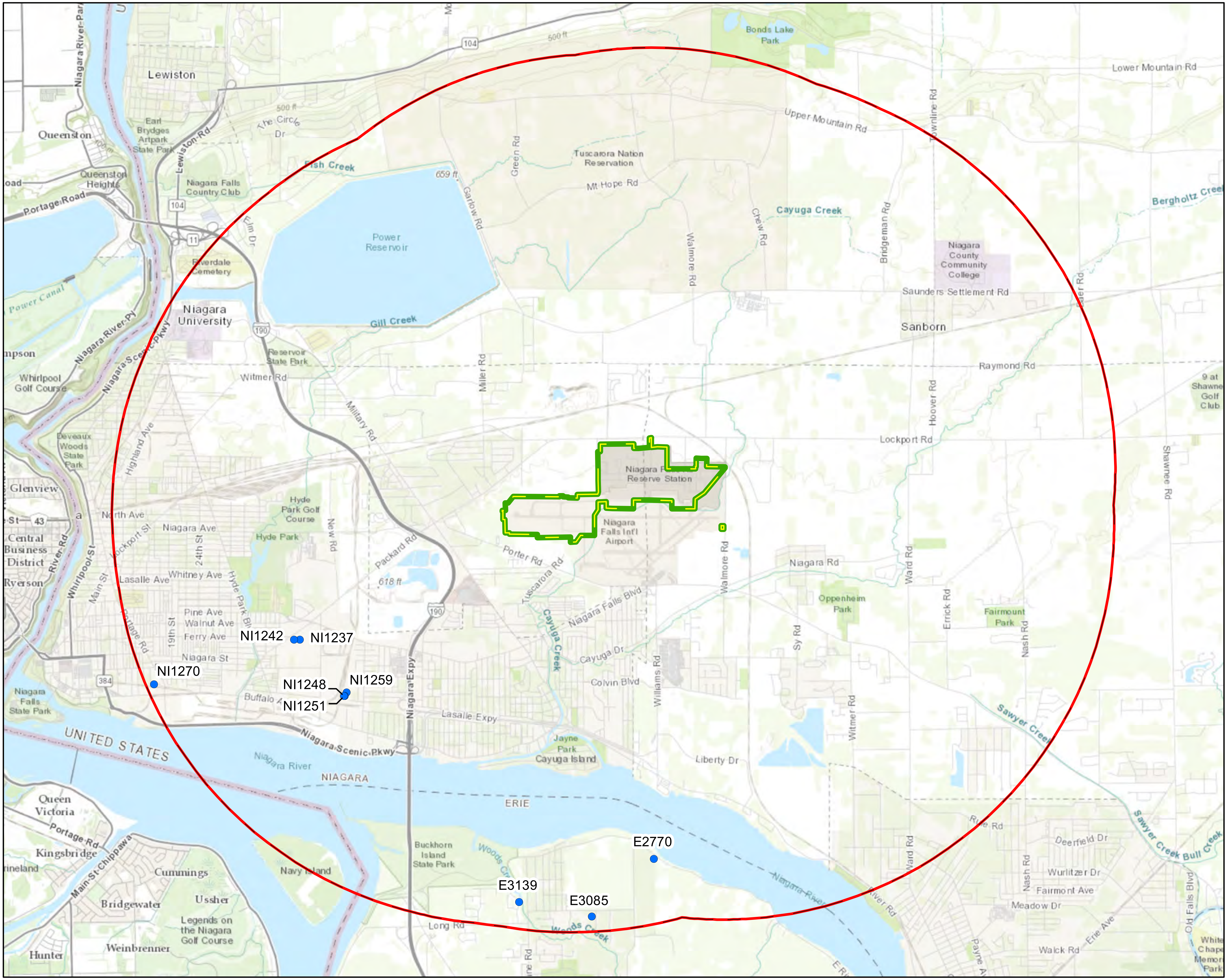


Figure 10-3
Geologic Cross Section A-A'
Niagara Falls Air Reserve Station
Niagara Falls, NY



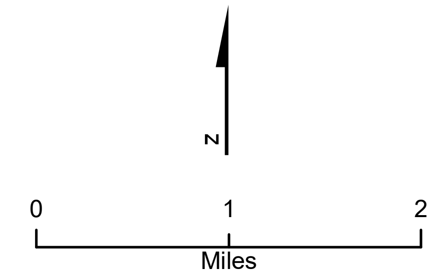
VICINITY MAP

★ Site Location

🟩 NFARS Boundary

🟥 4 Mile Radius

● Water Well



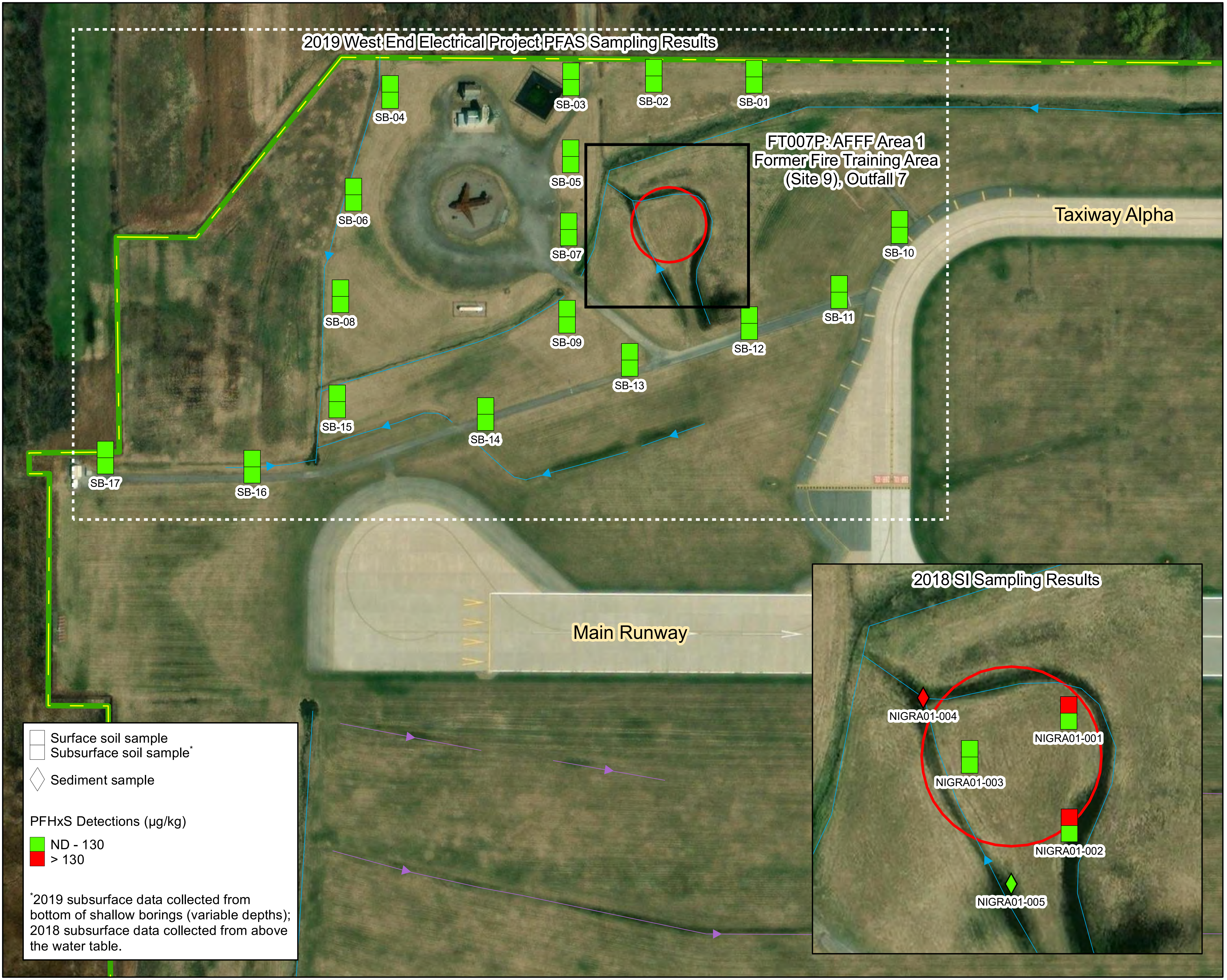
There are no public water wells within 4 miles of NFARS, although several private wells exist. The wells shown here were identified in the 2018 SI (ASL 2018) as designated for commercial or domestic use within 4 miles downgradient of the installation.

Map Date: 12/16/2022
Source: ESRI
Projection: NAD 1983 State Plane New York West

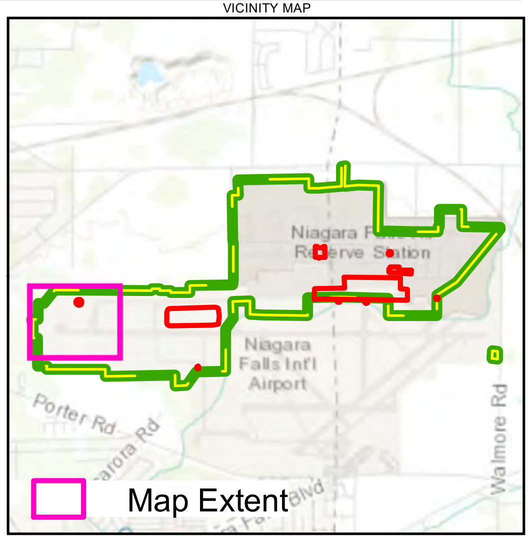
EA®

Figure 10-4
Water Wells Within 4 Miles
Downgradient of NFARS
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-4 Water Wells Within 4 Miles of NFARS.mxd



*2019 subsurface data collected from bottom of shallow borings (variable depths); 2018 subsurface data collected from above the water table.



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

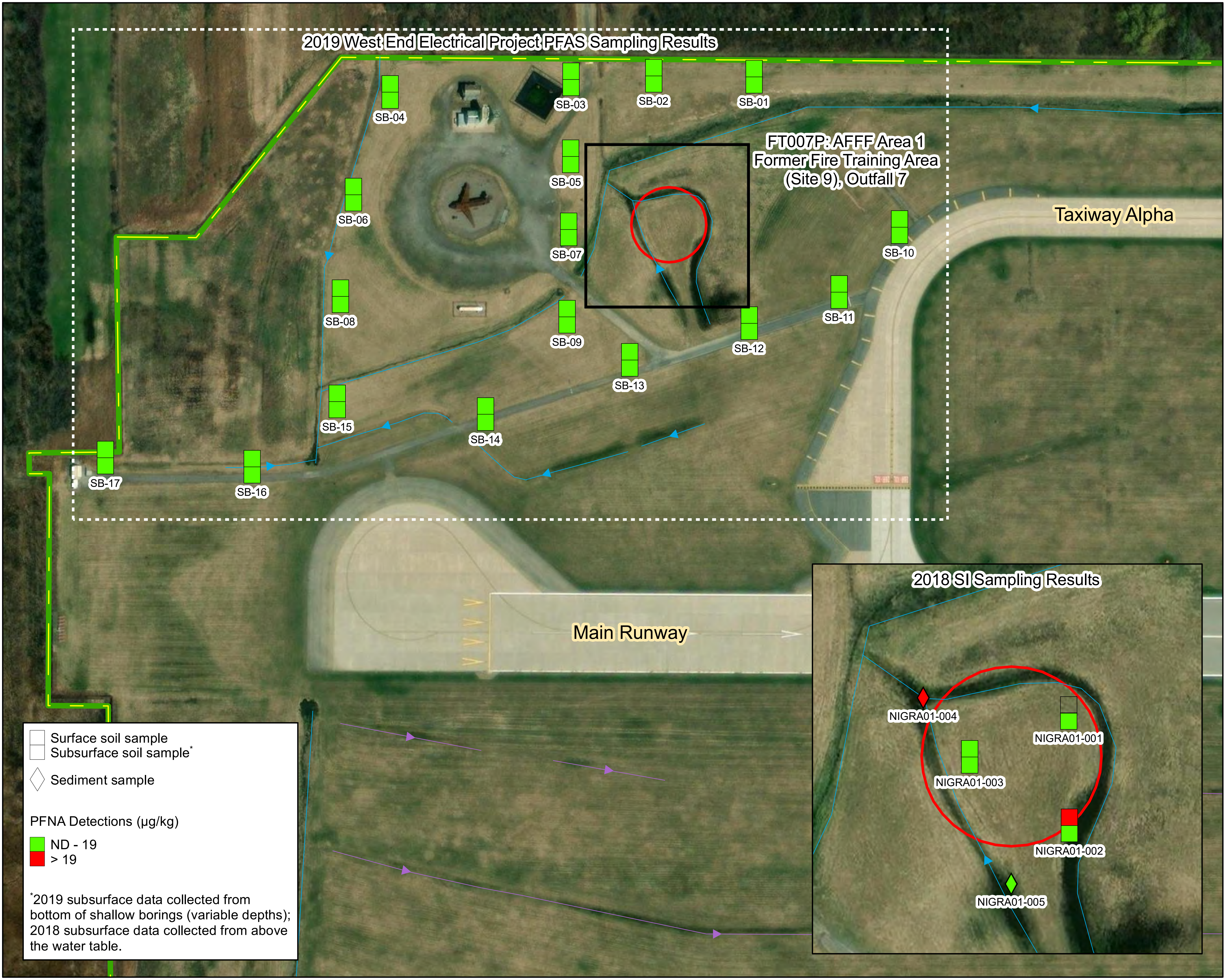
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

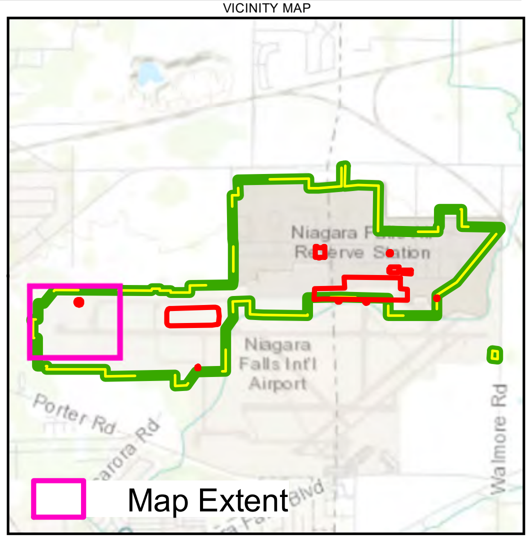
0 150 300
Feet

Figure 10-5
Historical Sampling Results
PFHxS Detections in Soil and Sediment
at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-5 Historical PFHxS Soil Sed.mxd



VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

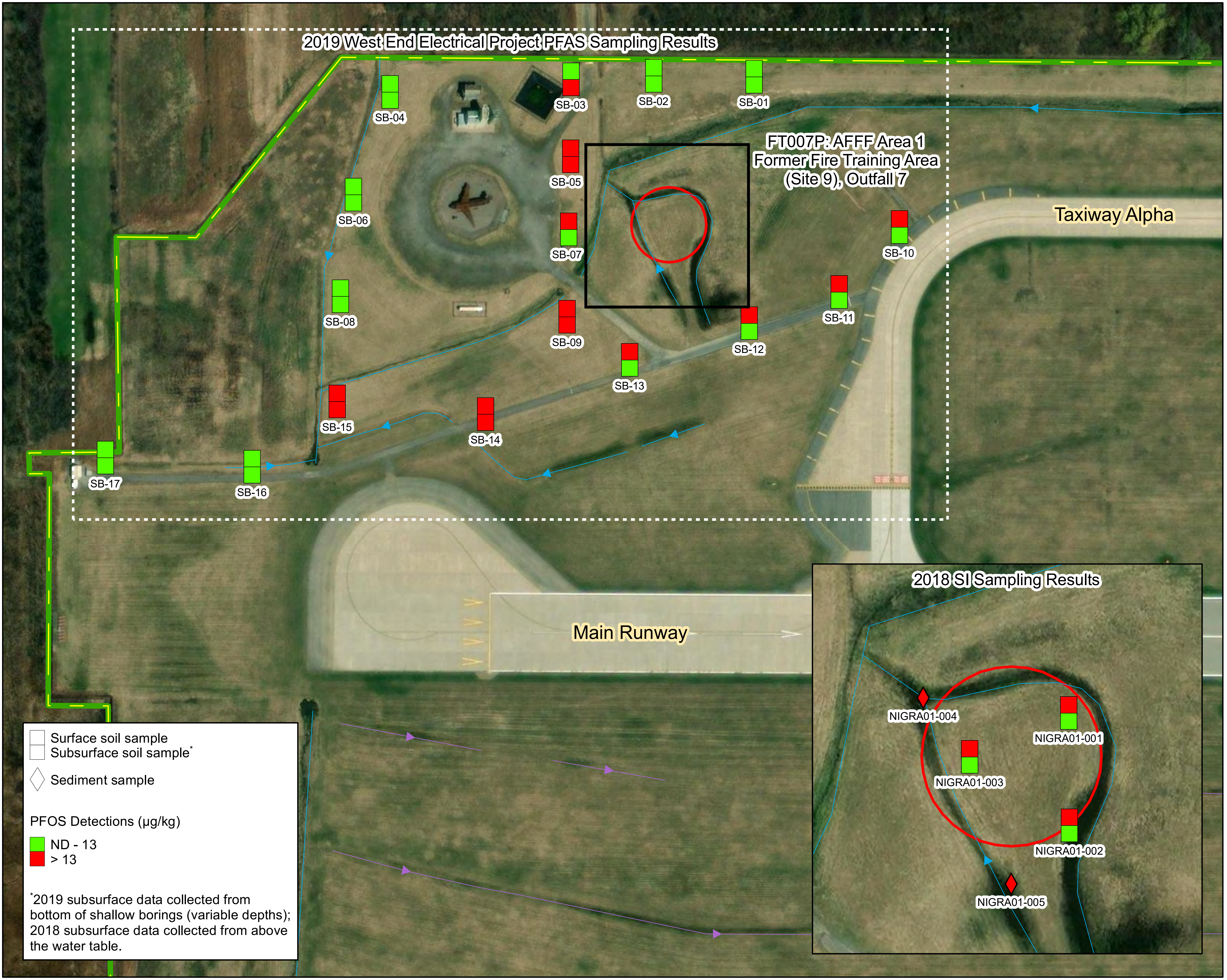
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

0 150 300
Feet

Figure 10-6
Historical Sampling Results
PFNA Detections in Soil and Sediment
at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-6 Historical PFNA Soil Sed.mxd

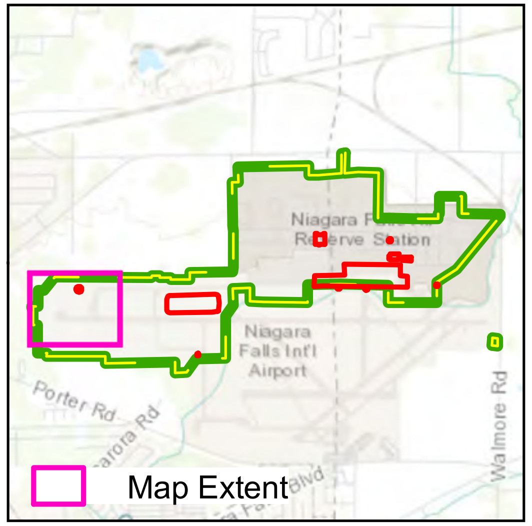


☐ Surface soil sample
☐ Subsurface soil sample*
◇ Sediment sample

PFOS Detections (µg/kg)
🟩 ND - 13
🟥 > 13

*2019 subsurface data collected from bottom of shallow borings (variable depths); 2018 subsurface data collected from above the water table.

VICINITY MAP



Map Extent

NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

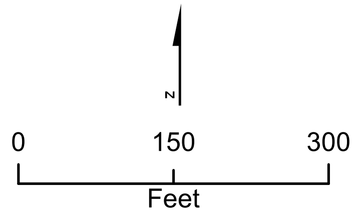
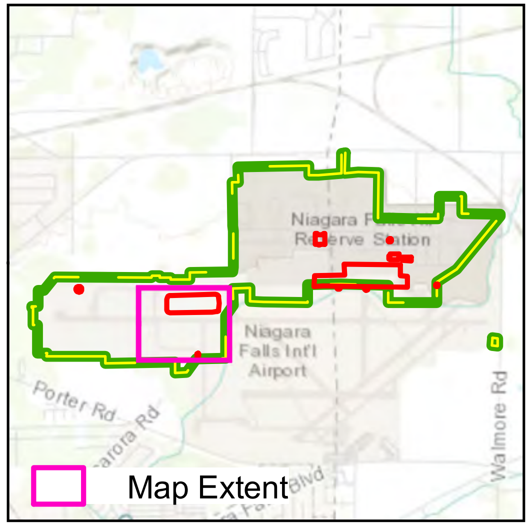


Figure 10-7a
Historical Sampling Results
PFOS Detections in Soil and Sediment
at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-7a Historical PFOS Soil Sed 1.mxd

VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

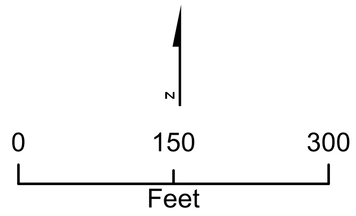
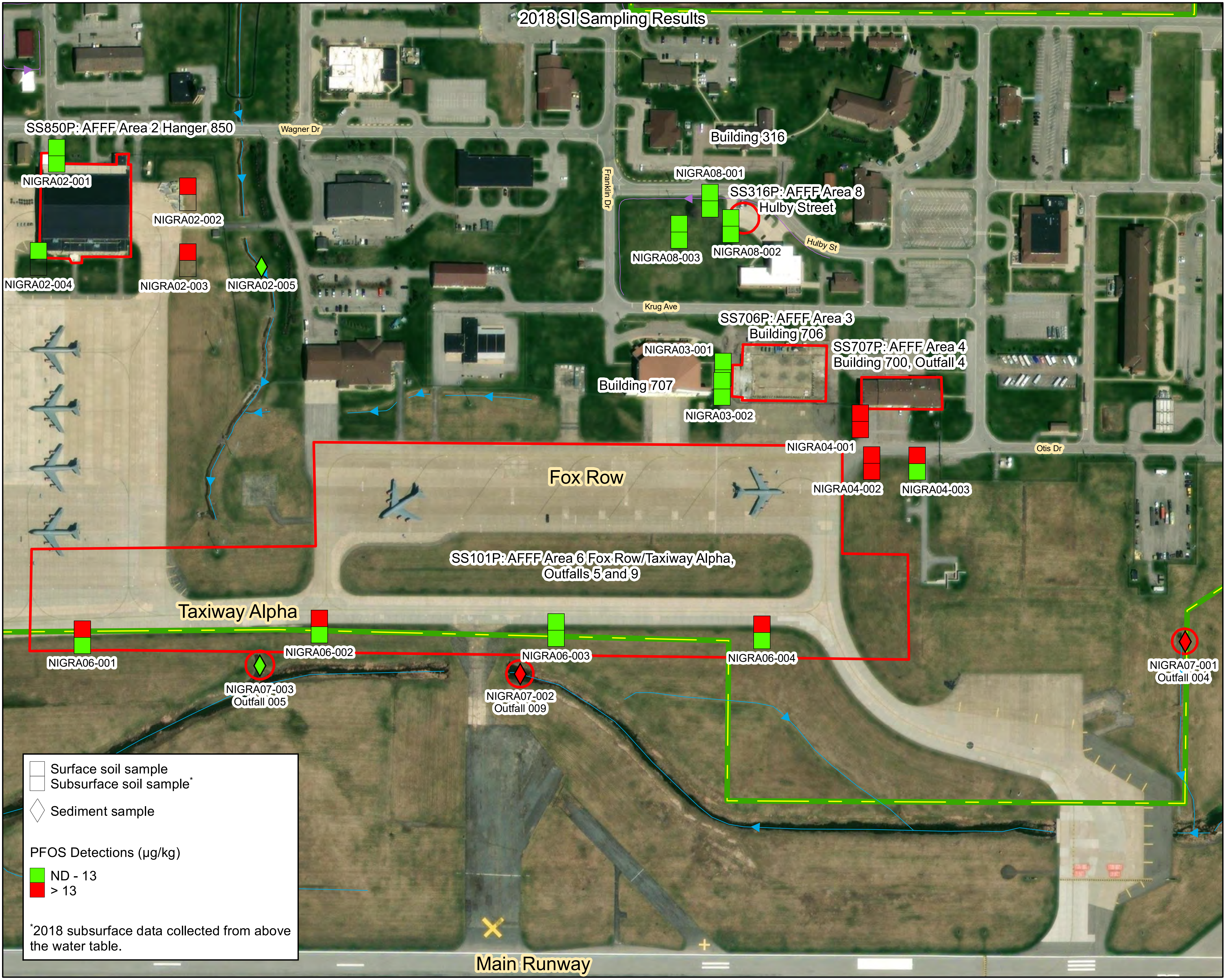


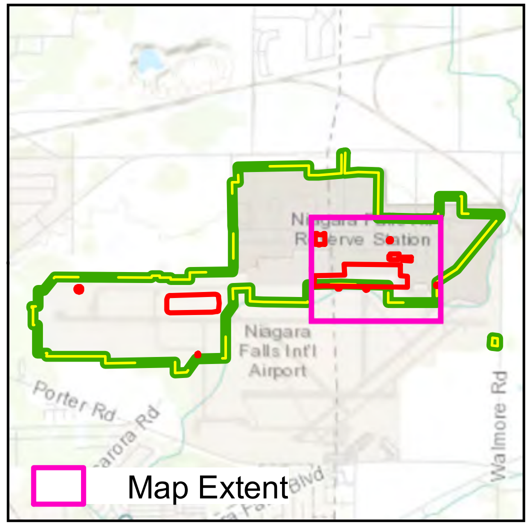
Figure 10-7b
Historical Sampling Results
PFOS Detections in Soil and Sediment at SS015P and Outfall 7 (FT007P)

Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-7b Historical PFOS Soil Sed 5.mxd



VICINITY MAP



🟩 NFARS Boundary

🟥 AFFF Release Area

→ Surface Water/Stream

→ Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

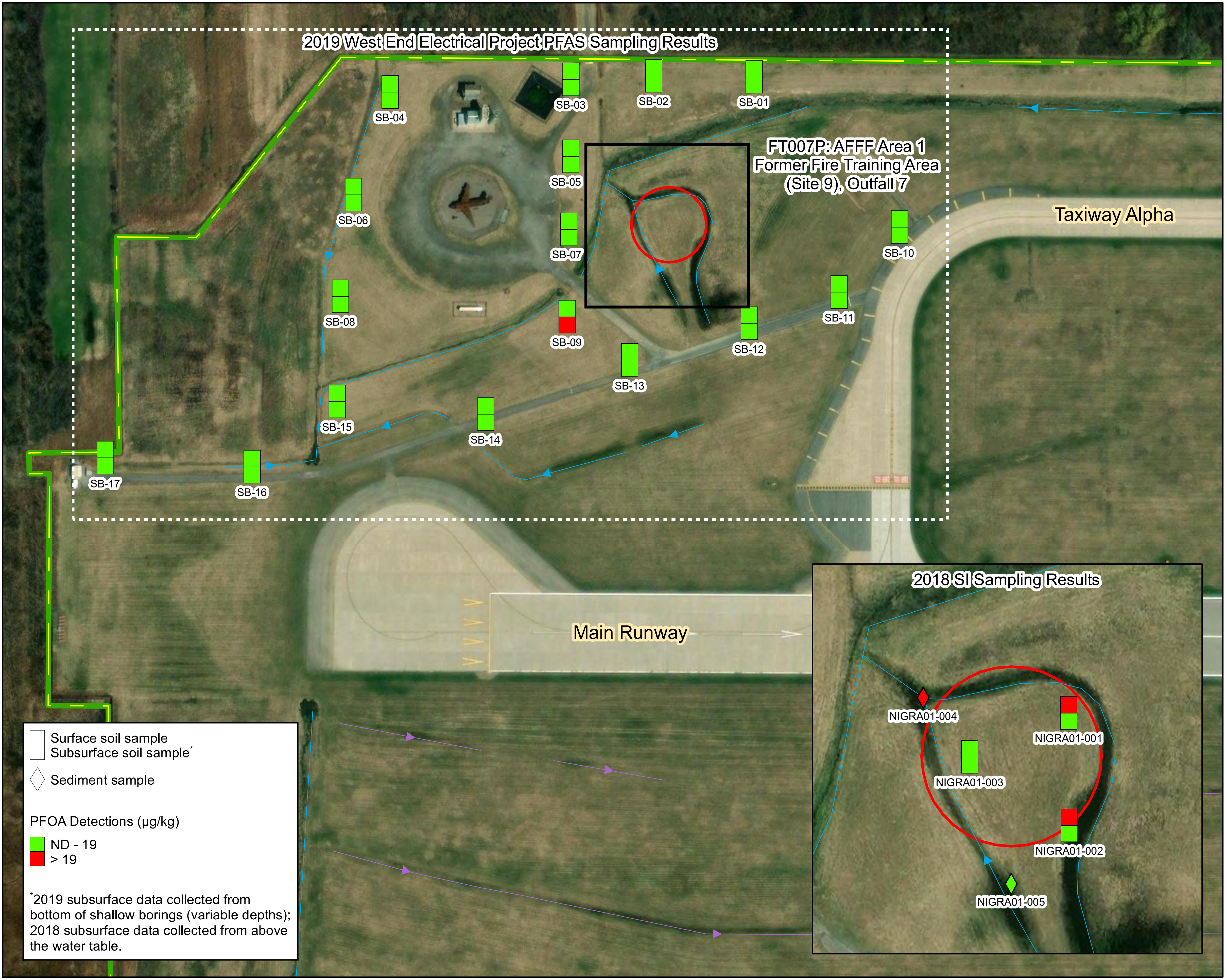
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

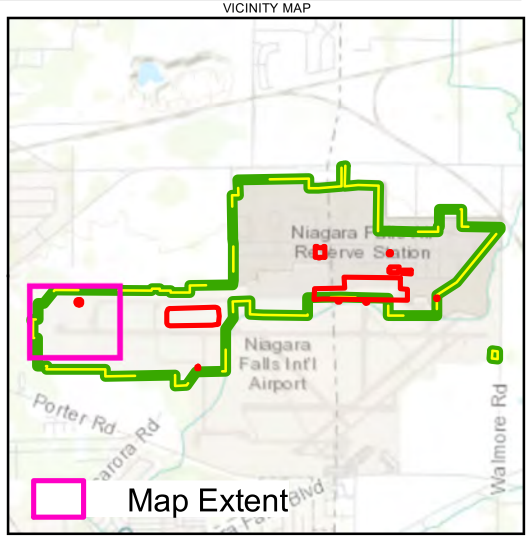
N

0 250 500
Feet

Figure 10-7c
Historical Sampling Results
PFOS Detections in Soil and Sediment
at SS850P, SS706P, SS707P,
SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafs\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-7c Historical PFOS Soil Sed 2,3,4,6,8.mxd





NFARS Boundary

AFFF Release Area

→ Surface Water/Stream

→ Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	1,900
Perfluorohexanesulfonic acid (PFHxS)	130
Perfluorononanoic acid (PFNA)	19
Perfluorooctanesulfonic acid (PFOS)	13
Perfluorooctanoic acid (PFOA)	19

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

Colorless soil samples indicate data which were rejected, and are plotted to distinguish surface from subsurface samples.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

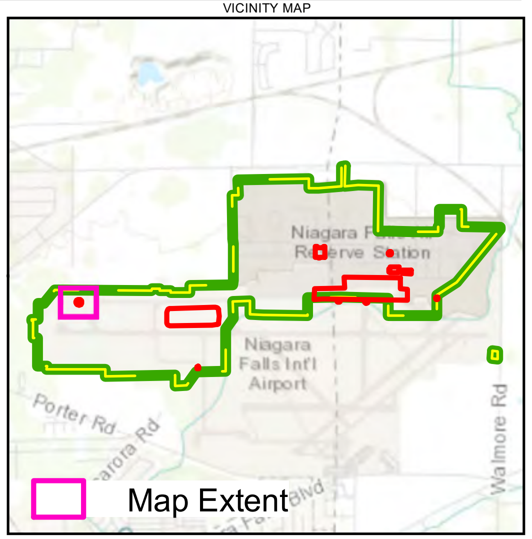
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

0 150 300
Feet

Figure 10-8
Historical Sampling Results
PFOA Detections in Soil and Sediment
at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-8 Historical PFOA Soil Sed.mxd



🟩 NFARS Boundary

🟥 AFFF Release Area

→ Surface Water/Stream

→ Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

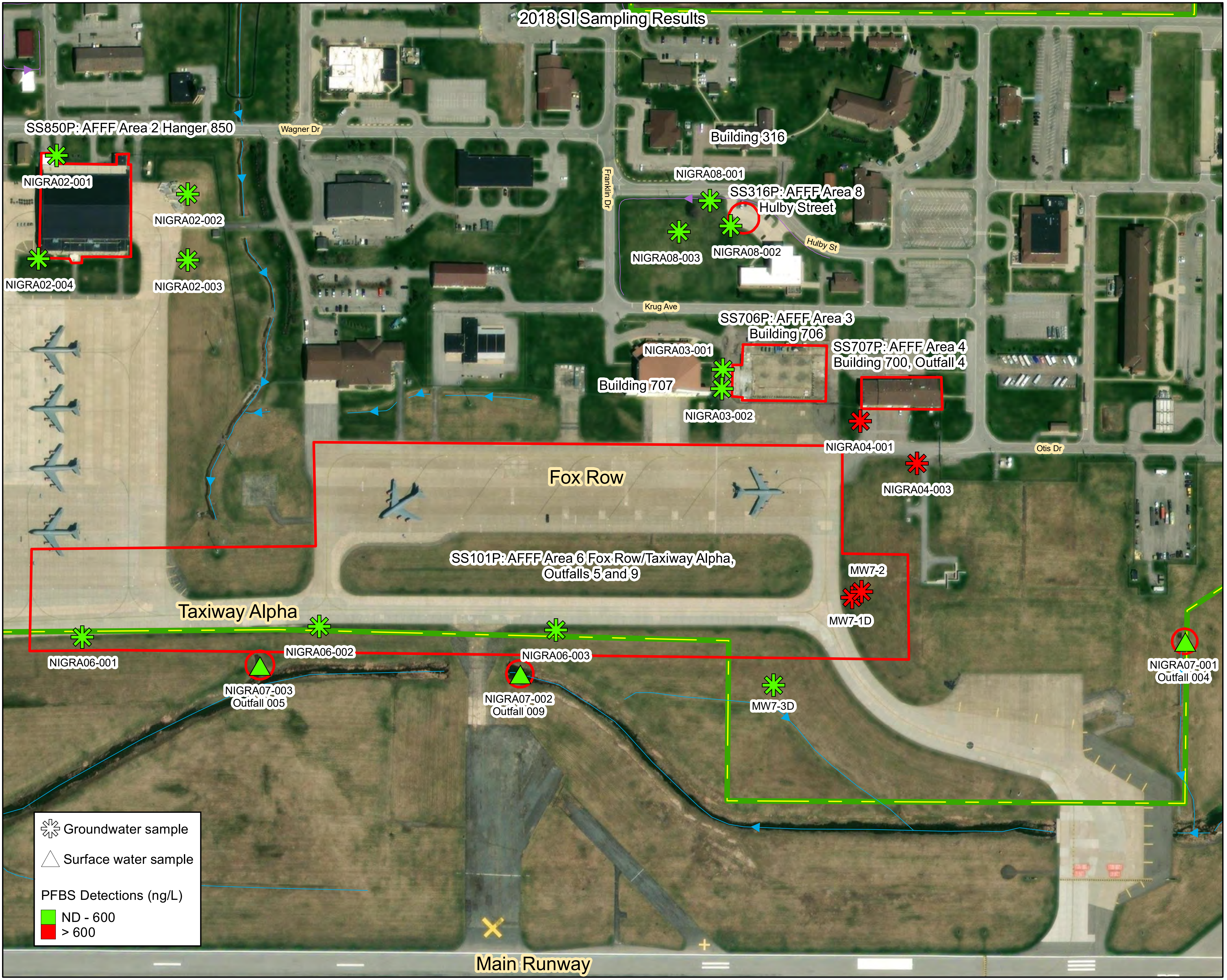
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

0 75 150
Feet

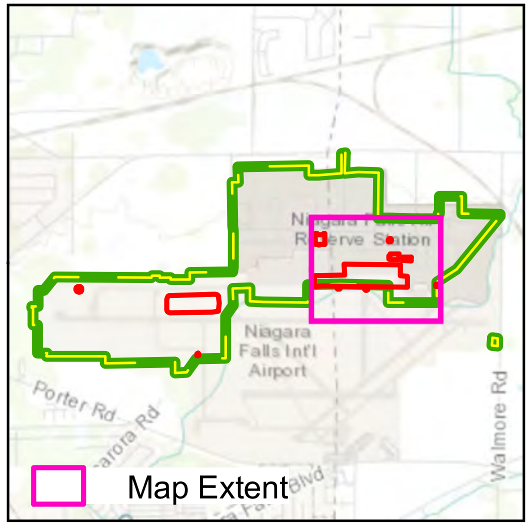
Figure 10-9a
Historical Sampling Results
PFBS Detections in Groundwater and
Surface Water at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-9a Historical PFBS GW SW 1.mxd



\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-9b Historical PFBS GW SW 2,3,4,6,8.mxd

VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

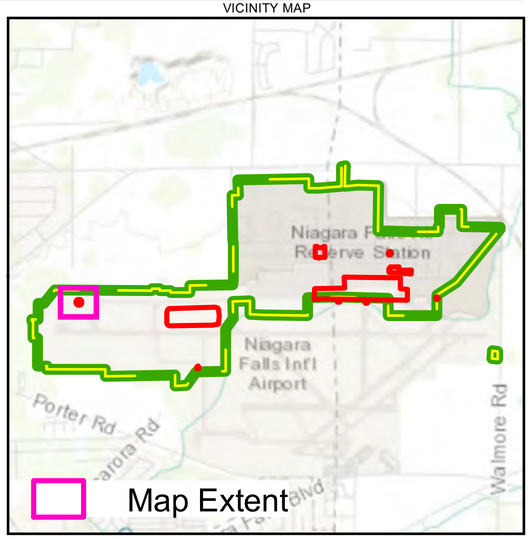
µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

0 250 500
Feet

Figure 10-9b
Historical Sampling Results
PFBS Detections in Groundwater and Surface Water at SS850P, SS706P, SS707P, SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

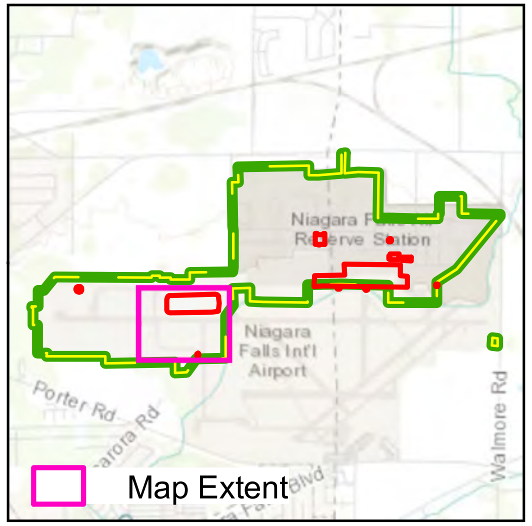
N

0 75 150
Feet

Figure 10-10a
Historical Sampling Results
PFHxS Detections in Groundwater and
Surface Water at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-10a Historical PFHxS GW SW 1.mxd

VICINITY MAP



Analyte	RSL[1] (μg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

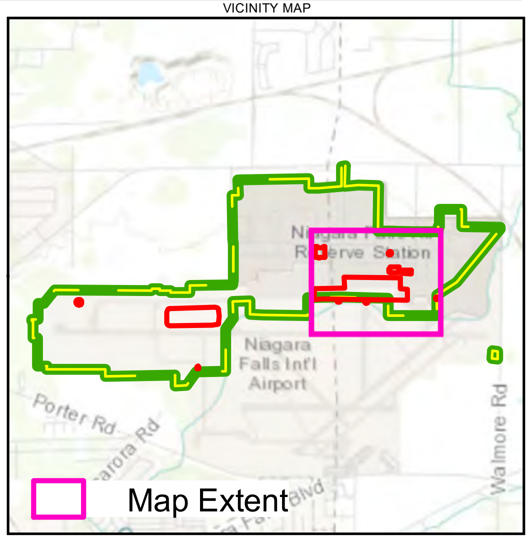
[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

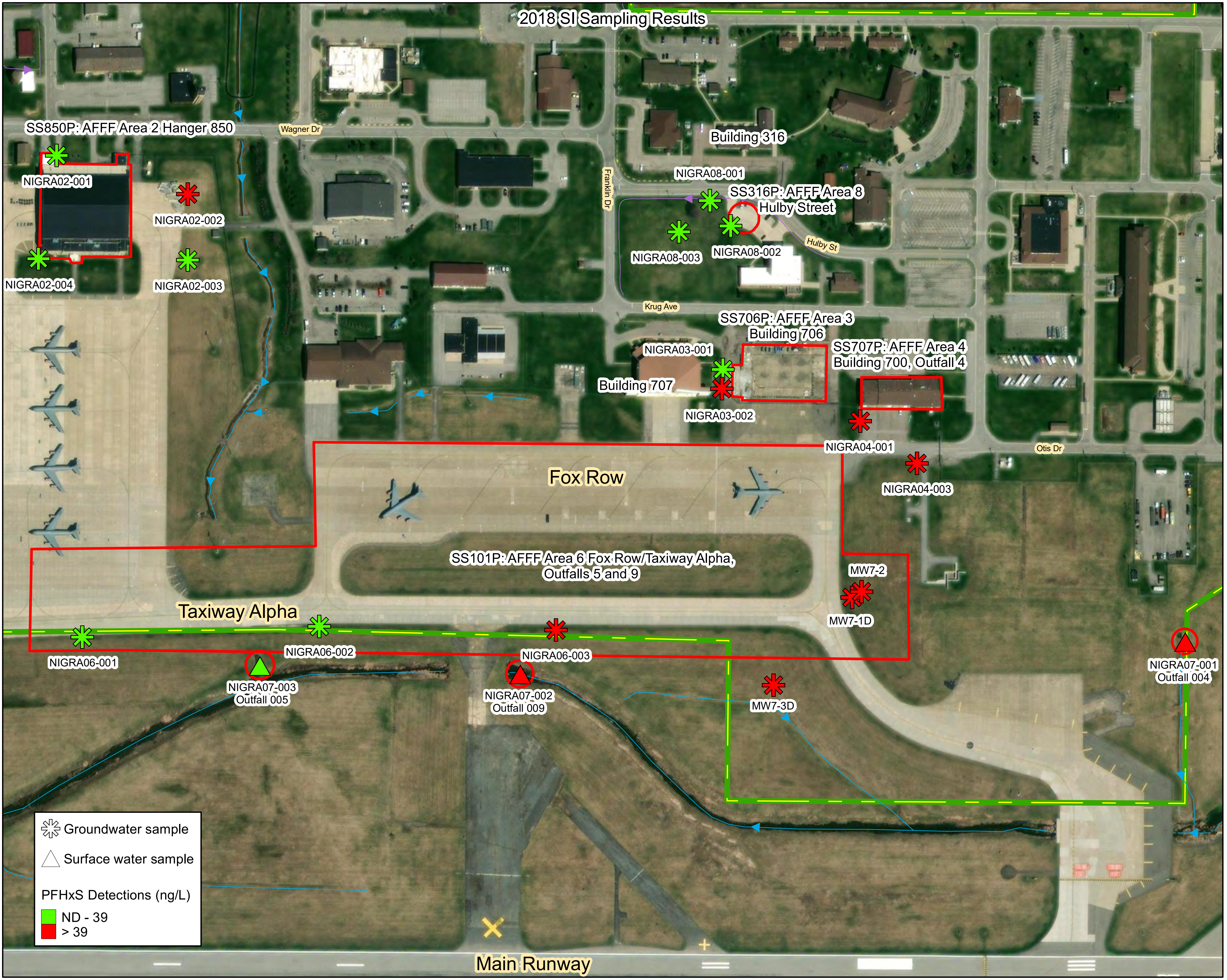
μg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 10-10b
Historical Sampling Results
PFHxS Detections in Groundwater and Surface Water at SS015P and Outfall 7 (FT007P)
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-10b Historical PFHxS GW SW 5.mxd





NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

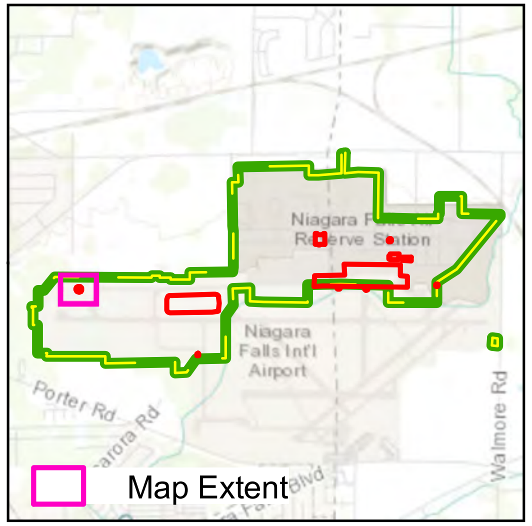
N

0 250 500
Feet

Figure 10-10c
Historical Sampling Results
PFHxS Detections in Groundwater and Surface Water at SS850P, SS706P, SS707P, SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-10c Historical PFHxS GW SW 2,3,4,6,8.mxd

VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (μg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

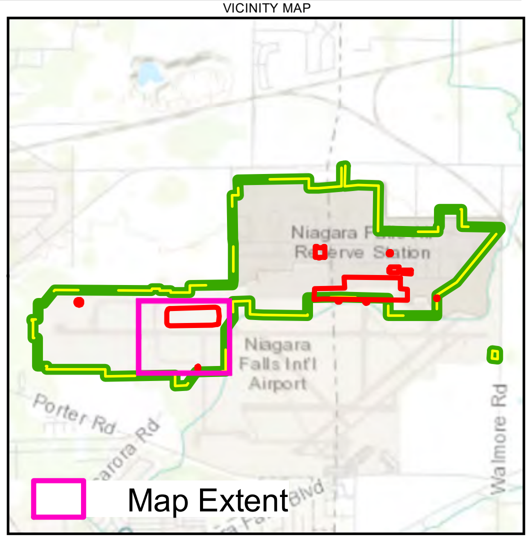
[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

μg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 10-11a
Historical Sampling Results
PFNA Detections in Groundwater and
Surface Water at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-11a Historical PFNA GW SW 1.mxd



Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

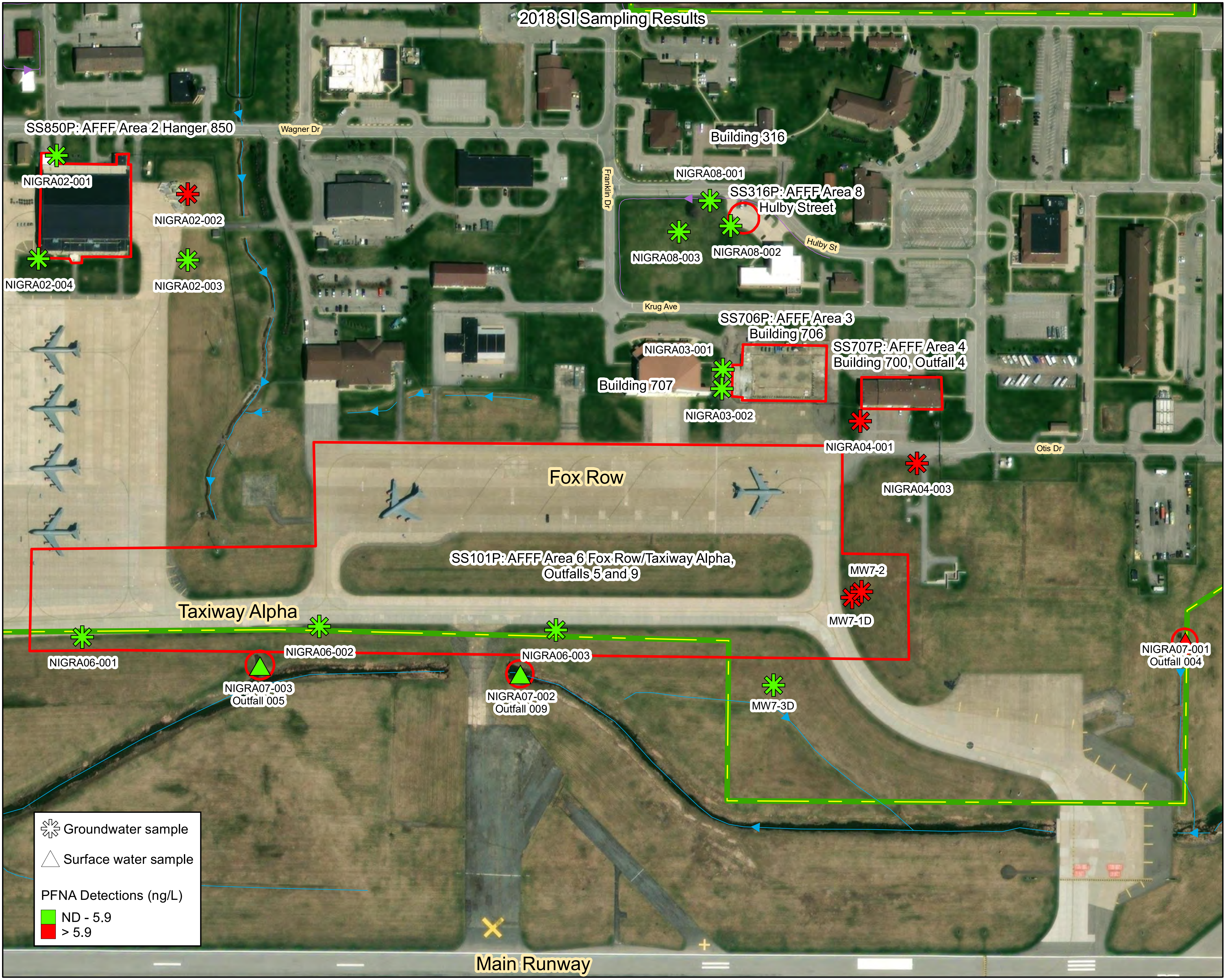
[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

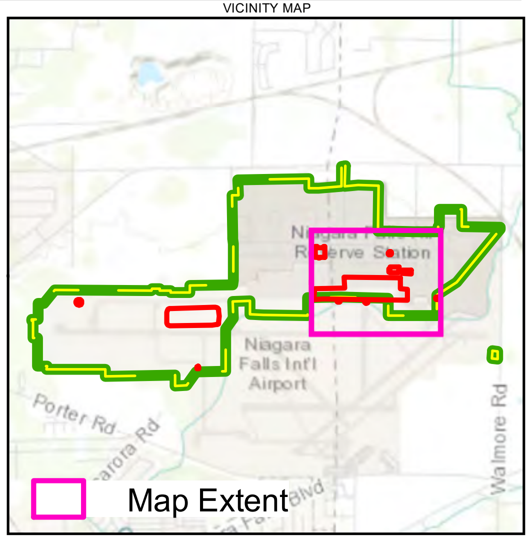
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 10-11b
Historical Sampling Results
PFNA Detections in Groundwater and Surface Water at AFFF Area 5
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-11b Historical PFNA GW SW 5.mxd



VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	RSL[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

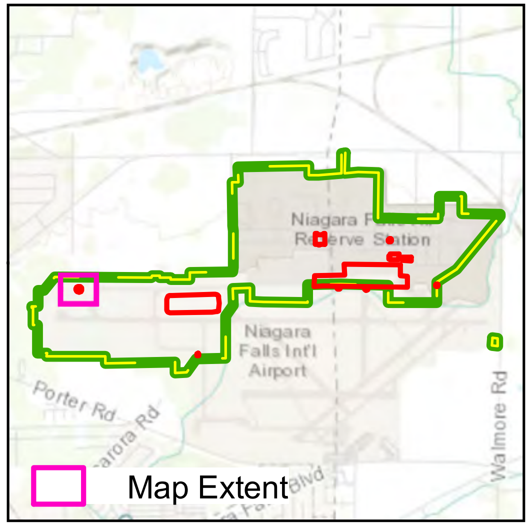
N

0 250 500
Feet

Figure 10-11c
Historical Sampling Results
PFNA Detections in Groundwater and Surface Water at SS850P, SS706P, SS707P, SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-11c Historical PFNA GW SW 2,3,4,6,8.mxd

VICINITY MAP



NFARS Boundary

AFFF Release Area

Surface Water/Stream

Drainage Ditch/Pathway

Analyte	**RSL**[1] (µg/kg)
Perfluorobutanesulfonic acid (PFBS)	601
Perfluorohexanesulfonic acid (PFHxS)	39
Perfluorononanoic acid (PFNA)	6
Perfluorooctanesulfonic acid (PFOS)	4
Perfluorooctanoic acid (PFOA)	6

[1] RSLs as presented in the memorandum from the Office of the ASD titled Investigating Per- and Polyflouroalkyl Substances within the Department of Defense Cleanup Program and signed into use on 6 July 2022 (ASD 2022); HQ = 0.1.

µg/kg = Microgram(s) per kilogram
ND = Not detected above the limit of detection
RSL = Regional Screening Level

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

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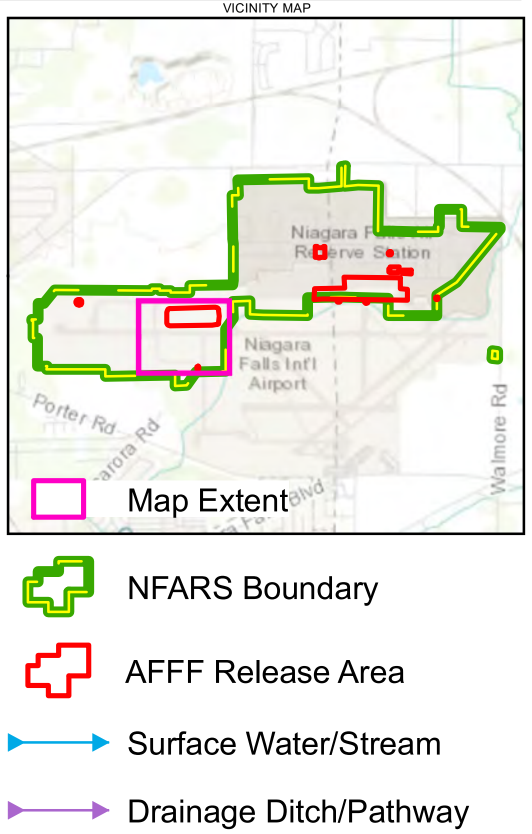
Feet

Figure 10-12a
Historical Sampling Results
PFOS Detections in Groundwater and
Surface Water at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-12a Historical PFOS GW SW 1.mxd



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Map Date: 8/17/2023
Source: ESRI
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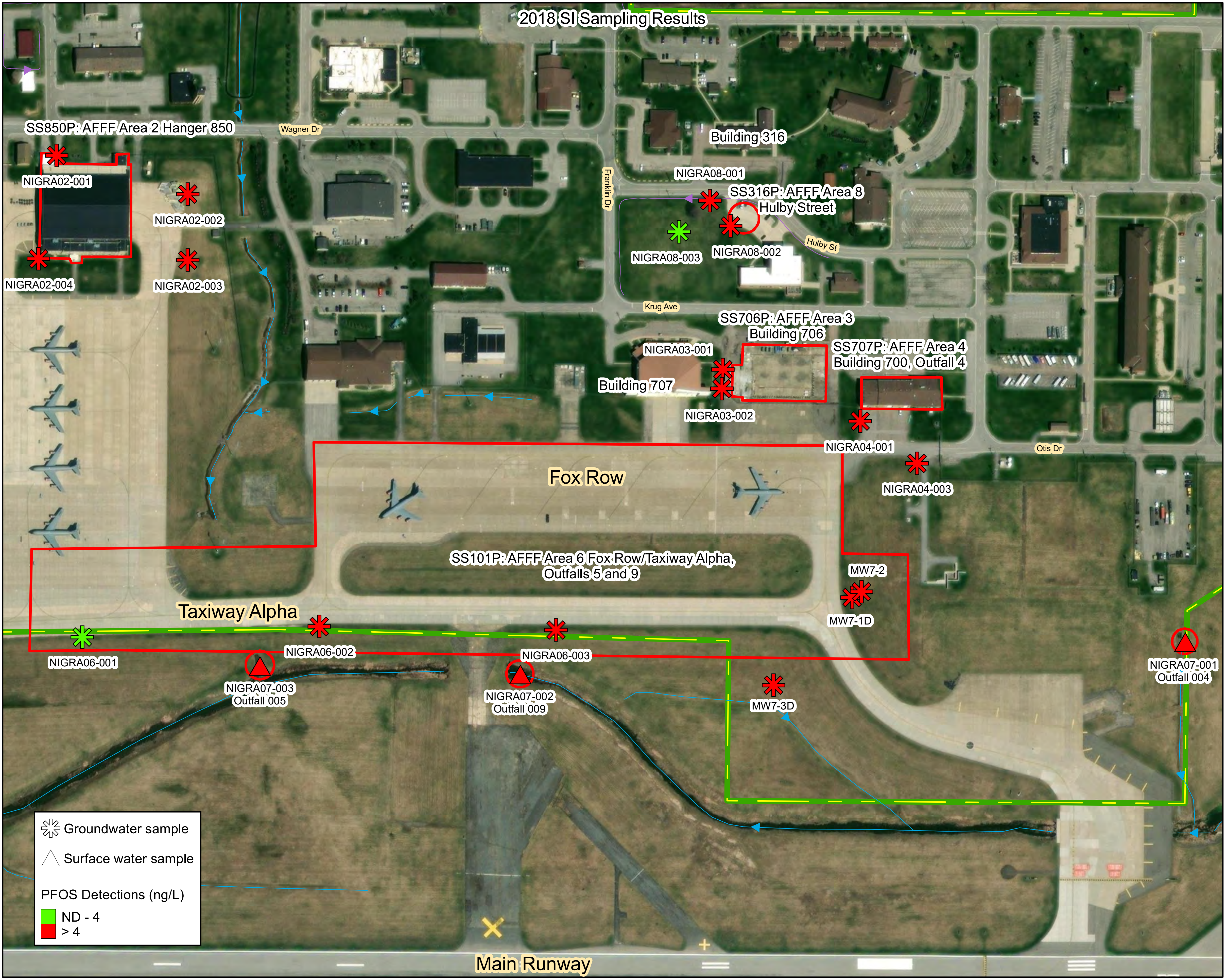
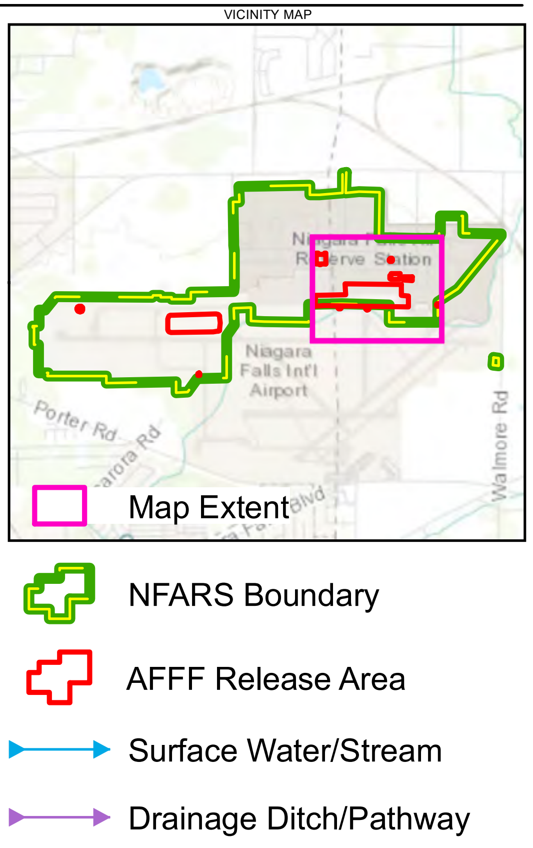
Figure 10-12b
Historical Sampling Results
PFOS Detections in Groundwater and
Surface Water at SS015P and Outfall 7 (FT007P)
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-12b Historical PFOS GW SW 5.mxd





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Source: ESRI
Projection: NAD 1983 State Plane New York West

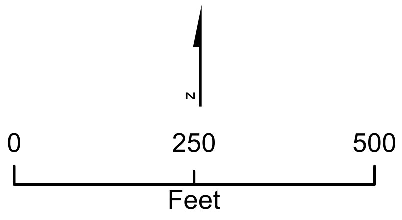
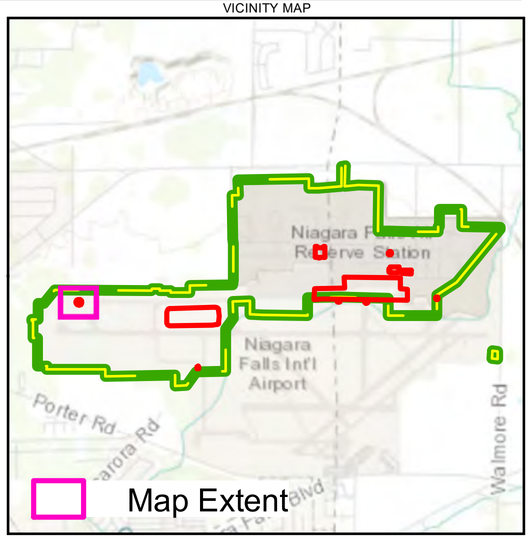


Figure 10-12c
Historical Sampling Results
PFOS Detections in Groundwater and
Surface Water at SS850P, SS706P, SS707P,
SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-12c Historical PFOS GW SW 2,3,4,6,8.mxd



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Surface Water/Stream

Drainage Ditch/Pathway

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Source: ESRI
Projection: NAD 1983 State Plane New York West

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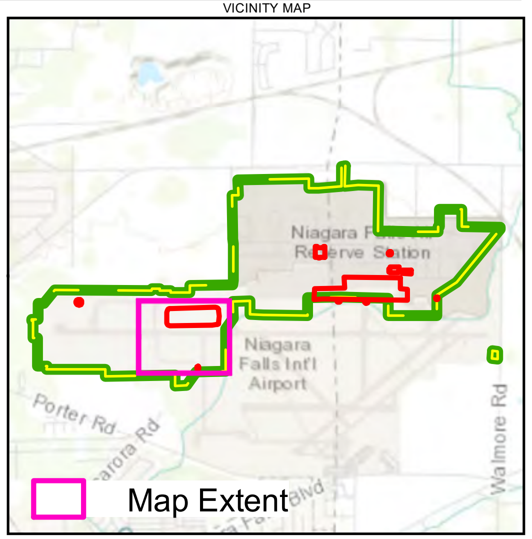
0 75 150
Feet

Figure 10-13a
Historical Sampling Results
PFOA Detections in Groundwater and
Surface Water at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-13a Historical PFOA GW SW 1.mxd



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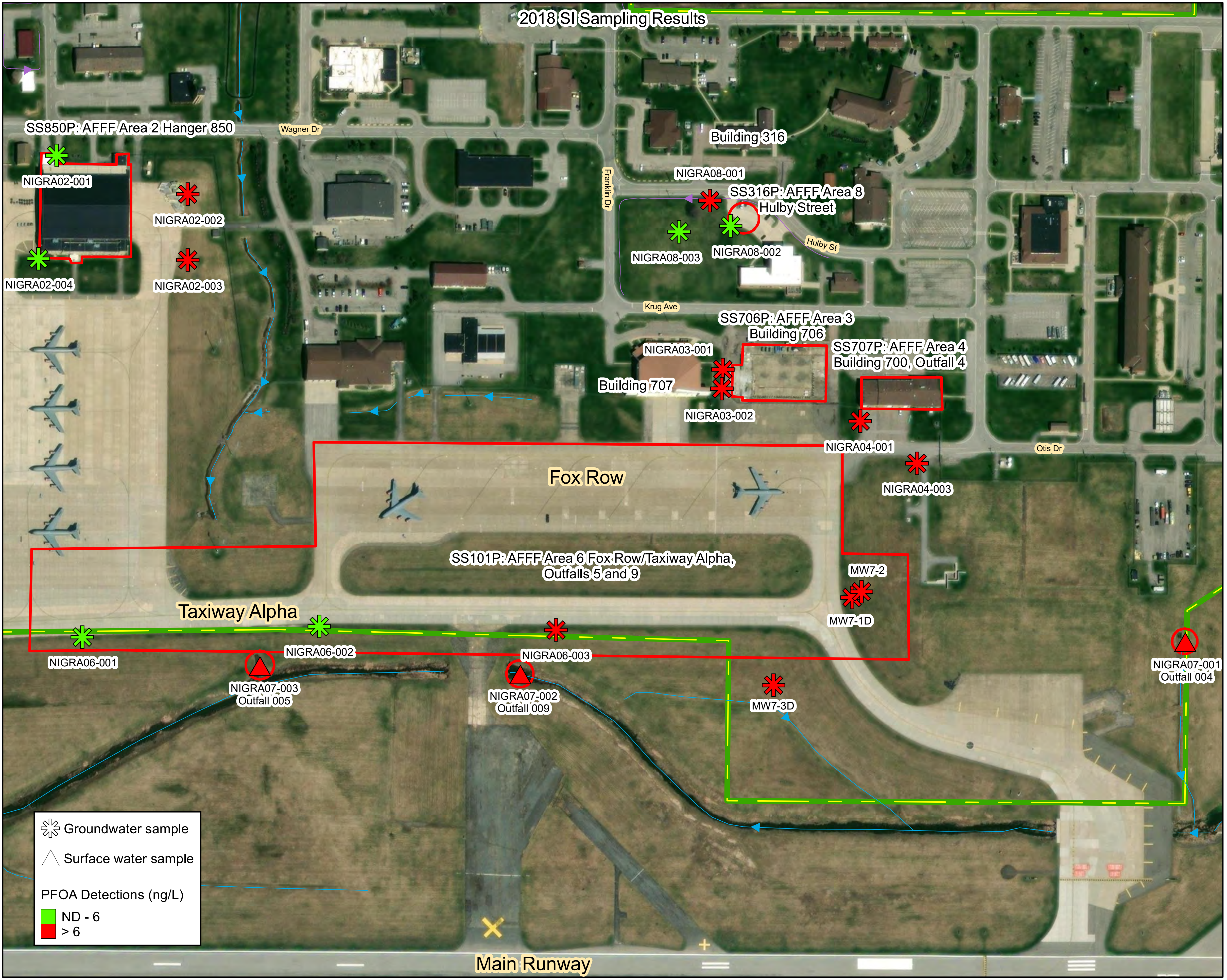
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

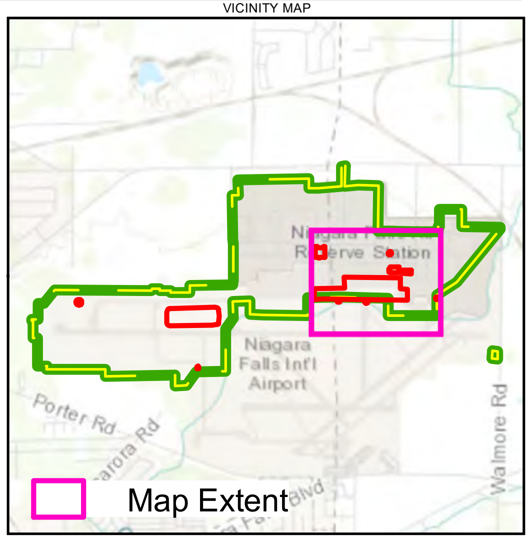
N

0 150 300
Feet

Figure 10-13b
Historical Sampling Results
PFOA Detections in Groundwater and
Surface Water at SS015P and Outfall 7 (FT007P)
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-13b Historical PFOA GW SW 5.mxd





NFARS Boundary

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Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

N

0 250 500
Feet

Figure 10-13c
Historical Sampling Results
PFOA Detections in Groundwater and Surface Water at SS850P, SS706P, SS707P, SS101P, SS316P, and SS316P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 10-13c Historical PFOA GW SW 2,3,4,6,8.mxd

UFP-QAPP Worksheet #11: Project/Data Quality Objectives

This worksheet is used to develop and document project DQOs using a systematic planning process that follows the EPA DQO process, and documents the environmental decisions that need to be made, and the level of data quality needed. The DQO process is outlined in the EPA 2006 guidance document–*Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA/240/B-06/001) (EPA 2006). The specific QA/QC requirements developed for the site are consistent with those presented in the DoD Quality Systems Manual, Version 5.4 (DoD 2021).

DQOs are both qualitative and quantitative statements that define the type, quality, and quantity of data necessary to support the decision-making process during project activities. The objective of this UFP-QAPP is to establish standard procedures so that the integrity, accuracy, precision, completeness, and representativeness of collected samples are maintained, and the required DQOs are achieved.

The DQO process provides a systematic procedure for defining the criteria that a data collection design should satisfy. The DQO process is designed to: (1) clarify study objectives and decisions to be made based on the data collected, (2) define the most appropriate type of data to collect, (3) determine the most appropriate conditions for collecting the data, and (4) specify acceptable decision error limits based on the consequences of making an incorrect decision. The DQO process established by the EPA, and incorporated into the 2012 UFP-QAPP guidance, consists of seven steps, and these steps are used during the planning of the data collection process to ensure that field and analytical activities, and the resulting data meet the project objectives.

1. State the problem (describe concisely the problem to be studied).

2. Identify the goals of the study; state the decisions to be made to solve the problem.

3. Identify information inputs; identify information and supporting measurements needed to make the decisions and describe the source(s) of the information.

4. Define the boundaries of the study; specify conditions (i.e., time periods and spatial locations).

5. Develop the analytic approach.

6. Specify performance or acceptance criteria.

7. Develop the plan for obtaining data; evaluate the results of the previous steps and develop the most resource-efficient design for data collection.

The Project/DQOs for the TO are outlined below. DQOs are influenced by the ongoing project planning discussions with stakeholders and will be updated if new consensus decisions materialize.

Step 1: State the Problem (describe concisely the problem to be studied).

The extent of PFAS in environmental media at NFARS which may pose a risk to human health or the environment is currently unknown. PFAS are a group of synthetic fluorinated compounds that can be found in a number of industrial and consumer products, including AFFF, which is commonly used at military installations. There is a potential for AFFF to be released to the environment during fire suppression training activities, active emergency response petroleum-fire suppression, and other routine base operational activities. The chemical structure of PFAS makes them resistant to breakdown in the environment, which may impact soil, groundwater, surface water, and drinking water at or near areas where it is released. PFAS are classified as emerging environmental contaminants that are garnering increasing regulatory interest due to their potential risks to human health and the environment. The regulatory framework for managing PFAS at both the federal and state level continues to evolve.

DoD has adopted a policy to retain facilities in the CERCLA process based on risk-based SLs for soil and groundwater, as described in a memorandum from the ASD signed into use 6 July 2022 (ASD 2022).. Following delineation of the nature and extent of PFAS exceeding the SLs established in the ASD memorandum, the sites may proceed to the next phase under CERCLA (FS). The ASD SLs apply to PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA. The SLs are presented in Worksheet #15.

Seven AFFF sites (PFAS release areas and associated outfalls) are being investigated during the Phase I RI:

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
- SS850P: AFFF Area 2 Hanger 850
- SS706P: AFFF Area 3 Building 706
- SS707P: AFFF Area 4 Building 700, Outfall 4
- SS015P: AFFF Area 5 Blue Angels Crash Site
- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
- SS316P: AFFF Area 8: Hulby Street

The sites require completion of a Phase I RI to determine the nature and extent of the PFAS in soil, sediment, surface water, porewater, and groundwater.

Step 2: Identify the Goal of the Study; state the decisions to be made to solve the problem.

The goal of the Phase I RI includes the following:

- Collect data to evaluate the releases (including source strength); establish concentration gradients; delineate the nature and extent of PFAS in soil, groundwater, surface water, and sediment; and update the CSM accordingly.

- Collect and document data that is both representative of field conditions and defensible within the precision, accuracy/bias, representativeness, completeness, comparability, and sensitivity parameters. This includes sufficient field supplies to fully characterize field conditions and heterogeneity as well as QC samples.

- Determine the horizontal and vertical boundaries of PFAS source areas (i.e., soil), and characterize the nature of contaminant transport to other media (e.g., air, surface water, sediment, or groundwater).

- Determine the mechanism(s) of PFAS release (e.g., erosion, leaching, etc.) and direction of pathway transport.

The RI approach is based on a data-driven, decision-based process that leverages continual refinement of CSMs to efficiently fill data gaps related to potential source areas, PFAS migration and fate, and plume stability. Data will be collected over a series of three phases (initial, second, and third phases) as presented below. Data from each phase will be presented to the project delivery team (PDT) (AFCEC, USACE, NFARS, NYSDEC, and New York State Department of Health [NYSDOH]) with proposed subsequent investigative elements during scoping meetings. Site CSMs will be updated following each phase, and proposed locations for the next phase of work will be presented in addendums to this UFP-QAPP. The step-wise Phase I RI effort is being conducted to facilitate a Phase II (Human Health Risk Assessment, Environmental Risk Assessment, and Phase II Report) if warranted.

- Initial Phase
  - Source area surface soil sampling at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; SS015P: AFFF Area 5 Blue Angels Crash Site; and SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
  - Surface water and sediment sampling Event #1 at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; and SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
  - GPS survey of sample locations

- Scoping meeting with the PDT to discuss results of the initial phase and confirm locations for the second phase prior to development of a UFP-QAPP addendum, which will detail this next phase of the investigation

- Second Phase
  - Basewide gauging
  - Source area surface soil and subsurface soil boring sampling at each AFFF site
  - Groundwater grab sampling at each AFFF site
  - Surface water and sediment sampling Event #2 at AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; and SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9
  - GPS survey of sample locations
  - Data gap soil or groundwater grab sampling at each AFFF site as needed

- Scoping meeting with the PDT to discuss results of the second phase and confirm locations for the third phase prior to development of a UFP-QAPP addendum, which will detail this next phase of the investigation

- Third Phase
  - Monitoring well installation and monitoring well sampling event #1 at each AFFF site
  - Lysimeter installation at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 and SS707P: AFFF Area 4 Building 700, Outfall 4 and lysimeter sampling event #1
  - Licensed survey of monitoring well locations and GPS survey of lysimeters
  - Monitoring well sampling event #2 at each AFFF site
  - Lysimeter (porewater) sampling events #2 at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 and SS707P: AFFF Area 4 Building 700, Outfall 4 and lysimeter sampling event #1
  - Basewide gauging.

Note that due to the shallow depth to water and bedrock, and low hydraulic conductivity of the overburden, lysimeters may not work. Additional soil Synthetic Precipitation Leaching Procedure (SPLP) samples may be proposed as an alternative.

This UFP-QAPP provides proposed sampling locations for the initial phase of RI fieldwork. Following data analysis and updates to site CSMs, subsequent proposed sampling locations/activities for the second and third phases of RI fieldwork will be provided through UFP-QAPP addendums. The first addendum will identify proposed soil boring and grab groundwater locations informed from a review of surface soil PFAS results. The second addendum will identify proposed monitoring well and lysimeter locations informed from a review of the soil boring and grab groundwater locations. This sequencing of field activities will minimize data gaps and will ensure that the Phase I RI program was comprehensive and adequate to determine the extent of PFAS impacts at NFARS.

Step 3: Identify the Information Inputs; identify information and supporting measurements needed to make the decisions and describe the source(s) of the information.

Primary information inputs include:

- Historical and installation-specific information through document reviews, site visits, NFARS records, public geographic information system databases, and conference calls.

- Information contained in the PA/SI Reports for NFARS

- Groundwater elevation data

- Surface soil, subsurface soil, surface water, sediment, groundwater, and porewater (from lysimetry) sample data collected in accordance with this UFP-QAPP

- Field data collected including survey data, groundwater elevations, and water quality parameters (pH, conductivity, temperature, oxidation-reduction potential [ORP], dissolved oxygen [DO], total dissolved solids [TDS], and turbidity) measured using a multi-parameter water quality meter.

Source Area Surface Soil Sampling

Source area surface soil sampling will be conducted during the initial phase of RI fieldwork at sites where the SI indicated PFAS above screening levels in surface soils (FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; SS015P: AFFF Area 5 Blue Angels Crash Site; and SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9) to delineate the nature and extent of PFAS in surface soil. SI soil analytical data suggest that PFAS migration through the vadose zone is slowed by adsorption to fine grained material, as evidenced by the higher concentrations observed during the SI in surface soils compared to subsurface soils. Surface soil from the remaining sites will be collected in a subsequent mobilization during soil boring activities.

Soil samples will be analyzed for PFAS. Results from the initial mobilization will be used to update site-specific CSMs and evaluate data gaps prior to identifying locations of subsequent soil borings for surface and sub-surface soil sampling, and the collection of grab groundwater samples from all sites.

Surface Water/Sediment

Surface water and sediment sampling for PFAS will be conducted from drainages associated with FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; and SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9 to evaluate potential migration along the stormwater system. Surface water and sediment samples will be analyzed for PFAS. Surface water quality parameters including pH, conductivity, temperature, ORP, DO, and turbidity will be recorded at each surface water sampling location.

An initial round of sampling will be conducted during the initial phase of RI fieldwork. Results from the initial phase of RI fieldwork will be used to update site-specific CSMs and evaluate data gaps prior to the second phase of RI fieldwork. A second round of sampling will be conducted during the second phase of RI fieldwork to confirm the revised CSMs and evaluate potential for seasonal changes in PFAS concentrations. If exceedances are detected in surface water or sediment during the initial phase of RI fieldwork, additional sampling/monitoring will be considered for the second phase of fieldwork, as concentrations could fluctuate depending on the season, amount of rainfall, etc.

Basewide Synoptic Gauging

Basewide synoptic gauging will be conducted to obtain additional data to enhance the understanding of basewide groundwater flow directions and interactions between groundwater and surface water.

Soil Boring Sampling/Lithologic Logging

Soil borings will be advanced and surface and subsurface soil sampling for PFAS will be conducted during the second phase of RI fieldwork to obtain additional data to enhance the understanding of the nature and extent (horizontal and vertical) of PFAS in soil at each AFFF site. Locations of soil borings will be biased to areas where the initial surface soil sampling indicates the highest PFAS concentrations or where additional sampling is needed to further bound observed SI exceedances (step in/step out). Up to three vadose zone soil samples will be collected from each boring, including one surface soil sample from 0-0.5 ft, and up to two deeper subsurface soil samples, with the deepest sample collected immediately above the water table.

Lithology data will be recorded during groundwater boring advancement. Surface and subsurface soil samples will be submitted for PFAS analysis. A subset of soil samples will also be homogenized and split for additional SPLP and PFAS analysis. Additional soil samples will be collected from different horizons to submit for geotechnical/physiochemical analysis (pH, grain size, TOC, porosity, permeability, and anion and cation exchange capacity) to provide basic soil parameter information.

A collective update to the site-specific CSMs will be conducted based on the results of the surface and subsurface soil sampling event to further refine remaining data gaps. Additional soil sampling will be performed if needed based on identified data gaps.

Groundwater Borings

Groundwater grab sampling will be conducted during the second phase of RI fieldwork to obtain data to enhance the understanding of the nature and extent of PFAS in groundwater at the site, provide additional hydrogeologic data, and determine PFAS max flux from identified source areas. Groundwater grab samples will be collected from below the water table at groundwater borings advanced in transects downgradient and perpendicular to groundwater flow. Locations of transects will be based on the results of the initial phase soil sampling.

Lithology data will be recorded during groundwater boring advancement. Groundwater samples will be analyzed for PFAS. A collective update to the site-specific CSMs will be conducted based on the results of the groundwater grab sampling to further refine remaining data gaps. Additional groundwater grab will be performed if needed based on identified data gaps. Results from the groundwater grab sampling will be used to identify locations of permanent monitoring wells.

Monitoring Well Drilling/Installation

A series of new monitoring wells will be installed during the third phase of RI fieldwork to estimate dissolved phase PFAS mass flux. Lithology data will be recorded during well drilling and soil samples will be collected from each well location for analysis of PFAS.

Wells will be installed in transects perpendicular to groundwater flow to estimate dissolved phase PFAS mass flux. Transect locations will be determined based on results of groundwater grab sampling. Well construction details such as depths and screened intervals will be determined during scoping sessions held with the PDT.

Groundwater Monitoring Well Sampling

Following the installation and development of new monitoring wells, two rounds of sampling will be conducted to confirm the revised CSMs and evaluate potential for seasonal changes in PFAS concentrations. The two sample events will be spaced approximately six months apart (bi-annual sampling) representing seasonal variations.

A synoptic round of water levels will be collected from all existing base wells and newly installed monitoring wells prior to each sampling event. Sampling will be conducted using low-flow sampling techniques. Water quality parameters including pH, conductivity, temperature, ORP, DO, TDS, and turbidity will be recorded in the field using a water quality meter prior to sample collection. Groundwater samples will be analyzed for PFAS.

Lysimeter Installation/Porewater Sampling

Based on results of the soil and groundwater grab sample data collection, a series of new lysimeters may be installed during the third phase of RI fieldwork in release areas at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 and SS707P: AFFF Area 4 Building 700, Outfall 4 to evaluate the potential for PFAS in soil to leach to groundwater. If lysimeters are installed, two rounds of porewater sampling will be conducted and porewater samples will be analyzed for PFAS. Due to the shallow depth to water and bedrock, and low hydraulic conductivity of the overburden, lysimeters may not work. Additional soil SPLP samples may be proposed as an alternative to lysimeters.

Surveying

A global positioning system unit capable of achieving sub-meter accuracy will be used to record the coordinates of surface soil sampling locations, co-located surface water and sediment sampling locations, soil and groundwater borings, and lysimeter locations. Surveying for location and elevation control for new monitoring wells will be completed by a state-licensed surveyor.

Step 4: Define the Boundaries of the Study; specify conditions

The spatial boundaries for this project are those associated with the boundaries of NFARS and the upgradient and downgradient extents of PFAS plume(s) upon delineation to SLs. If off-site sampling is conducted, for sampling locations on private property or other property outside the control of NFARS, a written request to the USACE PM will be submitted a minimum of 120 days in advance of the proposed entry date stating that a Right of Entry will be needed, which shall include appropriate property identification information as available. If possible, parcels that may be utilized for potential off-base investigation, if needed, will be identified during scoping sessions prior to each mobilization, such that sufficient time is allowed to obtain Right of Entry, with the goal of providing flexibility, depending on where step-outs are needed to laterally define extent of PFAS above SLs resulting from installation releases.

The spatial boundaries of the soil investigation at potential and identified release areas will generally be confined to the limits of the former site features; however, the investigation will proceed outside the former site features as necessary for soil delineation. The vertical limit for soil sampling is approximately 25 ft bgs. The spatial boundaries of surface water and sediment sampling is dependent upon observations in the field regarding the presence of surface water in conveyances and knowledge of the established pathways for surface water discharge.

The temporal boundaries describe the project time frame and when samples will be taken. The temporal boundaries include the following:

- Summer 2023: initial phase source area surface soil and surface water/sediment sampling
- Fall 2023: second phase source area soil boring and groundwater grab sampling and surface water/sediment sampling
- Spring 2024: second phase data gap soil or groundwater grab sampling as needed
- Fall 2024: third phase monitoring well installation/development, baseline groundwater sampling, lysimeter installation, and initial lysimeter sampling
- Spring 2025: third phase groundwater and lysimeter sampling event 2

Fieldwork is expected to occur through approximately mid to late 2025. Some data will be collected to account for seasonal variation, such as groundwater/surface water levels, surface water/sediment analytical data, groundwater analytical data, and lysimeter analytical data.

Step 5: Develop the Project Data Collection and Analysis Approach

All samples will be analyzed at a DoD Environmental Laboratory Accreditation Program (ELAP) certified laboratory as follows:

- PFAS Laboratory Analysis – Pace Gulf Coast, Baton Rouge, Louisiana
  - Analysis of soil/sediment, surface water, groundwater, and porewater samples for PFAS by EPA Method 1633 in accordance with Table B-24 of DoD QSM Version 5.4 (DoD 2021) (or most recent version)
  - Analysis of SPLP leachate (EPA SW-846 Method 1312) from a subset of soil samples for PFAS by EPA Method 1633 in accordance with DoD QSM Version 5.4 (DoD 2021) (or most recent version)
- Geotechnical Laboratory Analysis – Pace Sheridan, Sheridan, Wyoming
  - Analysis of soil samples for pH by EPA SW-846 Method 9045D
  - Analysis of soil samples for grain size using ASTM Method D422
  - Analysis of soil samples for TOC using SW-846 Method 9060A
  - Analysis of soil samples for porosity using ASTM Method D2937
  - Analysis of soil samples for permeability using ASTM Method D5084
  - Analysis of soil samples for cation exchange capacity by SW-846 Method 9081 and for anion exchange capacity by the New Zealand phosphorus retention method.

Data validation of PFAS results will be performed by a third party (Environmental Data Services, Ltd.) at a rate of 90% Stage 2B and 10% Stage 4.

Sampling data will be compared to selected SLs (Worksheet #15). Additional sampling will be completed as required to meet the goals of the RIs. The decision to collect additional samples will include an evaluation of the following:

<u>Groundwater/Surface Water:</u>

1) What are the concentrations of PFAS at potential source areas?
2) What are the concentrations of PFAS at the installation boundary?
3) Are the concentrations of PFAS defined to the selected SLs?
4) What does the CSM suggest in terms of sources, pathways, and potential receptors?

<u>Soil/Sediment:</u>

1) What are the concentrations of PFAS in shallow surface soil/sediment (0-0.5 ft bgs)?
2) What are the concentrations of PFAS in subsurface soil (i.e., vadose zone and capillary fringe)?
3) What is the max flux from soil sources to groundwater and what is its implication to the groundwater plume / potential need for action to prevent continued leaking?
4) What does the CSM suggest in terms of sources, pathways, and potential receptors?

Data collected during the RI will be used to support future decision making in later phases of the RI process, including a risk assessment for human and ecological receptors (Phase II, if warranted). The approach to data collection and analysis is discussed in detail in Worksheet #17, Sampling Design and Rationale. Anticipated tasks and general methodologies are described in Worksheets #14 & 16 and Worksheet #18. Analytical testing methods for collected samples are provided in Worksheet #15.

Step 6: Specify Performance or Acceptance Criteria

The data need to be of adequate quality to make decisions established for the project. The purpose of this is to minimize the possibility of making erroneous conclusions or failing to keep uncertainty estimates to within acceptable levels. Worksheet #12 presents the applicable measurement performance criteria. Worksheet #15 presents the project screening levels. Worksheet #37 presents information regarding the data usability assessment. Data usability will be assessed in terms of whether study goals (Step 2) have been achieved, to be evaluated during scoping sessions for each subsequent phase of fieldwork.

Step 7: Develop the Detailed Plan for Obtaining Data

The overall approach to RI data collection is presented in Worksheet #17. Following the initial data collection in Phase I, results will be reviewed and discussed by the PDT. The PDT will be involved in determining the locations for soil and groundwater grab sample collection in a stepwise approach, locations of the new monitoring wells, locations of the new lysimeters, and locations for additional sample collection as needed. After each round of sampling, the PDT will determine if additional sampling is required or if the collected data are sufficient for achieving the RI objectives.

Analytical design requirements are provided in Worksheets #19 & #30 and Worksheets #24 through #28. The final detailed sampling approach is described in Worksheets #14 &16, Worksheet #17, Worksheet #18, and Worksheet #20.

UFP-QAPP Worksheet #12: Measurement Performance Criteria

This worksheet documents the quantitative measurement performance criteria in terms of precision, bias, and sensitivity for laboratory measurements and is used to guide the selection of appropriate measurement techniques and analytical methods. Measurement performance criteria are developed to ensure collected data will satisfy the DQOs documented on Worksheet #11 and are provided in the following worksheets. There are no measurement performance criteria tables for porosity by ASTM Method D2937 and permeability by ASTM Method D5084.

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Table 12-1. Measurement Performance Criteria for PFAS

This worksheet documents the project-specific measurement performance criteria (MPC) in terms of data quality indicators (DQI) (i.e., precision, accuracy, sensitivity, representativeness, completeness, and comparability). Analytical methods for investigation-derived waste (IDW) characterization are not included in this worksheet because data generated using these methods will not be subject to validation.

Matrix: Soil/Sediment/Water
Analysis: PFAS by EPA Method 1633
Concentration Level: Low/Medium/High

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil and Sediment (SOPs 021, 025, 047 and 073) Groundwater and Surface Water Sampling (SOPs 007, 013, 047, 048, and 073)	PFAS by EPA Method 1633 Pace: ENV-SOP-BTRO-0149 Compliant with DoD QSM Version 5.4 (or more recent)	Accuracy/Bias and contamination	No analytes detected > ½ Limit of Quantitation (LOQ), or >1/10th the amount measured in any sample, or 1/10th the regulatory limit, whichever is greater.	Method Blank (MB)	A
		Accuracy/Bias	Recovery within statistically derived limits. Until these are developed, preliminary 40-150% are used. Lower statistical limit must be > 40%	Laboratory Control Sample (LCS)	A
		Accuracy/Bias and interference	Recovery within LCS limits. Preliminary 40-150% are used. Lower statistical limit must be > 40%	Matrix Spike (MS)	A
		Precision and interference	RPD ≤ 30%	Matrix Spike Duplicate (MSD)	A
		Accuracy/Bias	Recovery within statistically derived limits. Peak areas must be greater than 30% of the average area of calibration standards.	Non-Extracted Internal Standards	A
		Precision	For Water: RPD ≤ 30% when both results exceed LOQ; otherwise, difference < LOQ. For Soil/Sediment: RPD ≤ 50% when both results exceed LOQ; otherwise, difference < LOQ.	Field duplicate	S&A
		Bias Contamination	<1/2 LOQ	Field blank / Equipment blank	S&A

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
		Sensitivity	+/- 30% of true value, signal-to-noise ratio > 3	Instrument sensitivity check (ISC) at LOQ	S&A
		Accuracy in individual samples	Within statistically derived limits. Until these are developed, preliminary 20-150% are used. Lower statistical limit must be ≥ 20%	Extracted Internal Standards	S&A
		Completeness	90% of reported data is usable.	Reported Sample Data	S&A

Table 12-2. Measurement Performance Criteria for Total Organic Carbon (TOC)

Matrix: Soil
Analysis: TOC by EPA SW-846 Method 9060A
Concentration Level: Low

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil sampling (SOP 25, 47, and 73)	EPA SW-846 Method 9060A Pace: ENV-SOP-BTRO-0044	Accuracy/Bias	90-100% Recovery	LCS	A
		Accuracy/Bias	80-120% Recovery	MS	A
		Accuracy/Laboratory Contamination	No analytes detected > LOQ or >1/10 the amount measured in any sample, whichever is greater	Method Blank	A
		Precision	RPD ≤ 20%	Laboratory Duplicate	A
		Completeness	90%	Reported Sample Data	S&A

Table 12-3. Measurement Performance Criteria for pH

Matrix: Soil
Analysis: pH by EPA 9045D
Concentration Level: Low

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil sampling (SOP 25, 47, and 73)	EPA SW-846 Method 9045D Pace: ENV-SOP-BTRO-0037	Precision – Overall	Within 0.1 pH unit	Field Duplicate	S&A
		Precision	Within 0.1 pH unit	Laboratory Duplicate	A
		Completeness	90%	Reported Sample Data	S&A

Table 12-4. Measurement Performance Criteria for Grain Size Analysis

Matrix: Soil
Analysis: Grain size by ASTM D422
Concentration Level: Low

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil sampling (SOP 25, 47, and 73)	ASTM D422 (SOP WI11514)	Completeness	90%	Reported Sample Data	S&A

Table 12-5. Measurement Performance Criteria for Cation Exchange Capacity

Matrix: Soil
Analysis: Cation Exchange Capacity by EPA 9081
Concentration Level: Low

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil sampling (SOP 25, 47, and 73)	EPA SW-846 Method 9081 Pace: ENV_SOP_SHRT_004600	Accuracy/Bias	70%-130% recovery	LCS	A
		Precision	RPD ≤ 20%	Laboratory Duplicate	A
		Accuracy/Laboratory Contamination	<½ LOQ or <1/10th the amount measured in any sample whichever is greater.	MB	A
		Completeness	90%	Reported Sample Data	S&A

Table 12-6. Measurement Performance Criteria for Anion Exchange Capacity

Matrix: Soil
Analysis: Anion Exchange Capacity
Concentration Level: Low

Sampling Procedure	Analytical Method/SOP	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Soil sampling (SOP 025, 047, and 073)	New Zealand P Retention Method Pace: ENV-SOP-SHRT-0157	Precision	RPD ≤ 10%	Laboratory Duplicate	A
		Accuracy/Laboratory Contamination	<0.05 parts per million	MB (KCl/K_2HPO_4)	A
		Accuracy	90-110% of true value	Check Soil	A
		Completeness	90%	Reported Sample Data	S&A

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UFP-QAPP Worksheet #13: Secondary Data Uses and Limitations

Data Type	Data Source (Originating Organization, Report Title, and Date)	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Preliminary Assessment	ASL "Final Preliminary Assessment Report for Perfluorinated Compounds at Niagara Falls Air Reserve Station, Niagara County, New York" August 2016	Historical site information. Identifies locations at NFARS where perfluorinated compounds may have been released to the environment. Assesses possible migration pathways and receptors of potential PFAS contamination.	None; these data are considered valid and usable for comparison.
Site Investigation	ASL "Final Site Inspections Report of Fire Fighting Foam Usage at Niagara Falls Air Reserve Station, Niagara County, New York" December 2018	Historical site descriptions and site data. Identifies releases of AFFF that resulted in PFAS contamination in environmental media above applicable screening levels. Defines sites for additional RI activities.	Qualifiers applied to validated data may limit data use.
PFAS sampling	EA, 2020 "Memorandum: West End Electrical Project PFAS Sampling Summary Report Niagara Falls Air Force Reserve Station" March 2020	Historical PFAS investigation presenting soil sample analytical results	None; these data are considered usable
Geographic Information System	NFARS, updated by various contractors, 2022	Base map creation	None
Well Maintenance Database	NFARS, updated by various contractors, 2022	General information regarding project areas used to develop project background	None
Analytical database	Environmental Resources Program Information Management Systems (ERPIMS) database, 2012-2022	Historical analytical results for AFFF sites	None

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UFP-QAPP Worksheet #14 & #16: Project Tasks & Schedule

These worksheets provide an overview of the project tasks, describe the procedures to be followed, and present a summary of the project deliverables to be prepared in support of the planned project tasks. Field tasks will be conducted in accordance with 40 Code of Federal Regulations 300.420(c)(4), applicable NFARS regulations, and the planning documents supporting this project. The sampling design and rationale for the initial phase of RI fieldwork are discussed in Worksheet #17. Worksheet #18 summarizes planned sampling locations and methods for the initial phase of RI fieldwork. The sampling design and rationale and planned sampling locations and methods for the second and third phases will be presented in addendums to this UFP-QAPP. Field SOPs are listed in Worksheet #21 and are provided in **Appendix B**. Field forms used during field tasks are provided in **Appendix C**.

Field activities are anticipated to begin in Summer 2023. The general schedule for RI fieldwork at NFARS may vary and will follow the general task sequence in **Table 14-1**. Fieldwork will be conducted in accordance with the procedures presented in this UFP-QAPP and the field SOPs provided in **Appendix B.** Equipment to be used on-site will be reviewed ahead of mobilization to evaluate the compatibility for PFAS investigative work and evaluated again when the equipment is physically on-site prior to the start of field activities. Equipment and material compatibility will be in accordance with the PFAS Chemistry Instructions for Scopes of Services for Contracted Environmental Studies (USACE 2020).

The following tasks will be performed under this project:

- Preparation of planning documents
- Project management and administrative tasks
- Mobilization and demobilization tasks
- Health and safety tasks
- Field investigation tasks
- Surveying tasks
- Equipment Decontamination Tasks
- IDW disposal tasks
- QC tasks in accordance with the QCP provided in **Appendix F** of this UFP-QAPP
- Sample management tasks
- Laboratory analysis tasks
- Data review and validation
- Data management tasks

EA retains overall management functions including project management, site supervision, health and safety oversight, and QC. EA will execute this contract using subcontractor contractual arrangements with local and regional subcontractors. The EA PM will carefully formulate subcontracts to reflect detailed scopes of work and realistic performance objectives and specifications. The EA PM will ensure that provisions of the basic contract, health and safety requirements, and QA/QC requirements are incorporated, and that any other special conditions will be flowed down, as appropriate.

Before starting work, the PM will conduct a kick-off meeting to ensure that field personnel fully understand their responsibilities. During field operations, EA's field management staff (e.g., the Field Manager and Site Safety and Health Officer) will closely monitor work and assess all materials and equipment to ensure they meet contract requirements. Minor issues will be resolved at the site level. Issues that cannot be resolved at the Site will be directed to the PM. Negative performance trends will instigate an interim performance review and discussions with EA contract management personnel. As required, a corrective action plan will be developed to bring schedule/cost performance back to baseline. If a corrective action plan is developed, the PM will inform the USACE PM and NFARS RPM.

PREPARATION OF PLANNING DOCUMENTS – EA

Project Management Plan

EA has prepared a Project Management Plan, which specifies the schedule, technical approach, and resources required for the planning, execution, and completion of the performance objectives and also includes a payment milestone plan.

Uniform Federal Policy-Quality Assurance Project Plan

EA has applied the DQO process through the UFP-QAPP structure. This UFP-QAPP functions as the Work Plan for EA to implement the Phase I RI, and as such, it documents the project organization, specific procedures for execution of the technical field sampling, laboratory analytical procedures, QA/QC, and the assessment of oversight planning that will help ensure the quality of the investigation.

Accident Prevention Plan and Site Safety and Health Plan

EA has conducted a site-specific hazard evaluation of all potential hazards that workers may encounter during project execution, which will be incorporated into an APP/Site Safety and Health Plan (SSHP) to address safety procedures during on-site activities. The APP/SSHP, which is included in **Appendix C**, addresses all occupational safety and health hazards, including contaminant-related and biological hazards.

Waste Management Plan

EA has prepared a Waste Management Plan (WMP) detailing IDW generated during the remedial investigations. The WMP, which is included in **Appendix E**, applies to all IDW generated from the activities performed as part of the RIs, including soil and groundwater boring advancement, surface water/sediment sampling, soil sampling, monitoring well and lysimeter installation, monitoring well development and sampling, and lysimeter sampling, and includes associated secondary waste streams and management of waste during mobilization and demobilization phases of the project.

Quality Control Plan

EA has prepared a QCP for this RI to ensure QC during execution of the defined scope of work, as described in the Performance Work Statement issued with TO award, over the duration of the TO. The QCP is included in **Appendix F** and describes procedures for control, verification, and acceptance testing for each definable feature of work.

PROJECT MANAGEMENT AND ADMINISTRATION TASKS

Project management and administrative tasks will be conducted in accordance with the Project Management Plan, issued under a separate cover. EA will prepare monthly progress reports summarizing project activities from the previous month and planned activities for the next month. Reports will include descriptions of activities conducted; reportable safety accidents; a record of communication, correspondence, and invoices from completed work; and any schedule or personnel changes. In addition to contract-required deliverables and data management, EA will maintain regular communication with USACE and NFARS.

MOBILIZATION AND DEMOBILIZATION TASKS

Mobilization includes the procurement of field equipment and supplies and mobilization of field staff. The following tasks will be conducted prior to mobilization:

- Notify USACE and NFARS prior to mobilizing equipment and field personnel to the Site
- Coordinate with subcontractors, including drillers, laboratories, and surveyors
- Obtain necessary base access for field personnel
- Obtain necessary access, escorts, and conduct notifications for field personnel and drilling or other field subcontractors
- Inspect proposed locations to refine sampling locations as needed
- Obtain utility clearance for drilling locations
- Determine staging areas for equipment if necessary
- Order sample bottles and field monitoring equipment.

Coordination completed prior to mobilization will include coordinating site access, determining the locations of an equipment staging area and IDW storage and decontamination areas, utility clearance utilizing the installation dig permits/digger’s hotline (dig permits are required for any intrusive subsurface work being performed), flight line activities (as needed), coordinating with private property owners (as needed), and addressing any other installation concerns ahead of investigative site activities. This includes identifying items such as routes for access, timeframes that are optimal for ongoing installation activities or property owners and understanding the expectations of property owners for work completed on their property.

Coordination with NFARS will be completed to verify all requirements and restrictions for working on the flight line are followed, and any necessary training is completed. Specifically, prior to the start of any work on the airfield, EA will have participated in a pre-mobilization meeting with airfield management personnel, and scheduled and participated in any required training on flightline traffic safety, conduct, and procedures for working on the flightline and surrounding airfield. Before the start of daily field activities and throughout each workday, EA will notify airfield management in advance of entering and re-entering the airfield, coordinate with base escorts if necessary, and EA and their subcontractors will conduct foreign object debris (FOD) checks on all vehicles entering the airfield. For work on the flight line, a Federal Aviation Administration waiver is not anticipated; however, if a key location for sampling or monitoring well installation is located within the runway or taxiway clearance areas, coordination for the waiver would be completed in advance. All work completed on adjacent airport property will be coordinated with the airport authority through NFARS. Requirements for digging (beyond the digger’s hotline) will be completed as required by the airport authority. EA will coordinate with airfield management and obtain permission prior to staging (or directing subcontractors to stage) any and all vehicles, rigs, or equipment on the airfield, and will also coordinate with airfield management prior to retrieving and demobilizing previously staged vehicles and equipment.

Within 30 days of mobilization, all field personnel will complete Level I Operations Security training and Antiterrorism Level I training, if needed. Training certificates will be provided to the USACE PM within 5 days of completing the training, and the training will be completed on an annual basis.

Sample bottle requirements are summarized in Worksheets #19 and #30. The equipment necessary to execute the fieldwork and complete the project tasks is detailed below and in SOPs identified in Worksheet #21.

Demobilization will include removing field equipment and supplies, returning rented equipment, performing general cleanup, and organizing and finalizing field documentation.

HEALTH AND SAFETY TASKS

RI field activities will be conducted according to the APP provided in **Appendix D** of this UFP-QAPP. Each team member will read and sign the USACE-accepted APP and receive site-specific training that covers site safety, emergency procedures, QC (pass/fail criteria), general daily activities protocols, site communication, and general site layout including safe areas, and natural resource/environmental and cultural/ archaeological concerns. Site-specific training will be conducted by the Site Safety and Health Officer.

Entrance briefing and safety meetings will be conducted prior to the start of fieldwork to familiarize the team personnel with site health and safety requirements, the objectives and scope of field activities, and chain-of-command. Personnel mobilized to the site will meet requirements for Occupational Safety and Health Administration hazardous waste operations training and medical surveillance requirements as specified in the APP/SSHP, which is provided in **Appendix D**. Site personnel will also be trained to perform the specific tasks to which they are assigned. At no time will site personnel be tasked with performing an operation or duty for which they do not have appropriate training. The field team will be familiar with sample locations and will identify related field support areas and requirements.

FIELD INVESTIGATION TASKS– EA, SUBCONTRACTORS

The general schedule for the project is provided in **Table 14-1**. A summary of the field investigation tasks is included below. Field investigation tasks include the following and will be conducted in accordance with this UFP-QAPP and the SOPs listed in **Appendix B**.

- Instrument calibration
- Monitoring well gauging
- Subsurface utility clearance
- Soil and groundwater boring advancement
- Monitoring well installation
- Monitoring well development
- Lysimeter installation
- Sample collection (surface water, sediment, soil, groundwater, and porewater)
- Field QA/QC tasks
- Surveying

A dedicated field log will be maintained for all site activities as discussed under Documentation and Recording Tasks. Non-dedicated equipment used during field investigation activities will be decontaminated between sampling locations as discussed under Decontamination Tasks. IDW generated during field investigation activities will be handled as discussed under IDW Management Tasks.

Instrument Calibration Tasks

Requirements for calibration, maintenance, testing, and inspection of field equipment including photoionization detectors (PIDs) and water quality meters units summarized in Worksheet #22. Calibration information will be recorded on field forms are provided in **Appendix C**. The date and time of each calibration will be documented in the field log in accordance with EA SOP-016 (**Appendix B**).

PIDs will be calibrated daily prior to use in accordance with EA-SOP-011 (**Appendix B**).

Water quality meters will be calibrated daily prior to sampling activities, and calibration checks will be conducted at the end of each sampling day and when anomalous readings are obtained, in accordance with manufacturer recommendations and EA SOP-043 (**Appendix B**). Water quality meter calibration standards used will bracket the expected values for the parameter to be measured.

If the calibration procedure for the method does not allow for the number of standards needed to bracket expected concentrations, then additional standards will be incorporated into a calibration check performed at the start of the day immediately after calibration. Field screenings and samples analyzed prior to a failing calibration check will be resampled and/or re-analyzed accordingly.

Monitoring Well Gauging Tasks

Static water levels and well depths will be gauged with an electronic water level indicator with an accuracy of 0.01 ft in accordance with EA-SOP-010 (**Appendix B**). The measured depth to the bottom of each well will be compared to the bottom depth recorded in the original well construction logs to determine if screen occlusion due to siltation has occurred. Well headspace will be screened with a PID in accordance with EA-SOP-011 (**Appendix B**) during each gauging event. The date, time, well number, headspace readings, and gauging data will be recorded in the field log in accordance with EA SOP-016 (**Appendix B**).

Subsurface Utility Clearance Tasks

Subsurface utility clearance will be conducted prior to intrusive work in accordance with EA SOP-003 (**Appendix B**). EA will ensure all necessary dig permits / utility clearances are obtained through NFARS prior to starting field investigation activities. Dig permit documentation will be submitted a minimum of two weeks prior to mobilizing to the site.

All utilities/communications lines will be marked, and proposed drilling locations will be adjusted in the field based on utility clearance, as needed. Proposed locations would be adjusted in the field based on utility clearance, as needed. If any utilities are found during intrusive work, operations will stop immediately. If the utility is damaged, ruptured, or compromised, the responsible parties will be notified immediately, the site secured, and if applicable, emergency personnel and the IRP project manager will be contacted.

Soil and Groundwater Boring Advancement Tasks

Soil and groundwater borings will be advanced by Matrix Environmental Technologies Inc. using a track-mounted direct push drill rig (Geoprobe® or similar) in accordance with EA-SOP-047 (**Appendix B**). Direct-push drilling will be performed under the full-time supervision of an EA field geologist working under direction of a licensed Professional Geologist. Dig permits are required for any intrusive subsurface work being performed.

Continuous soil samples will be collected in 5-ft intervals using a macro-core sampler and dedicated acetate sleeves (2-inch diameter). The EA field geologist will complete soil logging and classification following ASTM D 2488 and in accordance with EA-SOP-064. At a minimum, the following information will be recorded on boring logs provided in **Appendix C**.

- Global positioning system coordinates and projection/datum information
- Date/times drilling occurred
- Subsurface interval and recovery

- Lithology description (color, moisture, texture, grain size, sorting, lithology, etc.)
- Headspace photoionization detector readings
- Any unusual characteristics (e.g., odor, sheens, staining, etc.)
- Depth to water
- Drill rig behavior and penetration rate (ft/minute)
- Borehole depth information

Boreholes will be abandoned by backfilling with bentonite to within 1 ft of the surface and then the last foot backfilled with native soil.

Monitoring Well Installation Tasks

Monitoring wells will be installed by Matrix Environmental Technologies Inc. using a track-mounted direct push drill rig (Geoprobe® or similar) equipped with 4 ¼ inch augers in accordance with EA-SOP-019 (**Appendix B**). Drilling and monitoring well installation will be performed under the full-time supervision of an EA field geologist working under direction of a licensed Professional Geologist. Dig permits are required for any intrusive subsurface work being performed.

Continuous soil samples will be collected in 5-ft intervals using a macro-core sampler and dedicated acetate sleeves (2-inch diameter). The EA field geologist will complete soil logging and classification following ASTM D 2488 and in accordance with EA-SOP-064. At a minimum, the following information will be recorded on the boring logs provided in **Appendix C**.

- Global positioning system coordinates and projection/datum information
- Date/times drilling occurred
- Subsurface interval and recovery
- Lithology description (color, moisture, texture, grain size, sorting, lithology, etc.)
- Headspace photoionization detector readings
- Any unusual characteristics (e.g., odor, sheens, staining, etc.)
- Depth to water
- Drill rig behavior and penetration rate (ft/minute)
- Borehole depth information
- Well construction information

Monitoring wells will be constructed with 2-inch internal diameter Schedule 40 polyvinyl chloride flush-joint casing with 0.010 slot screen. Well construction details such as depths and screened intervals will be determined during scoping sessions held with the PDT (USACE, NFARS, NYSDEC, and NYSDOH).

A filter pack design will consist of #00 US Silica (or equivalent) installed from the base of the boring to approximately 2-ft above the top of the well screen. A cement-bentonite seal will be installed above the sand pack in the remaining borehole annulus to grade. Wells will be completed at the surface with flushmount manways or stick-up protective casing as needed. For flushmounts, wells will be completed with an 8 inch flushmount manway at the ground surface and include a locking cap. The flushmount will be cemented in place within a 2 ft by 2 ft pad. For stick-ups, a 4-inch diameter steel protective casing pipe with locking cap will be installed and a 4-ft square × 6-in. thick concrete pad will be centered around the stick-up protective casing. Bollards will be installed as needed to protect stick-up wells installed in high traffic areas. Well construction information will be recorded on well construction diagrams provided in **Appendix C**.

Monitoring Well Development Tasks

Newly installed monitoring wells will be developed using surge and pump techniques in accordance with EA-SOP-019 (**Appendix B**) to remove fines from the filter pack and assure effective communication between the well and the surrounding aquifer. Development will not be implemented until the well seal has cured and settled. At a minimum, 24 hours will elapse between completion of well installation and initiation of well development.

Water levels and well depths will be measured prior to initiation of well development with an electronic water level indicator with an accuracy of 0.01 ft in accordance with EA-SOP-010 (**Appendix B**). Wells will be purged with a submersible pump (Grundfos or similar). Water depths, flow rates, and water quality parameters (pH, specific conductance, temperature, ORP, DO, TDS, and turbidity) will be monitored at 5-minute intervals throughout the development process using an electronic water level indicator with an accuracy of 0.01 ft; a flow measurement device (containers graduated in milliliters) and stop watch; and a multi-parameter water quality monitor with flow-through cell (Horiba U-22 water quality monitoring system or similar). A PID will be used to monitor vapor concentrations during purging and sampling in accordance with EA SOP-011 (**Appendix B**).

Liquid levels and water quality parameters will be recorded on well development logs presented in **Appendix C**. Any unusual conditions (colors, odors, surface sheens, etc.) noticed during well development, purging, or sampling will be recorded and reported.

Monitoring well development will be considered complete when water quality parameters have stabilized, a turbidity of less than 50 nephelometric turbidity units has been achieved, and a minimum of three to five times the standing water volume in the well (to include the well screen, casing, plus saturated annulus, assuming 30 percent annular porosity) has been removed.

- pH: ±0.1 standard units.
- Specific conductance: ±3 percent
- Temperature: ±10 percent
- ORP: ±10 millivolts
- DO: ±0.3 milligrams per liter
- Turbidity: <50 nephelometric turbidity units

Lysimeter Installation Tasks

Lysimeter installation will be completed in accordance with manufacturer instructions. To the extent practicable, lysimeters will be co-located with a drilled soil boring and monitoring well for the purposes of evaluating phase-partitioning and initial dissolved phase mixing. Borehole logging will be completed during lysimeter installation by an EA field geologist working under the direction of a licensed Professional Geologist. The EA field geologist will complete soil logging and classification following ASTM D 2488 and in accordance with EA-SOP-064 to place the screens within the zone immediately above the water table.

Sample Collection Tasks

Sampling will be completed by or under the full-time supervision of an EA field scientist or field geologist. PFAS sampling will be conducted in accordance with EA-SOP-073 (**Appendix B**). The following list of sampling and data collection tasks shall be completed as described in Worksheet #17. Samples will be collected at the frequency and distribution presented in Worksheet #18 and submitted for off-site laboratory analysis. Generic sample collection methods are presented below:

- Surface Water and Sediment Sampling
- Surface Soil Sampling
- Direct-Push Surface and Subsurface Vadose Zone Soil Sampling
- Direct-Push Groundwater Sampling
- Groundwater Monitoring Well Sampling
- Porewater Sampling

Detailed information regarding where a sample is collected will be included on the field form and in the field log. Samples will be collected using clean nitrile gloves and placed in laboratory provided sample containers presented in Worksheets #19 and 30. Sample containers shall be pre-preserved for those constituents which require chemical preservation. Samples will be handled as detailed under Sample Management Tasks.

Soil, surface water, sediment, groundwater, and porewater samples will be analyzed for PFAS by EPA Method 1633. While all PFAS compounds will be reported, the applicable screening criteria that will used to delineate PFOA, PFOS, PFBS, PFNA, PFHxS, and HFPO-DA are based on the 6 July 2022 ASD Memorandum, *Investigating Per- Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (ASD 2022).

A subset of subsurface soil samples will also be homogenized and split for SPLP followed by PFAS analysis. Additional soil samples will be collected from different horizons to submit for geotechnical/physiochemical analysis (pH, grain size, TOC, porosity, permeability, and anion and cation exchange capacity).

Surface Water Sampling Tasks

Discrete surface water samples will be collected in accordance with EA-SOP-007 (**Appendix B**). Samples will be collected directly into the laboratory provided sample container if site conditions permit (readily accessible/wadable depth) or may be collected using either a peristaltic pump with dedicated high-density polyethylene (HDPE) and silicone tubing (known to be PFAS free) or a stainless-steel dip sampler without disturbing bottom sediment and transferred to a laboratory provided sample container. If a stainless-steel dip sampler is used, the sampler will be properly decontaminated prior to sampling and between sampling locations in accordance with EA-SOP-005. As surface water samples will be co-located with sediment samples, surface water samples will be collected first so as not to disturb sediment and will be collected from downstream to upstream. Surface water samples will not be filtered prior to submittal for analysis.

Field water quality measurements (including temperature, pH, conductivity, DO, ORP, and turbidity) will be measured at each surface water sampling location after the sample is collected using a calibrated water quality meter (Horiba U-22 water quality monitoring system or similar). Coordinates for sampling locations will be collected in the field with a hand-held Global Positioning System (GPS) unit (to within sub-meter). Water quality data, sample collection information (sample identification, collection date/time), and sample coordinates will be recorded on Surface Water Sampling Logs presented in **Appendix C**.

Sediment Sampling Tasks

Discrete sediment samples will be collected in accordance with EA-SOP-021 (**Appendix B**). Each sample will be collected at each location from 0- to 0.5-ft depth interval. Samples will be collected directly from hand driven single-use PVC or acetate liners, which will not be decontaminated or reused at different locations. Sediment samples may also be collected with a decontaminated stainless-steel hand auger, or stainless-steel spoon, depending on depth of water and flow conditions (if risk of losing fines is minimal). Any standing water that accumulated in the sample will be decanted/removed.

Coordinates for sampling locations will be collected in the field with a hand-held GPS unit (to within sub-meter). A description of sediment (color, moisture, texture, grain size, sorting, lithology, etc.) and pertinent sampling information (sample identification, collection date/time) will be recorded on Sediment Sampling Logs presented in **Appendix C**.

Surface and Subsurface Soil Sampling Tasks

Soil sampling will be conducted in accordance with EA-SOP-025 (**Appendix B**). Initial surface soil grab samples (0-0.5 ft bgs) for PFAS analysis will be collected using hand augers or stainless-steel scoops/spoons and placed directly into laboratory provided sample containers.

Subsurface soil samples will be collected from acetate sleeves during soil boring advancement and monitoring well installation. Soil samples will be collected directly from the acetate sleeve using stainless steel scoops or spoons and placed into laboratory provided sample containers.

Non-dedicated sampling equipment will be decontaminated between sampling locations. Sample collection information (sample identification, collection date/time, depth interval) will be recorded on the associated soil boring logs used during drilling. Coordinates for sampling locations will be collected in the field with a hand-held GPS unit (to within sub-meter).

Groundwater Grab Sampling

Groundwater grab samples will be collected from each groundwater boring using a direct-push technology groundwater sampling device (e.g., SP-16) allowing for collection of a sample at approximately 5-ft into groundwater. Upon reaching the desired depth, the drill rods will be retracted to expose the groundwater sampler to formation water. Discrete in situ groundwater samples will be collected using dedicated HDPE tubing equipped with a stainless-steel check valve assembly. Water quality parameters including pH, conductivity, temperature, ORP, DO, TDS, and turbidity will be recorded with a calibrated water quality meter.

Water quality parameters and sample collection information (sample identification, collection date/time, depth interval) will be recorded on the associated soil boring logs used during drilling.

Groundwater Monitoring Well Sampling

Monitoring wells will be purged and sampled using peristaltic pumps with dedicated HDPE and silicone tubing and/or submersible stainless-steel bladder pumps equipped with dedicated HDPE bladders and tubing as presented in EA-SOP-073. If bladder pumps are used, the stainless-steel housing will be disassembled and properly decontaminated prior to sampling and between sampling locations in accordance with EA-SOP-005. The tubing/pump intake will be centered in the middle of the screened interval and monitoring wells will be purged in accordance with EA-SOP-048. Water quality parameters (pH, conductivity, temperature, ORP, DO, and turbidity) will be recorded and reported for all wells using a calibrated water quality meter and flow-through cell (Horiba U-22 water quality monitoring system or similar). Readings will be taken every 5 minutes until water quality parameters stabilize. Stabilization is considered to be achieved when 3 consecutive readings are within the following limits:

- pH readings within ± 0.1 pH units
- Water temperatures within ± 3%
- ORP within ± 10 millivolts
- DO within ± 10% for values greater than 0.5 milligrams per liter (mg/L); if three DO values are less than 0.5 mg/L, the values will be considered stabilized.
- Specific conductance within ± 3%
- Turbidity within ± 10% for values greater than 0.5 mg/L; if three turbidity values are less than 5 nephelometric turbidity units, the values will be considered stabilized.

Water quality parameters will be recorded on purge and sample forms (**Appendix C**). Any unusual conditions (colors, odors, surface sheens, etc.) noticed during well development, purging, or sampling will be recorded and reported.

Groundwater samples will be collected following stabilization of water quality parameters. Samples will be collected in laboratory provided sample containers. Sample collection information (sample identification, collection date/time, depth interval) will be recorded on the purge form.

Porewater Sampling Tasks

Lysimeters will be sampled in accordance with manufacturer instructions. The lysimeter sampling process involves applying a vacuum to the system to draw moisture into the lysimeter, transferring the water from the lysimeter to the transfer vessel and then applying pressure to the transfer vessel to drive the sample to the surface. At the surface the porewater is collected in a sample bottle. Lysimeters, transfer vessels, and sampling equipment will be PFAS-free or contain PFAS-free parts (i.e., no Teflon linings, tape, etc.).

Field Quality Assurance / Quality Control Tasks

Field QC tasks will be overseen by EA's Field Manager. Requirements for calibration, maintenance, testing, and inspection of field equipment are summarized in Worksheet #22. QC forms are provided in **Appendix F** (Daily QC Report, Preparatory Phase Checklist, Initial Phase Checklist, Final/Pre-Final Inspection Checklist, QC Surveillance Report, Deficiency Management Record, Non-Conformance Report, and Corrective Action Request).

Field QC samples are intended to provide an indication of the consistency of sample collection and analyses over the course of the program. The analytical and testing laboratories will be required to analyze QC samples in accordance with the documents and procedures listed in Worksheet #28.

Field QC samples for PFAS analysis are listed on Worksheet #20 and will include the following:

- ***Field Duplicates*****—**Collected at a rate of 10% of project samples (1 per 10 field samples). The purpose of these samples is to check the reproducibility of laboratory and field procedures and indicate non-homogeneity.

- ***MS/MSD*****—**Collected at a rate of 5% of project samples (1 per 20 field samples). MS/MSD samples are required by the laboratory to evaluate the matrix effect of the sample upon the analytical methodology.

- ***Field Blanks***—Collected at a rate of one per day. Field blanks are collected to check cross contamination during sample collection, sample shipment, and in the laboratory. Field blanks will be collected by pouring PFAS-free water directly into empty sample bottles in the field.

- ***Equipment Blanks***—Collected daily during sampling activities. Equipment blanks are collected to check cross contamination during sample collection, sample shipment, and in the laboratory. Equipment blanks will be collected by pouring PFAS-free water over non-dedicated sampling equipment into empty sample bottles in the field.

- ***Decontamination Blanks***—Collected from water sourced for decontamination to ensure that it is PFAS free.

- ***Temperature Blanks***—Temperature blanks will be submitted in each cooler being shipped to the laboratory. Temperature blanks are used to ensure samples are submitted within temperature requirements.

Surveying Tasks

Coordinates for surface water/sediment sampling locations, soil and groundwater borings, and lysimeters will be collected in the field with a hand-held GPS unit to within sub-meter in accordance with EA-SOP-008.

Horizontal coordinates and vertical elevations of newly installed monitoring wells will be surveyed by a state-licensed surveyor under the oversight of EA. Surveying will include the natural ground surface (not the top of the grout collar) of monitoring well and the highest point on the riser casing rim of the uncapped well casing and the protective casing. Vertical control will be established to the nearest +/-0.1 ft for all ground surface elevations. Elevations will be determined relative to the North American Vertical Datum of 1988, with reference made to an existing monument in the vicinity of the site. Horizontal control will be established by traverse runs to establish location with respect to the New York State planar horizontal coordinate grid system and provided in New York State Plane (North American Datum of 1983). Horizontal traverses will be tied into established permanent benchmarks. Horizontal traverse runs will be tied back to initial control points as a check for closure and error of closure was recorded. Horizontal coordinates will be reported in the New York State Plane West Zone (ft), North American Datum of 1983, to an accuracy of +/-0.5 ft.

EQUIPMENT DECONTAMINATION TASKS

All downhole drilling equipment and non-dedicated sampling equipment will be decontaminated prior to and between drilling/sampling locations in accordance with EA-SOP-005. Water used for decontamination activities will be certified PFAS-free by confirmation sampling prior to initiating RI field activities. A sample from the hose bib or hydrant identified as a source of decontamination water will be collected for PFAS analysis by EPA Method 1633 in accordance with DoD QSM Version 5.4 or a more recent version to which the laboratory is accredited. If raw water from a hydrant or other designated direct source is determined not to be PFAS free, then an alternate off-site source (i.e., Matrix Environmental Technologies, Inc. potable source) will be analyzed for PFAS and determined if acceptable. As a tertiary option an activated carbon drum will be used to treat the raw water prior to retesting and use as an alternate source of decontamination water.

Aqueous samples collected from water storage vessels brought on-site by the drilling subcontractors during field activities will also be analyzed for PFAS by EPA Method 1633 in accordance with DoD QSM Version 5.4 (or more recent) to verify that they are PFAS-free. The source water and storage vessels will be considered PFAS-free and acceptable for use if PFAS concentrations are less than 1/10th of the SLs (Worksheet #15) or not detected at the limit of detection (LOD). Storage vessels are anticipated to be used by the drilling subcontractors for containerizing water for activities such as grouting, equipment decontamination, and other miscellaneous tasks.

All downhole drilling equipment and non-dedicated sampling equipment will be scrubbed with a plastic brush or steam cleaned and rinsed thoroughly in PFAS-free water to clean away any debris or material on exposed surfaces and then triple-rinsed in PFAS-free distilled (Grade 3 or better) or deionized water (or Millipore water).

INVESTIGATIVE DERIVED WASTE TASKS

IDW generated during field activities will be handled as presented in the WMP and in accordance with EA-SOP-042. Drill cuttings, well development water, well purge water, and decontamination fluids will be containerized in 55-gallon DOT-approved drums and staged at a central location prior to off-site disposal.

Expendable waste used in completing the sampling activities including used personal protective equipment, tubing, and general trash will be double-bagged and properly disposed of as general debris/trash.

SAMPLE MANAGEMENT TASKS

Sample management is the process by which analytical samples are handled once collected. This process encompasses sample labeling, preservation, documentation, and shipment to the lab. Samples will be placed in an iced cooler immediately upon collection and maintained at less than 6 degrees Celsius (°C). Samples will be labeled, placed in water-tight bags, packed with ice double-bagged in plastic, and shipped to the analytical laboratory. Samples will be tracked by secure chain-of-custody protocol as detailed in Worksheet #26 and #27 and in accordance with EA-SOP-001, EA-SOP-002, and EA-SOP-004 (**Appendix B**). Records concerning the custody and condition of the samples will be maintained in field and laboratory records.

LABORATORY ANALYSIS TASKS

PFAS analysis for all media will be performed by Pace Gulf Coast, Baton Rouge, Louisiana, a DoD ELAP certified laboratory. The Pace Sheridan laboratory in Sheridan, Wyoming will perform geotechnical analyses. Laboratory certifications are presented in **Appendix G**.

Surface water, sediment, soil, groundwater and porewater samples will be submitted to the analytical laboratory for analysis of parameters included in Worksheet #18. The analytical laboratory will process and analyze field samples and field QC samples according to the sample chain-of-custody documents, and the requirements of this UFP-QAPP. Following receipt at the laboratory, samples will be tracked using laboratory sample logs.

Laboratory analytical methods will include the following. Applicable laboratory SOPs are listed in Worksheet #23 and provided in **Appendix G**.

- PFAS by EPA Method 1633
- SPLP by EPA SW-846 Method 1312
- pH by EPA SW-846 Method 9045D
- Grain size by ASTM Method D422
- TOC by EPA SW-846 Method 9060A
- Porosity by ASTM D2937
- Permeability by ASTM D5084
- Cation exchange capacity by EPA SW-846 Method 9081
- Anion exchange capacity by the New Zealand P Retention Method

Both laboratories will adhere to the DQOs established in this UFP-QAPP. Project QLs, action limits, and the selected screening criteria for each of the methods, matrices, and analytes that will be evaluated are presented in Worksheet #15. The analytical testing methodologies are listed in Worksheet #19 and #30 and Worksheet #23. The analytical laboratory will process and analyze samples according to the sample chain-of-custody documents, and the requirements of the UFP-QAPP. Following receipt at the laboratory, samples will be tracked using laboratory sample logs.

Samples will be analyzed on standard turnaround time. The analytical laboratory will generate Stage 4 data packages in portable document format. Electronic data deliverables will be provided in the ERPIMS format or format requested by the PDT.

LABORATORY QUALITY CONTROL TASKS

Laboratory QC tasks provide an indication of accuracy, precision, and sensitivity of analytical methods for each analytical batch of field samples that are analyzed. The project laboratory will be responsible for conducting laboratory QC procedures and reporting laboratory QC results in accordance with laboratory SOPs. The laboratory QA Manager is responsible for ensuring that laboratory internal QC checks are conducted in accordance with applicable methods and protocols, the laboratory's QA manual and the requirements of this UFP-QAPP.

The laboratory QC samples are method specific, as detailed in Worksheets #12 and #28. Internal and continuing calibration verification will be conducted for applicable equipment as summarized in Worksheets #24 and #25. Laboratory QC samples including method blanks, LCS, MS/MSDs, and calibration check standards will be prepared and analyzed in accordance with the analytical method requirements and laboratory SOPs as listed in Worksheet #23 and provided in **Appendix G**.

DOCUMENTATION AND RECORDING TASKS

EA personnel will maintain detailed field logs and record information about each field activity, including field personnel at the site, daily weather conditions, site conditions, tasks completed, general field notes, samples collected, field screening results, and any deviations from the approved UFP-QAPP and other plans as detailed in EA-SOP-016 (**Appendix B**). Field logs are the main reference documents. Field activities will be recorded daily in black or blue ink. Logs shall have a table of contents, and each page of field notes shall be numbered and dated showing the initials of all crew members. Errors shall be crossed out with a single line, initialed, and dated, and correct data entered adjacent to the error. As with field gear, clothing, and equipment, care will be taken to ensure that logs, field forms, and writing instruments comply with the list of materials in EA-SOP-073, which are generally acceptable for use in the field during PFAS sampling activities.

The following field log procedures specific to the site will be followed:

- Ensure that the cover of each field log lists the project name, location, activities, name of contact and phone number, and start and end date and time of log entries.
- Ensure that the date and start/end time of activities, personnel on site, site conditions (including presence of airborne particulates [soot, dust, etc. from heavy truck traffic], and presence of unusual odors) and visitors on site (as well as arrival and departure times) for each day are recorded.
- Ensure that weather entry for each day includes cloud cover (partly cloudy, full sun, etc.), precipitation (type and intensity), wind direction, temperature, wind speed, and humidity.
- Ensure that well condition and staff gauge information, including signs of damage or vandalism, is recorded.
- Ensure that the PPE, contract documents being followed, serial numbers of equipment utilized, serial/tracking number of shipments, deviances from the site plan, and times on-site and off-site are listed in field logs.
- Ensure that equipment calibration logs, field forms, and photographs are referenced in the field logs.
- Ensure no pages can be removed from the field logs.
- Ensure specific times are listed for each activity observed at the site in the field log.
- Ensure when the author releases a specific field log that the new author must print their name and sign the field log prior to making any entries in the field log.

Field forms including field equipment calibration forms, daily logs/reports, soil boring logs, well construction diagrams, well development logs, surface water sampling logs, sediment sampling logs, and groundwater purge forms will be used during on-site work. Field forms are provided in **Appendix C**. Additional field forms including health and safety forms will be completed as detailed in the APP and QCP for this project (provided in **Appendix D and F,** respectively).

Photographs will be used to document any unusual conditions observed during field activities. The identification number, date, time, the direction the photographer is looking, and a description of what the image is meant to convey shall be recorded in the field log.

All hardcopy data (field logs, photos, hard copies of chain-of-custody forms, airbills, etc.) will be kept in the project files.

DATA REVIEW AND VALIDATION TASKS

Review activities for analytical data and other project inputs are summarized in Worksheets #34, #35, and #36. Analytical data will be verified by the laboratory QC manager prior to providing to EA and will be reviewed by the EA Data Manager for completeness upon receipt. Corrective actions will be made upon decision of necessity to maintain the overall quality of the project data. Analytical results will be submitted to an independent third-party validator, Environmental Data Services, Ltd.

Data validation of PFAS results will be performed by at a rate of 90% Stage 2B and 10% Stage 4. Analytical data packages will be reviewed to ensure that required laboratory components are included, QA/QC requirements were performed, and data use restrictions were well defined. The analytical data will be qualified and appropriately flagged by the data validator. The validator will supply a report of the data to ensure compliance. Analytical data that are qualified will be taken into account during the interpretation of the data.

DATA MANAGEMENT TASKS

Worksheet #29 discusses project documents and records. All data and field notes will be maintained in the EA Syracuse, New York, office. The electronic data deliverables provided by the laboratory will be in ERPIMS format or format requested by the PDT. These data will be placed in an electronic database in which all electronic data will be backed up. Hard copies of data will also be stored in project files.

ASSESSMENT/AUDIT TASKS

SOPs will be reviewed prior to the performance of project tasks and updated as necessary. Technical system audits will be performed as required (Worksheets #31, #32, and #33). Independent technical review, and deliverable checks will be performed to assess the quality of field and reporting tasks. The project development team will perform interdisciplinary checks to ensure minimal interference between tasks. The EA PM will be responsible for responding to the assessment findings, including any corrective actions.

The Laboratory QA Manager will conduct assessments of the laboratory procedures, and data as described in the laboratory's QA manual.

FOLLOW-ON ACTIVITIES

Following completion of field activities and a review of analytical results, the Project Team will determine whether sufficient data have been collected to resolve all DQOs, and whether analytical results are expected as based on historical results and current site conditions. If unexpected results are found, and/or if data gaps are not closed or additional data gaps are identified, the Project Team may decide to conduct additional sampling or further investigative activities. These additional activities, if needed, will be addressed under an addendum to this QAPP.

PROJECT REPORTING TASKS

All major deliverables (UFP-QAPP and addendums, Interim Reports, and the RI Report) will be submitted in three phases unless otherwise coordinated with USACE and NFARS. Draft submissions will be for DoD-only review; EA will respond to each comment in writing and make appropriate revisions to the draft document.

A revised draft of each major deliverable will be submitted as a Draft Final document for wider regulatory review. EA will respond to each regulatory comment in writing and make appropriate revisions to each Draft Final document. Responses from EA to all regulatory agency comments will be reviewed by Government project delivery team before submission of comment responses to the wider regulatory agencies. If a comment resolution meeting is scheduled, EA will record meeting minutes and include in the minutes comments and responses provided by EA. The revised Draft Final document will be then submitted as the Final document.

At least one electronic copy of any final document submission to USACE and NFARS will include pertinent electronic files and all QC data, drawings, and GIS information, with original files including figures delivered in Microsoft Office file format and database formats as appropriate. Spatial data will be provided in SDSFIE format, in accordance with SDSFIE 3.1.1 for GIS data, Metadata FGDC Content Standard for Geospatial Metadata Version 2. Analytical data will be submitted to the ERPIMS following data validation.

Phase I Remedial Investigation Report

EA will prepare a Phase I RI Report that characterizes environmental conditions; describes the complete nature and extent of PFAS concentrations; describes and portrays comprehensive groundwater flow and contaminant hydrogeological conditions; and evaluates the migration pathways based on the geologic, geophysical, hydrogeological, ecological, chemical, physical, and hydrologic data.

The report will include analysis and interpretation of multiple factors such as groundwater hydrology/modeling and development of a CSM, groundwater transmissivity, fate transport and contaminant mass flux, calculation of travel times, contamination extent, source identification, and a preliminary evaluation of remedial alternatives. Also included in the RI are analytical data tables, hydrogeologic cross-sections, potentiometric maps, contaminant isocontour maps, electronic data deliverables, and recommendations for any future sampling to address risk assessment needs.

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Table 14-1. Project Tasks and Schedule

Task	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)
Pre-Mobilization Initial Phase	EA – Field Manager and personnel	August 2023	September2023	Not applicable
Mobilization Initial Phase	EA	September 2023	September 2023	Daily Quality Control Reports (DQCRs)
Fieldwork Initial Phase	EA	September 2023	October 2023	DQCRs, Tables/Figures with Screening Data as Available
Demobilization Initial Phase	EA	October 2023	October 2023	DQCRs
Data Review/Validation	Pace Gulf Coast, Baton Rouge, LA; Environmental Data Services, Ltd; EA	Variable with final shipment of samples received in October 2023	Variable with final data validation received by November 2023	Laboratory data packages, Data validation reports
Interim Reporting	EA	November 2023	December 2023	Data Report with 2 weeks for PDT review
PDT Meeting	EA	January 2024	January 2024	Meeting minutes
Development of QAPP Addendum 1	EA	January 2024	March 2024	QAPP Addendum 1
Pre-Mobilization Second Phase	EA	March 2024	April 2024	Not applicable
Mobilization Second Phase	EA, direct push subcontractor	April 2024	April 2024	DQCRs
Fieldwork Second Phase	EA, direct push subcontractor	April 2024	May 2024	DQCRs
Demobilization Second Phase	EA, direct push subcontractor	May 2024	May 2024	DQCRs
Data Review/Validation	Pace Gulf Coast, Baton Rouge, LA; Environmental Data Services, Ltd; EA	Variable with final shipment of samples received by May 2024	Variable with final data validation received by June 2024	Laboratory data packages, Data validation reports
Interim Reporting	EA	June 2024	July 2024	Data Report (with 2 weeks for stakeholder review)
PDT Meeting	EA	July 2024	July 2024	Meeting minutes
Development of QAPP Addendum 2	EA	July 2024	October 2024	QAPP Addendum 2
Pre-Mobilization Third Phase (well	EA	October 2024	October 2024	Not applicable

Task	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)
installation/baseline sampling)				
Mobilization Third Phase (well installation/baseline sampling)	EA, well installation subcontractor	October2024	October2024	DQCRs
Fieldwork Third Phase (well installation/baseline sampling)	EA, direct push subcontractor	October 2024	October 2024	DQCRs
Demobilization Third Phase (well installation/baseline sampling)	EA, well installation subcontractor	October 2024	November2024	DQCRs
Data Review/Validation	Pace Gulf Coast, Baton Rouge, LA; Environmental Data Services, Ltd; EA	Variable with final shipment of samples received by November 2024	Variable with final data validation received by December 2024	Laboratory data packages, Data validation reports
Interim Reporting	EA	December 2024	January 2025	Data Report (with 2 weeks for stakeholder review)
Pre-Mobilization Third Phase (second round groundwater/lysimeter sampling)	EA	March 2025	April 2025	Not applicable
Mobilization Third Phase (second round groundwater/lysimeter sampling)	EA	April 2025	April 2025	DQCRs
Fieldwork Third Phase (second round groundwater/lysimeter sampling)	EA	April 2025	May 2025	DQCRs
Demobilization Third Phase (second round	EA	May 2025	May 2025	DQCRs

Task	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)
groundwater/lysimeter sampling)				
Data Review/Validation	Pace Gulf Coast, Baton Rouge, LA; Environmental Data Services, Ltd; EA	Variable with final shipment of samples received by May 2025	Variable with final Mobilization 2 results received by June 2025	Laboratory data packages, Data validation reports
Interim Reporting	EA	June 2025	July 2025	Data Report (with 2 weeks for stakeholder review)
PDT Meeting	EA	July 2025	July 2025	Meeting minutes
Reporting	EA	July 2025	September 2025	Draft RI Report

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UFP-QAPP Worksheet #15: Project Screening Levels and Laboratory-Specific Detection/Quantitation Limits[1]

This worksheet presents analytical methods, analytes, project screening values, and achievable laboratory limits including LOQs, LODs, and MDLs. The purpose of this worksheet is to determine if laboratory limits will be meet project PALs (i.e., screening values). Matrix effects or necessary dilutions may affect the laboratory limits reported for project samples. Note there are no PALs for grain size by ASTM Method D422, porosity by ASTM Method D2937, and permeability by ASTM Method D5084.

The MDL is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. Although a result at or above the MDL indicates that the analyte is present, the absence of a result at or above the MDL is inconclusive (i.e., one cannot confidently state whether the analyte is present or absent), because the false negative rate at the MDL is 50 percent. The MDL is used to determine the LOD for each analyte and matrix as well as for preparatory and cleanup methods routinely used on samples.

The LOD is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99% confidence level. If a sample has a true concentration at the LOD, there is a minimum probability of 99% of reporting a detection (a measured value greater than or equal to the MDL) and a 1% chance of reporting a non-detect (a false negative). Due to the false negative rate at the LOD (1%), the laboratory will report non-detectable values as less than the LOD.

The LOQ is the lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias. Quantitative concentration results within specified limits of precision and bias can only be achieved at or above the LOQ; however, the analytical laboratory may identify analytes between the MDL and the LOQ. In these instances, the laboratory will report concentration values between the MDL and the LOQ as estimated (J) values.

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[1] Acronyms used throughout this worksheet are defined in the "List of Acronyms and Abbreviations" immediately following the Table of Contents at the beginning of this UFP-QAPP.

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Table 15-1. Reference Limits and Evaluation Table for PFAS – Soil/Sediment

Matrix: Soil/Sediment
Analytical Group: PFAS
Method: EPA Draft Method 1633
Laboratory: Pace Gulf Coast, Baton Rouge, Louisiana

Analyte	Acronym	CAS	ASD Calculated Residential Scenario Screening Levels For Soil Calculated Using EPA RSL Calculator, HQ = 0.1 (µg/kg)[1]	Laboratory Limits (µg/kg)		
				LOQ	LOD	DL
Perfluoroalkyl carboxylic acids (PFCA)						
Perfluorobutanoic acid	PFBA	375-22-4	No RSL	0.8	0.4	0.1436
Perfluoropentanoic acid	PFPeA	2706-90-3	No RSL	0.4	0.2	0.0616
Perfluorohexanoic acid	PFHxA	307-24-4	No RSL	0.2	0.16	0.0775
Perfluoroheptanoic acid	PFHpA	375-85-9	No RSL	0.2	0.1	0.0296
Perfluorooctanoic acid	PFOA	335-67-1	19	0.2	0.1	0.0362
Perfluorononanoic acid	PFNA	375-95-1	19	0.2	0.1	0.0441
Perfluorodecanoic acid	PFDA	335-76-2	No RSL	0.2	0.1	0.384
Perfluoroundecanoic acid	PFUnA	2058-94-8	No RSL	0.2	0.1	0.0299
Perfluorododecanoic acid	PFDoA	307-55-1	No RSL	0.2	0.1	0.0378
Perfluorotridecanoic acid	PFTriDA	72629-94-8	No RSL	0.2	0.1	0.0314
Perfluorotetradecanoic acid	PFTeDA	376-06-7	No RSL	0.2	0.1	0.0303
Perfluoroalkyl sulfonic acids (PFSA)						
Perfluorobutanesulfonic acid	PFBS	375-73-5	1,900	0.2	0.1	0.0269
Perfluoropentansulfonic acid	PFPeS	2706-91-4	No RSL	0.2	0.1	0.0323
Perfluorohexanesulfonic acid	PFHxS	355-46-4	130	0.2	0.1	0.0328
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	No RSL	0.2	0.1	0.0249
Perfluorooctanesulfonic acid	PFOS	1763-23-1	13	0.2	0.1	0.0516
Perfluorononanesulfonic acid	PFNS	68259-12-1	No RSL	0.2	0.1	0.0396
Perfluorodecanesulfonic acid	PFDS	335-77-3	No RSL	0.2	0.1	0.0333
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	No RSL	0.2	0.1	0.0281
Fluorotelomer sulfonic acids (FTSA)						
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	4:2FTS	757124-72-4	No RSL	0.8	0.4	0.1507
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2FTS	27619-97-2	No RSL	0.8	0.4	0.1391
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2FTS	39108-34-4	No RSL	0.8	0.4	0.1281
Fluorooctane sulfonamides (FOSA)						
Perfluorooctanesulfonamide	PFOSA	754-91-6	No RSL	0.2	0.1	0.0471
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	No RSL	0.2	0.1	0.0341
N-ethyl perfluorooctanesulfonamide	NEtFOSA	4151-50-2	No RSL	0.2	0.15	0.0588
Perfluorooctane sulfonamidoacetic acids (FOSAA)						
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	No RSL	0.2	0.1	0.0485
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	No RSL	0.2	0.1	0.0262
Perfluorooctane sulfonamide ethanols (FOSE)						
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7	No RSL	2	1	0.3955
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2	No RSL	2	1	0.4418
Per- and polyfluoroether carboxylic acids						
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	23	0.8	0.4	0.1001
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	No RSL	0.8	0.4	0.0991
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	No RSL	0.4	0.2	0.0417
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	No RSL	0.4	0.2	0.0382
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	No RSL	0.4	0.2	0.0597

Analyte	Acronym	CAS	ASD Calculated Residential Scenario Screening Levels For Soil Calculated Using EPA RSL Calculator, HQ = 0.1 (µg/kg)[1]	Laboratory Limits (µg/kg)		
				LOQ	**LOD**	**DL**
Ether sulfonic acids						
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	No RSL	0.8	0.4	0.0814
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	No RSL	0.8	0.4	0.1136
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	No RSL	0.4	0.2	0.048
Fluorotelomer carboxylic acids (FTCA)						
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	No RSL	1	0.5	0.2091
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	No RSL	5	2.5	1.114
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	No RSL	5	2.5	0.998

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022)

Table 15-2. Reference Limits and Evaluation Table for PFAS – Groundwater/Surface Water

Matrix: Groundwater/Surface Water/Porewater
Analytical Group: PFAS
Method: EPA Draft Method 1633
Laboratory: Pace Gulf Coast, Baton Rouge, Louisiana

Analyte	Acronym	CAS	ASD Calculated Residential Scenario Screening Levels for Tapwater Calculated Using EPA RSL Calculator, HQ = 0.1 (ng/L)[1]	Laboratory Limits (ng/L)		
				LOQ	LOD	DL
Perfluoroalkyl carboxylic acids (PFCA)						
Perfluorobutanoic acid	PFBA	375-22-4	No RSL	4	2	0.545
Perfluoropentanoic acid	PFPeA	2706-90-3	No RSL	2	1	0.2891
Perfluorohexanoic acid	PFHxA	307-24-4	No RSL	1	0.5	0.1179
Perfluoroheptanoic acid	PFHpA	375-85-9	No RSL	1	0.5	0.158
Perfluorooctanoic acid	PFOA	335-67-1	6	1	0.5	0.1571
Perfluorononanoic acid	PFNA	375-95-1	6	1	0.5	0.1664
Perfluorodecanoic acid	PFDA	335-76-2	No RSL	1	0.5	0.1812
Perfluoroundecanoic acid	PFUnA	2058-94-8	No RSL	1	0.5	0.1815
Perfluorododecanoic acid	PFDoA	307-55-1	No RSL	1	0.5	0.1692
Perfluorotridecanoic acid	PFTrDA	72629-94-8	No RSL	1	0.5	0.196
Perfluorotetradecanoic acid	PFTeDA	376-06-7	No RSL	1	0.5	0.1676
Perfluoroalkyl sulfonic acids (PFSA)						
Perfluorobutanesulfonic acid	PFBS	375-73-5	601	1	0.5	0.1041
Perfluoropentansulfonic acid	PFPeS	2706-91-4	No RSL	1	0.5	0.1164
Perfluorohexanesulfonic acid	PFHxS	355-46-4	39	1	0.5	0.1714
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	No RSL	1	0.5	0.1122
Perfluorooctanesulfonic acid	PFOS	1763-23-1	4	1	0.75	0.2586
Perfluorononanesulfonic acid	PFNS	68259-12-1	No RSL	1	0.5	0.2182
Perfluorodecanesulfonic acid	PFDS	335-77-3	No RSL	1	0.5	0.1534
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	No RSL	1	0.5	0.3408
Fluorotelomer sulfonic acids (FTSA)						
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	4:2FTS	757124-72-4	No RSL	4	2	0.6337
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2FTS	27619-97-2	No RSL	4	2	0.9453
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2FTS	39108-34-4	No RSL	4	2	0.5442
Fluorooctane sulfonamides (FOSA)						
Perfluorooctanesulfonamide	PFOSA	754-91-6	No RSL	1	0.5	0.1539
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	No RSL	1	0.5	0.1529
N-ethyl perfluorooctanesulfonamide	NEtFOSA	4151-50-2	No RSL	1	0.5	0.1443
Perfluorooctane sulfonamidoacetic acids (FOSAA)						
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	No RSL	1	0.5	0.2174
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	No RSL	1	0.75	0.2571
Perfluorooctane sulfonamide ethanols (FOSE)						
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7	No RSL	10	5	1.5154
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2	No RSL	10	5	2.3555
Per- and polyfluoroether carboxylic acids						
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	6	4	2	0.8906
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	No RSL	4	2	0.5716
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	No RSL	2	1	0.3205
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	No RSL	2	1	0.2962
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	No RSL	2	1	0.4918

Analyte	Acronym	CAS	ASD Calculated Residential Scenario Screening Levels for Tapwater Calculated Using EPA RSL Calculator, HQ = 0.1 (ng/L)[1]	Laboratory Limits (ng/L)		
				LOQ	LOD	DL
Ether sulfonic acids						
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	No RSL	4	2	0.7343
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	No RSL	4	2	0.9354
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	No RSL	2	1	0.4772
Fluorotelomer carboxylic acids (FTCA)						
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	No RSL	5	3	1.4817
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	No RSL	25	8	1.8805
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	No RSL	25	10	2.5639

1) RSLs as presented in the memorandum from the Office of the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 6 July 2022 (ASD 2022)

Table 15-3. Reference Limits and Evaluation Table for Total Organic Carbon – Soil

Matrix: Soil
Analytical Group: TOC
Method: EPA SW-846 Method 9060A
Laboratory: Pace Gulf Coast, Baton Rouge, Louisiana

Analyte	CAS	Laboratory Limits (µg/kg)		
		LOQ	LOD	DL
TOC	C-012	500,000	350,000	153,000

Notes:
CAS = Chemical Abstracts Service

Table 15-4. Reference Limits and Evaluation Table for pH – Soil

Matrix: Soil
Analytical Group: pH
Method: SW9045D
Laboratory: Pace Gulf Coast, Baton Rouge, Louisiana

Analyte	CAS	Laboratory Limits (su)		
		LOQ	LOD	DL
pH	NA	1	1	1

Notes:
su = Standard unit(s)

Table 15-5. Reference Limits and Evaluation Table for Cation Exchange Capacity – Soil

Matrix: Soil Extract
Analytical Group: Cation Exchange Capacity
Method: EPA SW-846 Method 9081
Laboratory: Pace Sheridan, Sheridan, Wyoming

Analyte	CAS No.	Laboratory Limits	
		LOQ	DL
Sodium	7440-23-5	0.05 meq/100 g	0.006 mg/L

Notes:
meq/100 g = milliequivalent(s) per 100 grams

Table 15-6. Reference Limits and Evaluation Table for Anion Exchange Capacity – Soil

Matrix: Soil Extract
Analytical Group: Anion Exchange Capacity
Method: New Zealand Phosphorus Retention
Laboratory: Pace Gulf Coast, Baton Rouge, Louisiana

Analyte	CAS No.	Achievable Laboratory Limits	
		LOQ	DL
Phosphorus	7723-14-0	0.1 meq/100g	0.01 mg/L

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UFP-QAPP Worksheet #17: Sampling Design and Rationale

The approach to complete RI fieldwork at each NFARS AFFF site is described below. This worksheet describes the sampling design and basis for selection for each sampling location (including information on the number and locations of samples planned for the initial phase of RI fieldwork). The Phase I RI is being conducted using a data-driven sequential phased approach where data is collected and presented to the PDT with proposed subsequent investigative elements during scoping meetings. RI fieldwork will be conducted over a series of three phases: initial, second, and third phase.

Data generated during each phase of RI fieldwork will include definitive analytical results used for decision making, delineation, and future risk assessment purposes. All sample analysis will be performed by a fixed-base laboratory (Worksheet #15).

Following each phase RI field activities, the data generated will be incorporated into an updated CSM. The results of each phase of field activities will be presented in Data Reports and used to select soil boring and groundwater boring locations for the second phase of field activities. Scoping sessions will be hosted with the PDT (AFCEC, USACE, NFARS, NYSDEC, and NYSDOH) to discuss the updated CSM and refined sampling plan prior to the subsequent phase of RI field activities. The sampling design and rationale and planned sampling locations and methods for the second and third phases will be presented in addendums to this UFP-QAPP.

INITIAL PHASE FIELD ACTIVITIES

Field activities during the initial phase mobilization(s) will include: (1) source area surface soil sampling at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; SS015P: AFFF Area 5 Blue Angels Crash Site; and SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9, (2) initial surface water/sediment sampling. Surface soil grid locations and proposed surface water/sediment sampling locations are shown on **Figures 17-1 through 17-5.** The surface soil sampling will support delineation of source areas and selection of locations and transects for the second phase of RI fieldwork. Results from the initial mobilization will be used to update site-specific CSMs and evaluate data gaps prior to the second phase of RI fieldwork.

Soil Sampling

Surface soil sampling is proposed as the initial phase based upon results reported in the SI, which suggested PFAS migration through the vadose zone is slowed by adsorption to fine-grained material, as evidenced by the higher concentrations observed during the SI in surface soils compared to sub-surface soils. Grab soil samples will be collected from sites where the SI indicated PFAS above screening levels (FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS015P: AFFF Area 5 Blue Angels Crash Site; and SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9) to evaluate the extent of PFAS in surface soil and to evaluate the source strength and mass loading. Surface soils from the remaining sites will be collected in a subsequent mobilization during soil boring activities.

Up to 65 surface soil samples will be collected from depths of 0-0.5 ft bgs as follows:

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 15 surface soil samples (**Figure 17-1**) and up to 20 total surface soil samples
- SS707P: AFFF Area 4 Building 700, Outfall 4 – 13 surface soil samples (**Figure 17-2**) and up to 20 total surface soil samples_
- SS015P: AFFF Area 5 Blue Angels Crash Site – 8 surface soil samples (**Figure 17-3**) and up to 10 total surface soil samples
- SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9 – 12 surface soil samples (**Figure 17-4**) and up to 15 total surface soil samples

Sampling at each AFFF site will be conducted within suspected release areas using a biased grid. Proposed grids are presented in **Figures 17-1 through 17-4**. Initial locations will be biased to suspected release areas, accumulation points, and locations where elevated groundwater concentrations were reported during the SI. Subsequent samples will be collected in a step in/step out fashion, moving from areas of impacted soil to areas where no impacts exist. Surface soil samples will be analyzed for PFAS by EPA Method 1633.

Surface Water and Sediment Sampling

Co-located surface water and sediment grab samples will be collected from drainages associated with FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; and SS101P: AFFF Area 6 Fox Row/ Taxiway Alpha, Outfalls 5 and 9 to evaluate potential migration along the stormwater system. Proposed surface water sampling locations are presented in **Figure 17-5**. Surface soil and sediment samples will be collected following the procedures listed in Worksheet #14 and #16. Up to 20 co-located samples will be collected as presented below. Samples will be collected at locations both upstream and downstream of release areas, to compare upstream vs. downstream concentrations.

Surface water and sediment samples are planned for Spring 2023, to correspond with saturated conditions. Surface water samples will be collected before co-located sediment samples to avoid suspending solids in the sample. Surface water samples will be collected during periods of flow, with samples collected from the middle of the channel at mid-depth. Sediment samples will be collected from mid-channel at depths of 0-6 in. bgs.

Water quality parameters (pH, specific conductance, temperature, ORP, DO, and turbidity) will be collected for each surface water sample, and each surface water and sediment sample will be analyzed for PFAS by EPA Method 1633.

SECOND PHASE FIELD ACTIVITIES

Field activities during the second mobilization will include: (1) initial synoptic water level measurement event, (2) source area soil boring advancement and surface and subsurface soil sampling, (3) groundwater soil boring advancement and groundwater grab sampling, and (4) a second surface water/sediment sampling event. The rationale for sample placement for the second phase will be presented in an addendum to this UFP-QAPP.

The second phase surface and subsurface soil sampling and groundwater grab sampling analytical results will support delineation of source areas, selection of monitoring well locations and screen intervals, and selection of lysimeter locations for the third phase of RI fieldwork. Results from the second mobilization will be used to update site-specific CSMs and evaluate data gaps prior to the third phase of RI fieldwork.

Synoptic Event

A baseline synoptic groundwater gauging event will be completed at 123 existing monitoring wells installed as part of past investigations at the base (**Figure 17-6**). Synoptic gauging is being conducted to enhance the understanding of basewide groundwater flow directions and interactions between groundwater and surface water and determine regional groundwater flow surrounding each AFFF site. Potentiometric maps will be developed using the groundwater elevation data. These data will be used along with the PFAS RI site specific groundwater elevations and flow directions described in the SI to assist in planning monitoring well locations.

Source Area Soil Boring Sampling

Soil borings will be advanced and surface and subsurface soil sampling will be conducted to obtain additional data to enhance the understanding of the nature and extent (horizontal and vertical) of PFAS in soil at each AFFF site. Up to 42 soil borings will be advanced using direct-push technology as presented in Worksheet #14 and #16. Locations of soil borings will be biased to areas where the initial surface soil sampling indicate the highest PFAS or where additional sampling is needed to further bound observed SI exceedances (step in/step out).

Borings will be advanced to maximum depths of 25 ft bgs. Continuous soil coring will be completed from the ground surface to the base of each boring to observe and record lithology. Borings may be shallower or deeper depending on observations while in the field.

Up to three vadose soil samples will be collected from each boring to delineate source areas as follows:

- Surface soil (0–0.5 ft bgs)
- Subsurface soil sample collected immediately above the water table interface
- Where deemed applicable, subsurface soil sample collected from midway between the surface and water table interface

Depth to water at each AFFF site during SI soil boring advancement is presented below. The location of soil borings will be detailed in the UFP-QAPP addendum for the second phase of RI fieldwork.

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 7-8 ft bgs
- SS850P: AFFF Area 2 Hanger 850 – 11-14 ft bgs
- SS706P: AFFF Area 3 Building 706 – 4-6 ft bgs
- SS707P: AFFF Area 4 Building 700, Outfall 4 – Water not encountered; bedrock encountered at 4-7.82 ft bgs
- SS015P: AFFF Area 5 Blue Angels Crash Site – 2.5-5.5 ft bgs
- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9 – 2.5 ft bgs
- SS316P: AFFF Area 8 Hulby Street – 8 ft bgs

The proposed number of soil borings and soil samples to be collected at each AFFF site is presented below.

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 8 soil borings; 8 surface soil samples and 16 subsurface soil samples for analysis of PFAS; 10 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters
- SS850P: AFFF Area 2 Hanger 850 – 8 soil borings; 8 surface soil samples and 16 subsurface soil samples for analysis of PFAS; 3 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters
- SS706P: AFFF Area 3 Building 706 – 5 soil borings; 5 surface soil samples and 10 subsurface soil samples for analysis of PFAS; 2 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters
- SS707P: AFFF Area 4 Building 700, Outfall 4 – 8 soil borings; 8 surface soil samples and 16 subsurface soil samples for analysis of PFAS; 10 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters
- SS015P: AFFF Area 5 Blue Angels Crash Site – 4 soil borings; 4 surface soil samples and 4 subsurface soil samples for analysis of PFAS; 4 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters

- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9 – 4 soil borings; 4 surface soil samples and 4 subsurface soil samples for analysis of PFAS; 4 samples homogenized and split for SPLP and PFAS analysis; 3 samples for geotechnical/physiochemical parameters

- SS316P: AFFF Area 8 Hulby Street – 5 soil borings; 5 surface soil samples and 10 subsurface soil samples for analysis of PFAS; 3 samples for geotechnical/physiochemical parameters

Each discrete soil sample will be submitted for PFAS by EPA Method 1633. A subset of samples will also be homogenized and split for additional SPLP and PFAS analysis. Additional soil samples will be collected for analysis of geotechnical/physiochemical parameters (pH, grain size, permeability, TOC, and anion/cation exchange capacity) at locations and intervals considered to be presentative of saturated flow zones. Grain size, permeability, and pH data will be used to evaluate aquifer permeability and hydraulic conductivity. TOC and anion/cation exchange capacity will be used to evaluate PFAS fate and transport in the subsurface.

Groundwater Grab Sampling

Groundwater grab sampling will be conducted at each AFFF site to determine the horizontal distribution of contamination, to provide additional hydrogeologic data, and to determine PFAS max flux from identified source areas. Groundwater borings will be advanced in transects downgradient and perpendicular to groundwater flow will be used to define plume extent and mass flux. Results of the initial phase of RI fieldwork (surface soil sampling) and second phase basewide synoptic gauging data, along with the PFAS RI site specific groundwater elevations and flow directions described in the SI, will be used to assist in planning transect locations.

Up to 135 groundwater borings will be advanced using direct-push technology as presented in Worksheet #14 and #16. One groundwater grab sample will be collected at each groundwater boring from below the water table. The proposed number of borings and groundwater grab samples at each AFFF site is presented below. The final number and location of borings/samples at each AFFF site will be detailed in the UFP-QAPP addendum for the second phase of RI fieldwork.

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 25 groundwater borings / samples

- SS850P: AFFF Area 2 Hanger 850 – 25 groundwater borings / samples

- SS706P: AFFF Area 3 Building 706 – 15 groundwater borings / samples

- SS707P: AFFF Area 4 Building 700, Outfall 4 – 15 groundwater borings / samples

- SS015P: AFFF Area 5 Blue Angels Crash Site – 15 groundwater borings / samples

- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9 – 15 groundwater borings / samples

- SS316P: AFFF Area 8 Hulby Street – 25 groundwater borings / samples

Continuous soil coring will be completed from the ground surface to the base of each boring to observe and record lithology. Groundwater samples will be analyzed for PFAS by EPA Method 1633. Water quality parameters (pH, specific conductance, temperature, ORP, DO, and turbidity) will be recorded for each sample.

Surface Water and Sediment Sampling

Co-located surface water and sediment grab samples will be collected from FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; and SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9 to confirm the revised CSMs and evaluate potential for seasonal changes in PFAS concentrations. A total of 20 samples of each media are proposed to be collected, consistent with sampling during the initial phase of RI fieldwork. Additional sampling/monitoring will be considered for the second phase of fieldwork if exceedances are detected in the initial phase surface water or sediment samples, as concentrations could fluctuate depending on the season, amount of rainfall, etc. The final number and location of surface water and sediment samples at each AFFF site will be detailed in the UFP-QAPP addendum for the second phase of RI fieldwork.

Water quality parameters (pH, specific conductance, temperature, ORP, DO, and turbidity) will be collected for each surface water sample, and each surface water and sediment sample will be analyzed for PFAS by EPA Method 1633.

THIRD PHASE FIELD ACTIVITIES

Field activities during the third phase of RI fieldwork will include: (1) monitoring well installation and development, (2) completion of source area soil investigation with installation of lysimeters based on soil sampling results, (3) synoptic water level measurement event (new and existing monitoring wells), (5) groundwater (new and existing monitoring wells) and lysimeter sampling event #1, and (6) groundwater (new and existing monitoring wells) and lysimeter sampling event #2. The rationale for sample placement for the third phase will be presented in an addendum to this UFP-QAPP.

Monitoring Well Installation

A series of new monitoring wells will be installed and sampled to estimate dissolved phase PFAS mass flux. Up to 49 new wells will be installed to maximum depths of 25 ft bgs using a track-mounted direct push drill rig (Geoprobe® or similar) and hollow-stem auger drilling techniques as presented in Worksheet #14 and #16. Monitoring wells will be installed at each AFFF site in transects perpendicular to groundwater flow based on results of synoptic gauging and groundwater grab sampling during the second phase of RI fieldwork. Well construction details such as depths and screened intervals will be determined during scoping sessions held with the PDT.

The proposed number of wells at each AFFF site is presented below. The final location of monitoring wells at each site and well construction details will be detailed in the UFP-QAPP addendum for the third phase of RI fieldwork.

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 12 monitoring wells to depth of 12-25 ft bgs
- SS850P: AFFF Area 2 Hanger 850 – 5 monitoring wells to depth of 12-25 ft bgs
- SS706P: AFFF Area 3 Building 706 – 4 monitoring wells to depth of 12-25 ft bgs
- SS707P: AFFF Area 4 Building 700, Outfall 4 – 14 monitoring wells to depth of 12-25 ft bgs
- SS015P: AFFF Area 5 Blue Angels Crash Site, Outfalls 5 and 9 – 5 monitoring wells to depth of 12-25 ft bgs
- SS101P: AFFF Area 6 Fox Row/Taxiway Alpha – 5 monitoring wells to depth of 12-25 ft bgs
- Hulby Street – 4 monitoring wells to depth of 12-25 ft bgs

Soil Sampling

During monitoring well installation, continuous soil coring will be completed from the ground surface to the base of each boring to observe and record lithology. Soil samples will be collected from each location as follows:

- Up to 3 soil samples from groundwater monitoring well locations in a suspected source area as follows:
  - Surface soil (0–0.5 ft bgs)
  - Subsurface soil sample collected immediately above the water table interface

Where deemed applicable, subsurface soil sample collected from midway between the surface and water table interface

- 1 subsurface soil sample collected immediately above the water table at each groundwater monitoring well location installed outside the source area

Soil samples will be analyzed for PFAS by EPA Method 1633.

Groundwater Synoptic Gauging and Sampling

Two rounds of groundwater sampling will be conducted at an estimated 49 new monitoring wells to confirm the revised CSMs and evaluate potential for seasonal changes in PFAS concentrations. The first sampling event will be conducted a minimum of two weeks following completion of well development. The second event will be spaced approximately six months after the first (bi-annual sampling) to provide for seasonal variability.

After each sampling event, a synoptic round of water levels will be collected from 123 prior known wells installed as part of past investigations at the base and each of the 49 newly installed monitoring wells. Surface water elevations at adjacent water bodies and drainages will also be level-surveyed and locations recorded with GPS to determine invert elevations of drainages and evaluate groundwater-surface water interaction. Gauging data will be used to determine localized groundwater flow surrounding each AFFF site and develop potentiometric maps.

Low-flow sampling techniques will be used for each event as presented in Worksheet #14 and #16. Water quality parameters including pH, conductivity, temperature, ORP, DO, TDS, and turbidity be recorded in the field using a water quality meter prior to sample collection. Groundwater samples will be collected and analyzed for PFAS by EPA Method 1633.

Lysimeter Installation and Sampling

Based on results of the soil and groundwater grab sample data collection, a series of new lysimeters may be installed during the third phase of RI fieldwork in release areas at FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 and SS707P: AFFF Area 4 Building 700, Outfall 4 to evaluate the potential for PFAS in soil to leach to groundwater. Due to the shallow depth to water and bedrock, and low hydraulic conductivity of the overburden, lysimeters may not work. Additional soil SPLP samples may be proposed as an alternative to lysimeters. Further detail will be presented in the UFP-QAPP addendum for the third phase of RI fieldwork.

Up to 8 new suction lysimeters may be installed at a representative range of soil types and contamination levels to evaluate migration to groundwater (source strength) as follows:

- FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7 – 5 lysimeters within the source area

- SS707P: AFFF Area 4 Building 700, Outfall 4 – 3 lysimeters within the source area

Selection of locations for lysimeters will be based on a review of soil data to ensure lysimeters are placed at locations best suited to address potential migration to groundwater. Lysimeters will be installed within the horizontal contours of highest soil contamination, and as close to the water table as practical per source area. The final location of lysimeters at each AFFF site and well construction details will be detailed in the UFP-QAPP addendum for the third phase of RI fieldwork.

Two rounds of porewater sampling will be conducted. The duration of time between each of the sampling events will be determined during scoping sessions held with the PDT. Porewater samples will be analyzed for PFAS by EPA Method 1633.

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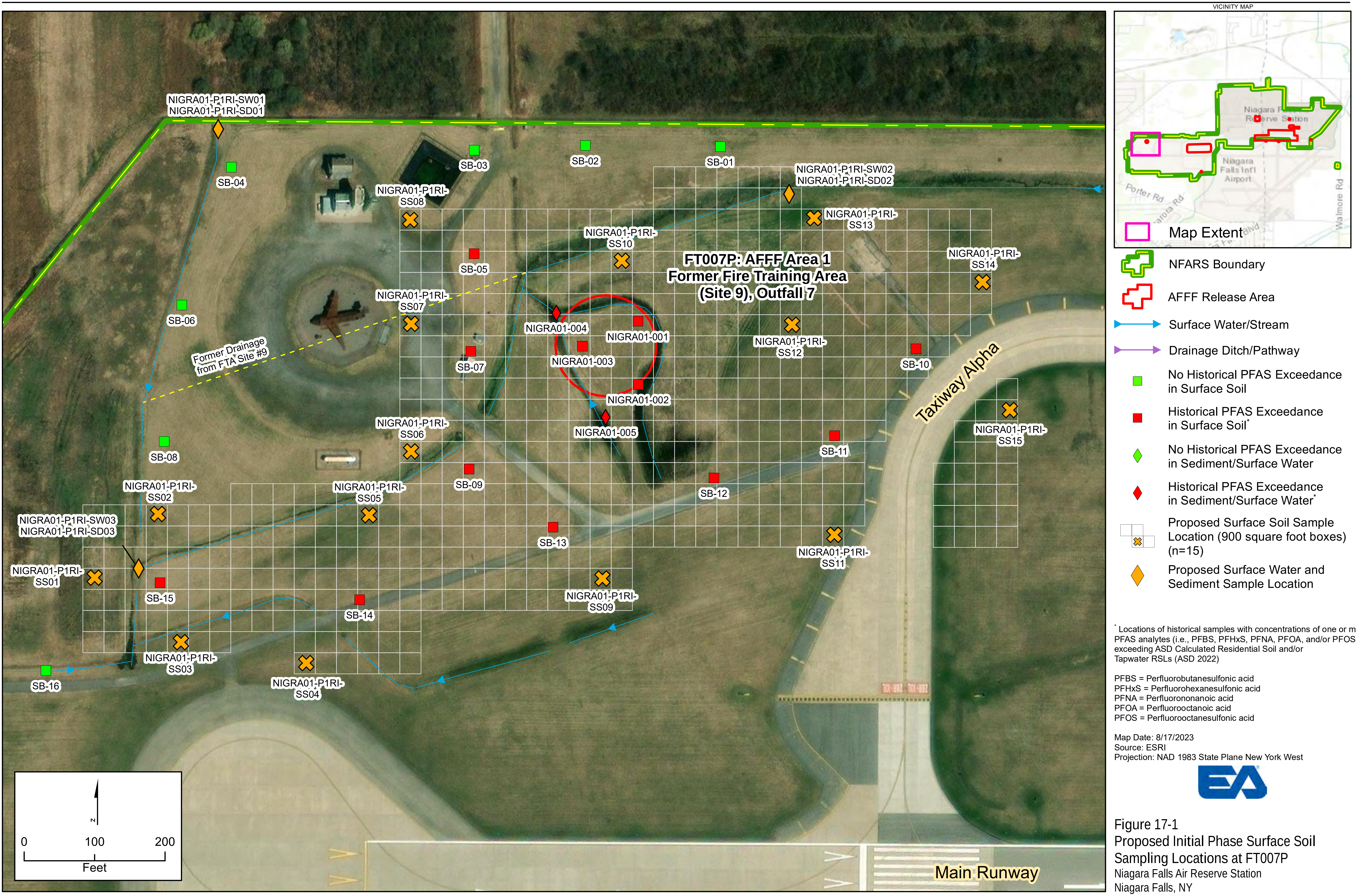


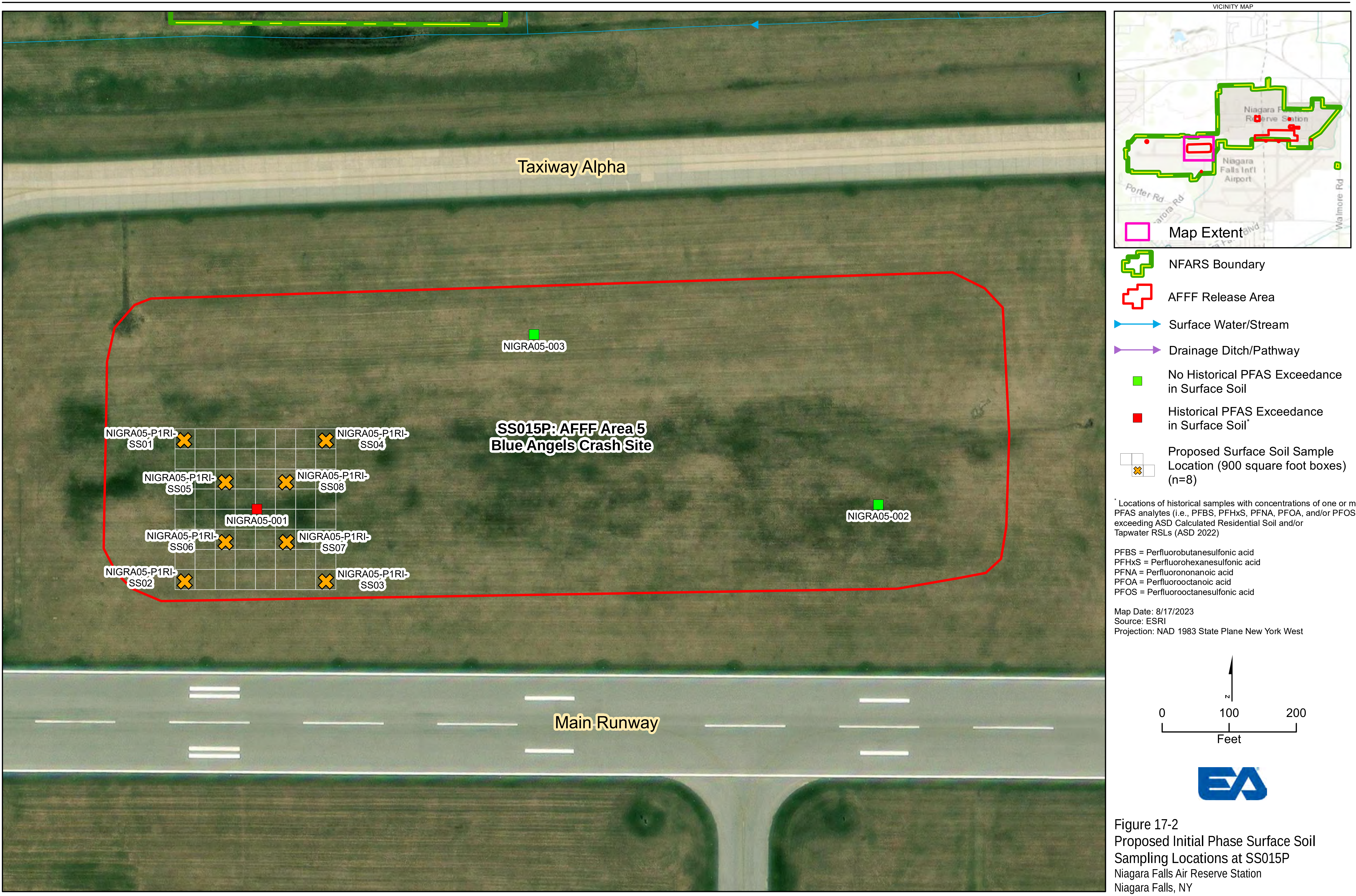
* Locations of historical samples with concentrations of one or more PFAS analytes (i.e., PFBS, PFHxS, PFNA, PFOA, and/or PFOS) exceeding ASD Calculated Residential Soil and/or Tapwater RSLs (ASD 2022)

PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-1
Proposed Initial Phase Surface Soil Sampling Locations at FT007P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI05_GIS\Planning Documents\MXD\Figure 17-1 Proposed Sampling Locations 1.mxd



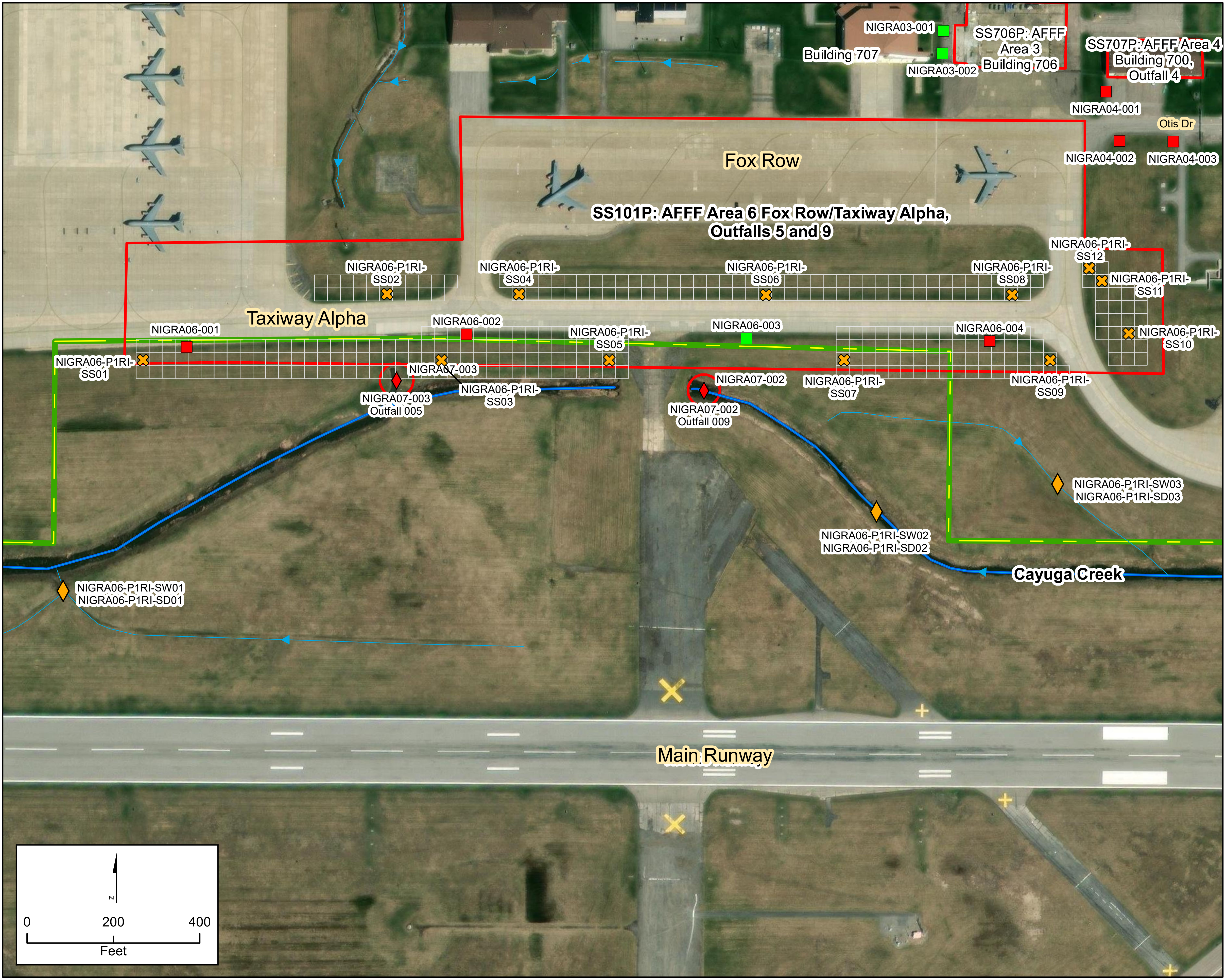
[*] Locations of historical samples with concentrations of one or more PFAS analytes (i.e., PFBS, PFHxS, PFNA, PFOA, and/or PFOS) exceeding ASD Calculated Residential Soil and/or Tapwater RSLs (ASD 2022)

PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid

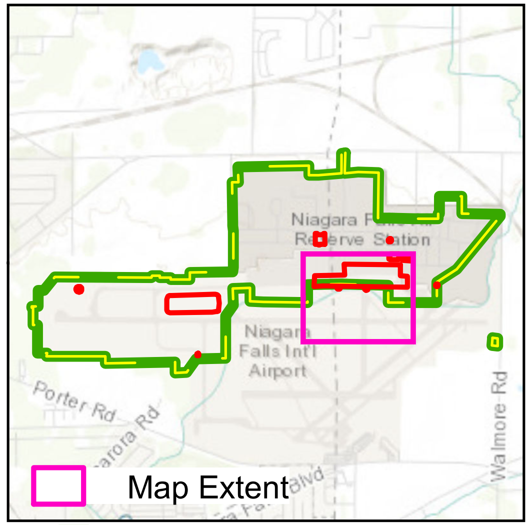
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-2
Proposed Initial Phase Surface Soil Sampling Locations at SS015P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafs\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 17-2 Proposed Sampling Locations 5.mxd



VICINITY MAP



🟪 Map Extent

🟩 NFARS Boundary

🟥 AFFF Release Area

→ Surface Water/Stream

→ Drainage Ditch/Pathway

🟩 No Historical PFAS Exceedance in Surface Soil

🟥 Historical PFAS Exceedance in Surface Soil*

◆ No Historical PFAS Exceedance in Sediment/Surface Water

◆ Historical PFAS Exceedance in Sediment/Surface Water*

☒ Proposed Surface Soil Sample Location (900 square foot boxes) (n=12)

◆ Proposed Surface Water and Sediment Sample Location

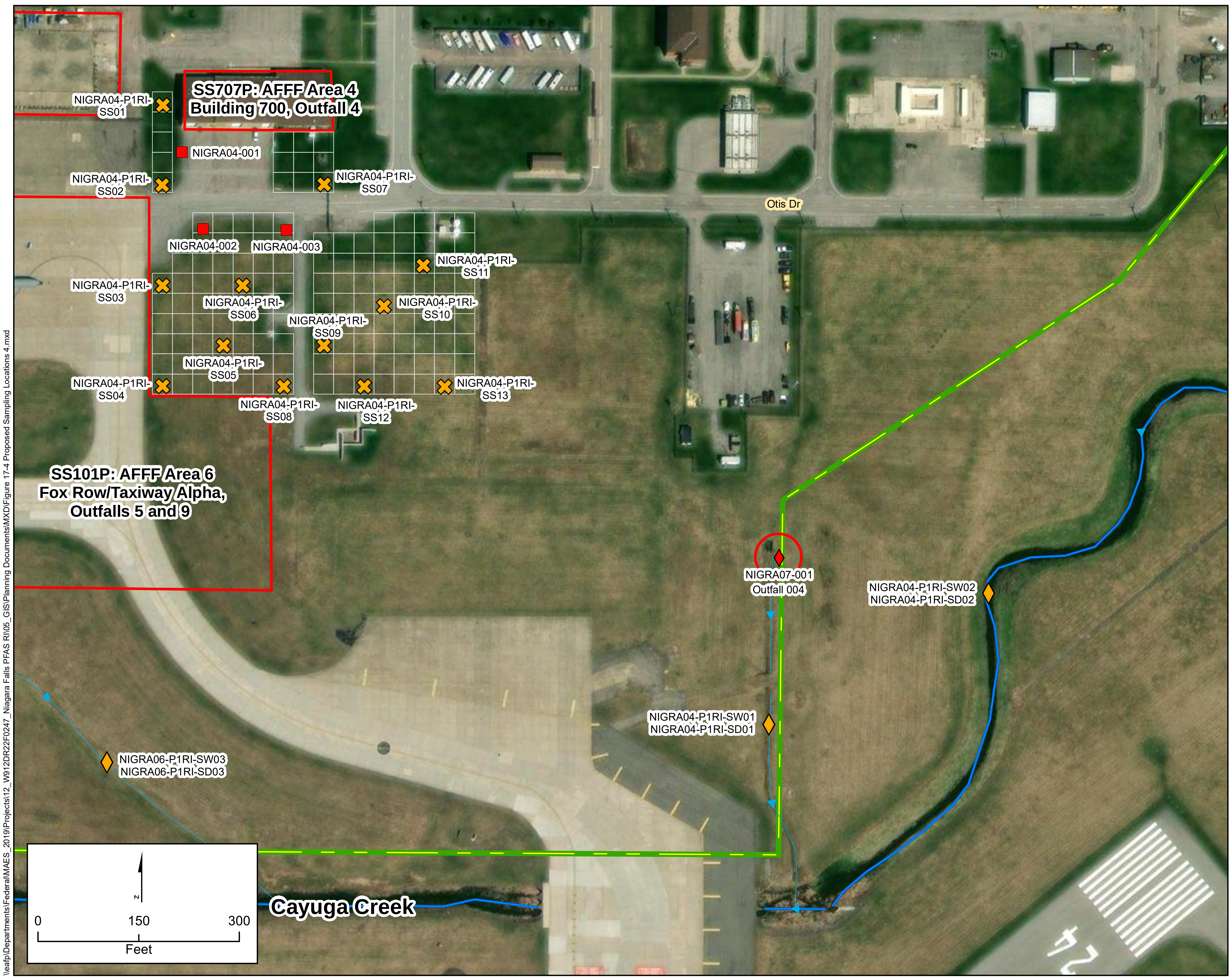
* Locations of historical samples with concentrations of one or more PFAS analytes (i.e., PFBS, PFHxS, PFNA, PFOA, and/or PFOS) exceeding ASD Calculated Residential Soil and/or Tapwater RSLs (ASD 2022)

PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid

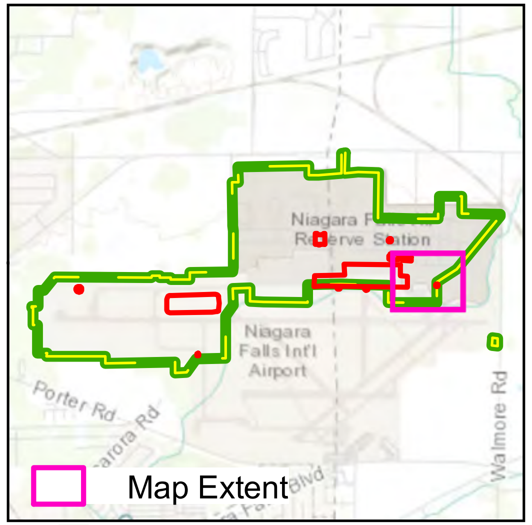
Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-3
Proposed Initial Phase Surface Soil Sampling Locations at SS101P
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 17-3 Proposed Sampling Locations 6.mxd



VICINITY MAP



- 🟪 Map Extent
- NFARS Boundary
- AFFF Release Area
- Surface Water/Stream
- Drainage Ditch/Pathway
- 🟩 No Historical PFAS Exceedance in Surface Soil
- 🟥 Historical PFAS Exceedance in Surface Soil*
- ◆ No Historical PFAS Exceedance in Sediment/Surface Water
- ◆ Historical PFAS Exceedance in Sediment/Surface Water*
- ☒ Proposed Surface Soil Sample Location (900 square foot boxes) (n=13)
- ◆ Proposed Surface Water and Sediment Sample Location

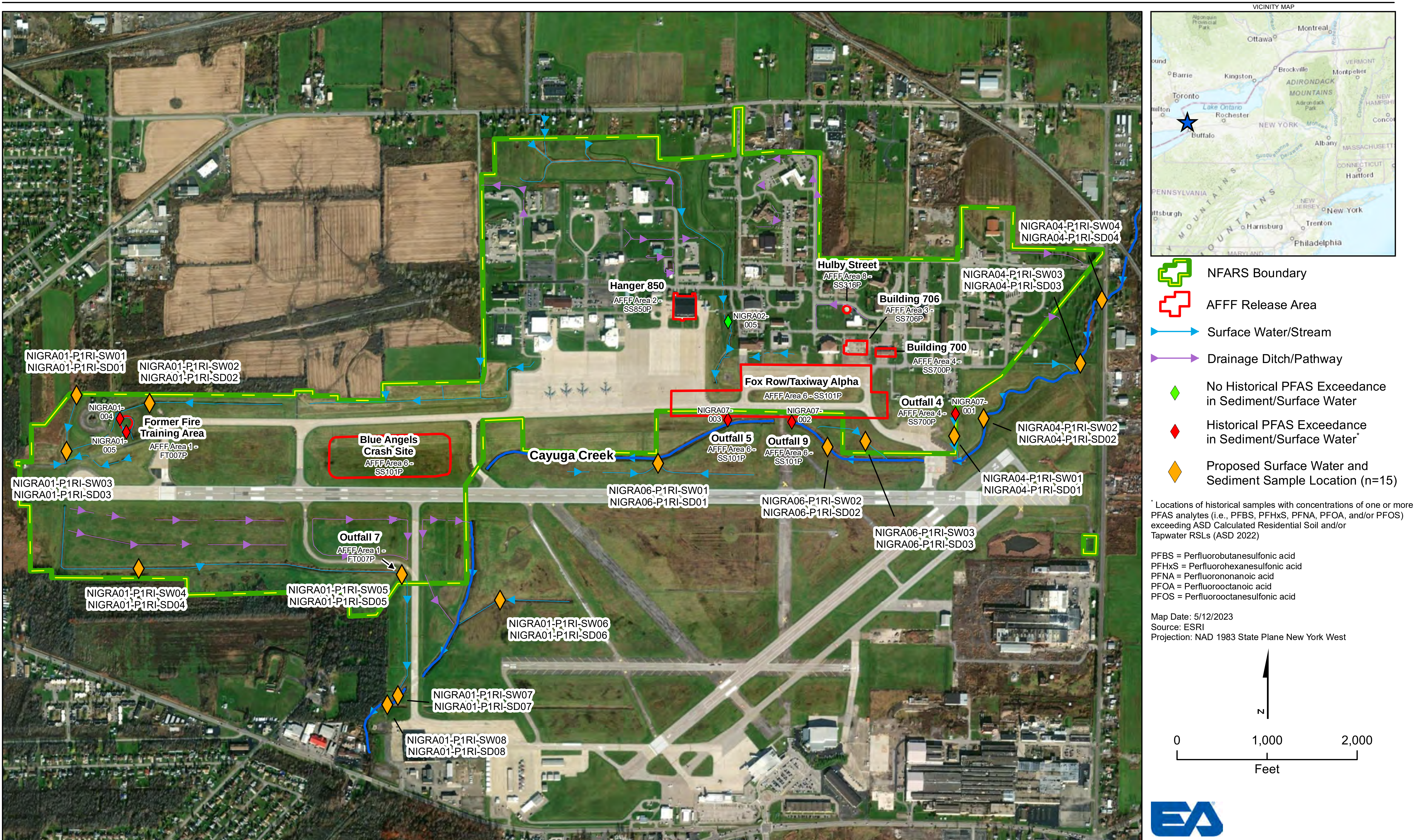
[*] Locations of historical samples with concentrations of one or more PFAS analytes (i.e., PFBS, PFHxS, PFNA, PFOA, and/or PFOS) exceeding ASD Calculated Residential Soil and/or Tapwater RSLs (ASD 2022)

PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid

Map Date: 8/17/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-4
Proposed Initial Phase Surface Soil Sampling Locations at AFFF Area 4
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 17-4 Proposed Sampling Locations 4.mxd



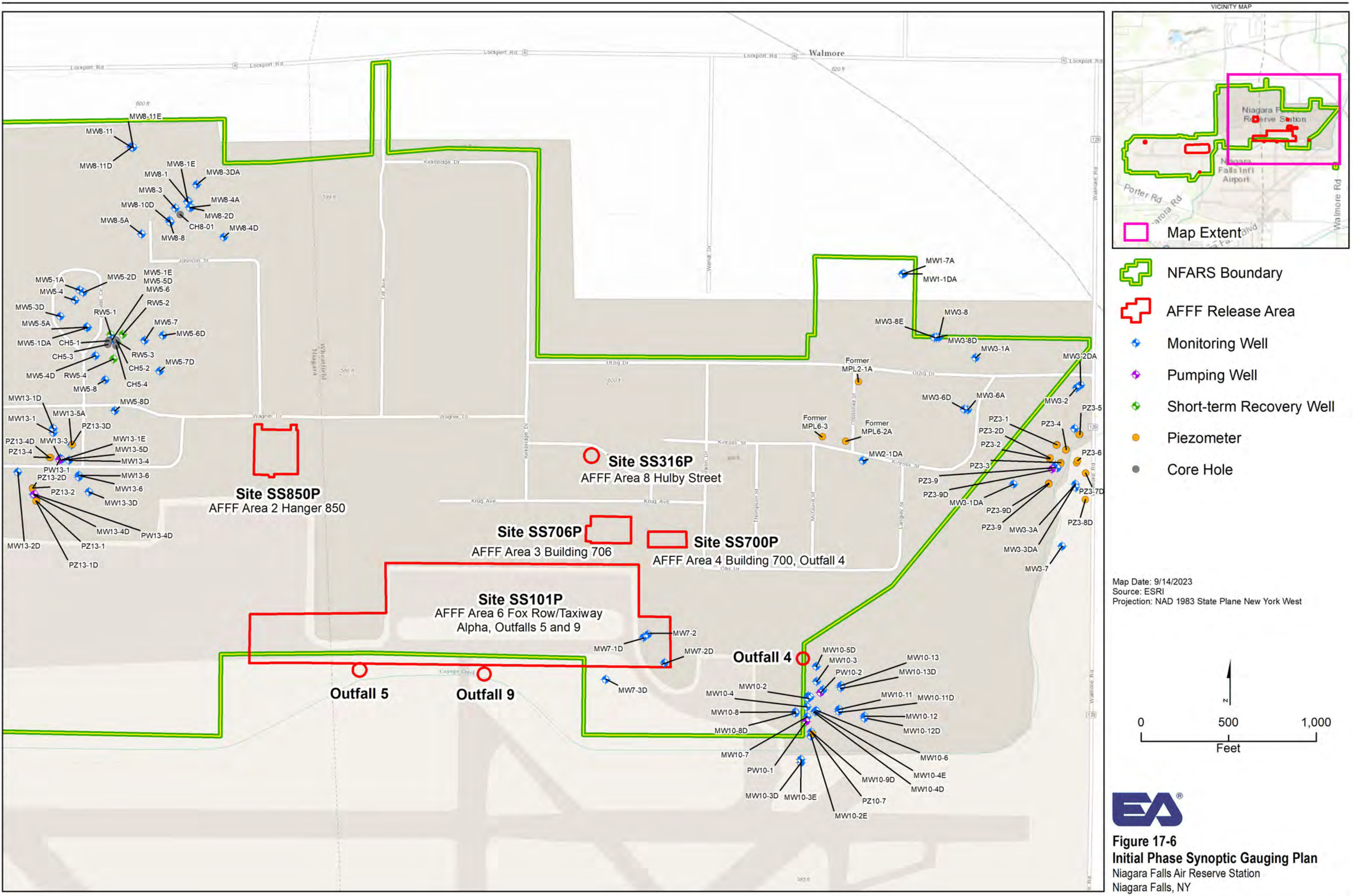
* Locations of historical samples with concentrations of one or more PFAS analytes (i.e., PFBS, PFHxS, PFNA, PFOA, and/or PFOS) exceeding ASD Calculated Residential Soil and/or Tapwater RSLs (ASD 2022)

PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid

Map Date: 5/12/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-5
Proposed Initial Phase Surface Water and Sediment Sampling Locations
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafs\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 17-5 Proposed SW SED Sampling Locations.mxd



Map Date: 9/14/2023
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 17-6
Initial Phase Synoptic Gauging Plan
Niagara Falls Air Reserve Station
Niagara Falls, NY

\\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\MXD\Figure 17-6 Second Phase Synoptic Gauging Plan.mxd

UFP-QAPP Worksheet #18: Sampling Locations and Methods

This Worksheet presents the proposed sampling locations, estimated depth, and associated analytes for the initial phase of RI fieldwork, and synoptic gauging to be conducted during the second phase of RI fieldwork as follows:

- Source area surface soil sampling at FT007P: AFFF Area 1 Former Fire Training Area (Site 9) Outfall 7; SS707P: AFFF Area 4 Building 700, Outfall 4; SS015P: AFFF Area 5 Blue Angels Crash Site; and SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9

- Initial surface water/sediment sampling.

- Existing well network (initial synoptic water level measurement event)

Existing monitoring wells, surface soil grid locations and proposed surface water/sediment sampling locations are shown on **Figures 17-1 through 17-5**. **Table 18-1** summarizes the proposed sample identifications, matrix, and methods for the proposed initial phase sample locations described in Worksheet #17. **Table 18-2** presents existing wells and synoptic gauging locations. **Table 18-1** will be updated prior to the second and third phases of RI fieldwork to include the sampling proposed for those phases once locations are finalized by the project team. **Table 18-2** will be updated following installation of monitoring wells to include newly installed well locations that will be incorporated into the synoptic gauging to be conducted during the third phase of RI fieldwork.

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Table 18-1 Summary of Proposed Sample Identifications and Methods

Sample Identifier	Matrix	Depth (ft bgs)	Sampling Method / SOP	Analyte/ Analytical Group
FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7				
NIGRA01-P1RI-SS01-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS02-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS03-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS04-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS05-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS06-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS07-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS08-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS09-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS10-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS11-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS12-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS13-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS14-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS15-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS16-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS17-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS18-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS19-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SS20-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW01-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD01-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW02-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD02-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633

Sample Identifier	Matrix	Depth (ft bgs)	Sampling Method / SOP	Analyte/ Analytical Group
NIGRA01-P1RI-SW03-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD03-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW04-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD04-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW05-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD05-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW06-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD06-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW07-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD07-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SW08-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA01-P1RI-SD08-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
SS707P: AFFF Area 4 Building 700, Outfall 4				
NIGRA04-P1RI-SS01-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS02-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS03-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS04-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS05-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS06-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS07-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS08-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS09-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS10-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS11-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS12-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SS13-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633

Sample Identifier	Matrix	Depth (ft bgs)	Sampling Method / SOP	Analyte/ Analytical Group
NIGRA04-P1RI-SW01-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SD01-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SW02-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SD02-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SW03-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SD03-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SW04-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA04-P1RI-SD04-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
SS015P: AFFF Area 5 Blue Angels Crash Site				
NIGRA05-P1RI-SS01-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS02-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS03-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS04-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS05-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS06-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS07-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA05-P1RI-SS08-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9				
NIGRA06-P1RI-SS01-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS02-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS03-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS04-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS05-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS06-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS07-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS08-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633

Sample Identifier	Matrix	Depth (ft bgs)	Sampling Method / SOP	Analyte/ Analytical Group
NIGRA06-P1RI-SS09-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS10-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS11-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS12-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS13-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS14-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SS15-MMDDYY	Surface soil	0-0.5	Grab; EA-SOP-025, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SW01-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SD01-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SW02-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SD02-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SW03-MMDDYY	Surface water	Surface	Grab; EA-SOP-007, EA-SOP-073	PFAS by EPA Method 1633
NIGRA06-P1RI-SD03-MMDDYY	Sediment	0-0.5	Grab; EA-SOP-021, EA-SOP-073	PFAS by EPA Method 1633

Table 18-2 Synoptic Gauging Locations

Longitude	Latitude	Well ID	Well Type
-78.932316	43.111291	MW10-11	Overburden Well/Piezometer
-78.931771	43.111187	MW10-12	Overburden Well/Piezometer
-78.932276	43.111667	MW10-13	Overburden Well/Piezometer
-78.932968	43.111464	MW10-2	Overburden Well/Piezometer
-78.932792	43.111727	MW10-3	Overburden Well/Piezometer
-78.933000	43.111330	MW10-4	Overburden Well/Piezometer
-78.932799	43.111260	MW10-6	Overburden Well/Piezometer
-78.932991	43.111175	MW10-7	Overburden Well/Piezometer
-78.933245	43.111247	MW10-8	Overburden Well/Piezometer
-78.949130	43.115570	MW13-1	Overburden Well/Piezometer
-78.948974	43.115156	MW13-3	Overburden Well/Piezometer
-78.948793	43.115138	MW13-4	Overburden Well/Piezometer
-78.948584	43.114904	MW13-6	Overburden Well/Piezometer
-78.930996	43.118109	MW1-7A	Overburden Well/Piezometer
-78.929427	43.116805	MW3-1A	Overburden Well/Piezometer
-78.927265	43.116337	MW3-2	Overburden Well/Piezometer
-78.929590	43.115990	MW3-6A	Overburden Well/Piezometer
-78.927562	43.113858	MW3-7	Overburden Well/Piezometer
-78.930213	43.117118	MW3-8	Overburden Well/Piezometer
-78.948584	43.117804	MW5-1A	Overburden Well/Piezometer
-78.948681	43.117643	MW5-4	Overburden Well/Piezometer
-78.948430	43.117225	MW5-5A	Overburden Well/Piezometer

Longitude	Latitude	Well ID	Well Type
-78.947892	43.117032	MW5-6	Overburden Well/Piezometer
-78.947187	43.117020	MW5-7	Overburden Well/Piezometer
-78.948027	43.116400	MW5-8	Overburden Well/Piezometer
-78.946205	43.119104	MW8-1	Overburden Well/Piezometer
-78.947502	43.120048	MW8-11	Overburden Well/Piezometer
-78.946543	43.119090	MW8-3	Overburden Well/Piezometer
-78.946283	43.119196	MW8-4A	Overburden Well/Piezometer
-78.947261	43.118684	MW8-5A	Overburden Well/Piezometer
-78.946669	43.118896	MW8-8	Overburden Well/Piezometer
-78.933013	43.111100	PW10-1	Overburden Well/Piezometer
-78.932871	43.110902	PZ10-7	Overburden Well/Piezometer
-78.949480	43.114498	PZ13-1	Overburden Well/Piezometer
-78.949569	43.114705	PZ13-2	Overburden Well/Piezometer
-78.949184	43.115180	PZ13-4	Overburden Well/Piezometer
-78.927678	43.115449	PZ3-1	Overburden Well/Piezometer
-78.927834	43.115228	PZ3-2	Overburden Well/Piezometer
-78.927600	43.115168	PZ3-3	Overburden Well/Piezometer
-78.927478	43.115373	PZ3-4	Overburden Well/Piezometer
-78.927193	43.115609	PZ3-5	Overburden Well/Piezometer
-78.927239	43.115203	PZ3-6	Overburden Well/Piezometer
-78.927850	43.114835	PZ3-9	Overburden Well/Piezometer
-78.947914	43.117107	RW5-1	Overburden Well/Piezometer
-78.947656	43.117111	RW5-2	Overburden Well/Piezometer

Longitude	Latitude	Well ID	Well Type
-78.947780	43.116989	RW5-3	Overburden Well/Piezometer
-78.947853	43.116727	RW5-4	Overburden Well/Piezometer
-78.931929	43.116422	MPL2-1A	Overburden Well/Piezometer
-78.932198	43.115489	MPL6-2A	Overburden Well/Piezometer
-78.932695	43.115558	MPL6-3	Overburden Well/Piezometer
-78.947953	43.117014	CH5-1	Shallow Bedrock Well/Piezometer
-78.947796	43.117023	CH5-2	Shallow Bedrock Well/Piezometer
-78.947978	43.116954	CH5-3	Shallow Bedrock Well/Piezometer
-78.947801	43.116933	CH5-4	Shallow Bedrock Well/Piezometer
-78.946443	43.118993	CH8-01	Shallow Bedrock Well/Piezometer
-78.932657	43.111595	MW10-10D	Shallow Bedrock Well/Piezometer
-78.932316	43.111259	MW10-11D	Shallow Bedrock Well/Piezometer
-78.931767	43.111156	MW10-12D	Shallow Bedrock Well/Piezometer
-78.932275	43.111633	MW10-13D	Shallow Bedrock Well/Piezometer
-78.932994	43.111463	MW10-1DA	Shallow Bedrock Well/Piezometer
-78.933120	43.110455	MW10-3D	Shallow Bedrock Well/Piezometer
-78.932806	43.111271	MW10-4D	Shallow Bedrock Well/Piezometer
-78.932805	43.111961	MW10-5D	Shallow Bedrock Well/Piezometer
-78.933248	43.111230	MW10-8D	Shallow Bedrock Well/Piezometer
-78.932914	43.110871	MW10-9D	Shallow Bedrock Well/Piezometer
-78.930965	43.118113	MW1-1DA	Shallow Bedrock Well/Piezometer
-78.949131	43.115635	MW13-1D	Shallow Bedrock Well/Piezometer

Longitude	Latitude	Well ID	Well Type
-78.949886	43.114949	MW13-2D	Shallow Bedrock Well/Piezometer
-78.948364	43.114645	MW13-3D	Shallow Bedrock Well/Piezometer
-78.949546	43.114598	MW13-4D	Shallow Bedrock Well/Piezometer
-78.948739	43.115378	MW13-5A	Shallow Bedrock Well/Piezometer
-78.948954	43.115149	MW13-5D	Shallow Bedrock Well/Piezometer
-78.948583	43.114877	MW13-6D	Shallow Bedrock Well/Piezometer
-78.931821	43.115188	MW2-1DA	Shallow Bedrock Well/Piezometer
-78.928607	43.114826	MW3-1DA	Shallow Bedrock Well/Piezometer
-78.927181	43.116383	MW3-2DA	Shallow Bedrock Well/Piezometer
-78.927282	43.114832	MW3-3A	Shallow Bedrock Well/Piezometer
-78.927275	43.114781	MW3-3DA	Shallow Bedrock Well/Piezometer
-78.927674	43.115082	MW3-4DA	Shallow Bedrock Well/Piezometer
-78.927307	43.115702	MW3-5D	Shallow Bedrock Well/Piezometer
-78.929664	43.115998	MW3-6D	Shallow Bedrock Well/Piezometer
-78.930265	43.117119	MW3-8D	Shallow Bedrock Well/Piezometer
-78.948412	43.117217	MW5-1DA	Shallow Bedrock Well/Piezometer
-78.948500	43.117769	MW5-2D	Shallow Bedrock Well/Piezometer
-78.948992	43.117393	MW5-3D	Shallow Bedrock Well/Piezometer
-78.948239	43.116776	MW5-4D	Shallow Bedrock Well/Piezometer
-78.947859	43.117010	MW5-5D	Shallow Bedrock Well/Piezometer
-78.946797	43.117101	MW5-6D	Shallow Bedrock Well/Piezometer

Longitude	Latitude	Well ID	Well Type
-78.946862	43.116541	MW5-7D	Shallow Bedrock Well/Piezometer
-78.947820	43.115916	MW5-8D	Shallow Bedrock Well/Piezometer
-78.946652	43.118872	MW8-10D	Shallow Bedrock Well/Piezometer
-78.947477	43.120043	MW8-11D	Shallow Bedrock Well/Piezometer
-78.946258	43.119201	MW8-2D	Shallow Bedrock Well/Piezometer
-78.946092	43.119461	MW8-3DA	Shallow Bedrock Well/Piezometer
-78.945504	43.118643	MW8-4D	Shallow Bedrock Well/Piezometer
-78.932709	43.111552	PW10-2	Shallow Bedrock Well/Piezometer
-78.948997	43.115146	PW13-1	Shallow Bedrock Well/Piezometer
-78.949532	43.114605	PW13-4D	Shallow Bedrock Well/Piezometer
-78.927783	43.115064	PW3-3A	Shallow Bedrock Well/Piezometer
-78.949499	43.114499	PZ13-1D	Shallow Bedrock Well/Piezometer
-78.949571	43.114690	PZ13-2D	Shallow Bedrock Well/Piezometer
-78.948724	43.115386	PZ13-3D	Shallow Bedrock Well/Piezometer
-78.949289	43.115188	PZ13-4D	Shallow Bedrock Well/Piezometer
-78.927688	43.115438	PZ3-1D	Shallow Bedrock Well/Piezometer
-78.927826	43.115241	PZ3-2D	Shallow Bedrock Well/Piezometer
-78.927604	43.115150	PZ3-3D	Shallow Bedrock Well/Piezometer
-78.927491	43.115364	PZ3-4D	Shallow Bedrock Well/Piezometer
-78.927210	43.115606	PZ3-5D	Shallow Bedrock Well/Piezometer
-78.927257	43.115167	PZ3-6D	Shallow Bedrock Well/Piezometer

Longitude	Latitude	Well ID	Well Type
-78.927064	43.115005	PZ3-7D	Shallow Bedrock Well/Piezometer
-78.927065	43.114591	PZ3-8D	Shallow Bedrock Well/Piezometer
-78.927854	43.114843	PZ3-9D	Shallow Bedrock Well/Piezometer
-78.932975	43.111496	MW10-1EA	Deep Bedrock Well
-78.932931	43.111485	MW10-1F	Deep Bedrock Well
-78.932904	43.110937	MW10-2E	Deep Bedrock Well
-78.933121	43.110505	MW10-3E	Deep Bedrock Well
-78.932824	43.111254	MW10-4E	Deep Bedrock Well
-78.948978	43.115168	MW13-1E	Deep Bedrock Well
-78.927709	43.115119	MW3-1E	Deep Bedrock Well
-78.930310	43.117118	MW3-8E	Deep Bedrock Well
-78.947862	43.117037	MW5-1E	Deep Bedrock Well
-78.947452	43.120039	MW8-11E	Deep Bedrock Well
-78.946236	43.119105	MW8-1E	Deep Bedrock Well

UFP-QAPP Worksheets #19 & #30: Sample Containers, Preservation, and Hold Times

Analytical Laboratory:

Pace Analytical – Gulf Coast Laboratory, Baton Rouge, Louisiana (PFAS)
7979 Innovation Park Drive
Baton Rouge, Louisiana 70820
Accreditation: DoD ELAP QSM Version 5.4
Accreditation: National Environmental Laboratory Accreditation Program (NELAP)
Sample Delivery Method: Overnight Shipping

Analytical Group	Matrix	Analytical and Preparation Method	Accreditation Expiration Date	Container(s) (number, size, and type)	Preservation	Max. Holding Time (Preparation/ Analysis)
PFAS	Soil/Solids	Draft EPA Method 1633	31 August 2024	Polypropylene (PP) with PP linerless cap 1 x 90 milliliter (mL)	Cool, 0-6°C[1];protected from light	28 days / 28 days
PFAS	Aqueous	Draft EPA Method 1633	31 August 2024	HDPE with PP linerless cap 2 x 500 mL 1 x 125 mL	Cool, 0-6ºC[1]; protected from light	28 days / 28 days

Notes:

1) Maintain all samples for PFAS analysis protected from light at 0 - 6 ºC from the time of collection until shipped to the laboratory. Samples must be shipped as soon as practical with sufficient ice to maintain the sample temperature below 6 ºC during transport and be received by the laboratory within 48 hours of collection. The laboratory must confirm that the sample temperature is 0 - 6 ºC upon receipt.

Analytical Laboratory:

Pace Analytical – Sheridan Laboratory, Sheridan, Wyoming (pH, grain size, TOC, porosity, permeability, Cation Exchange Capacity [CEC], Anion Exchange Capacity [AEC])
1673 Terra Avenue
Sheridan, WY 82801
Accreditation: DoD Environmental Laboratory Accreditation Program (ELAP) QSM Version 5.4
Accreditation: National Environmental Laboratory Accreditation Program (NELAP)

Sample Delivery Method: Overnight Shipping

Analytical Group	Matrix	Analytical and Preparation Method	Accreditation Expiration Date	Container(s) (number, size, and type)	Preservation	Max. Holding Time (Preparation/ Analysis)
pH	Solids	EPA SW-846 Method 9045D	ELAP-8/31/2024 NELAP-6/30/2023	Polyethylene or Glass 1 x 2-oz jar	None	NA / As soon as possible[1]
Grainsize Sieve	Solids	ASTM D422	None	1 gallon Ziploc baggie	None	None
Grain Size/Hydrometer	Solids	ASTM D422	None	1 gallon Ziploc baggie		None
TOC	Solids	EPA SW-846 Method 9060A	ELAP: 8/31/2024 NELAP: 6/30/2023	Polyethylene or Glass 1 x 2-ounce (oz) jar	Cool, 0-6ºC	NA / 28 days from collection to analysis
Permeability	Solids	ASTM D5084-16	None	Shelby tube	None	6 months
Cation Exchange Capacity	Solids	EPA SW-846 Method 9081	None	1 gallon Ziploc baggie	None	NA / 6 months
Anion Exchange Capacity	Solids	New Zealand P Retention	None	1 gallon Ziploc baggie	None	NA / 6 months

Notes:

1) pH determination is intended to be an in situ parameter. Pace Gulf Coast's facilities are located in Baton Rouge, Louisiana. Pace Gulf Coast commits to analyzing any pH samples received at its facility in an "as soon as possible" manner. Resulting data is qualified to reflect the variance to the method's assumptions.

UFP-QAPP Worksheet #20: Field QC Summary

This table presents sample quantities for the initial phase surface soil, surface water, and sediment sampling. This worksheet will be updated prior to the second and third phases of RI fieldwork to include the sampling proposed for those phases once locations are finalized by the project team.

Matrix	Analyte/Analytical Group	Concentration Level	Field Samples	Field Duplicates	MS/MSD	Field Blank	Equipment Blank	Total # Samples to Lab[1]
Surface Water	PFAS	Low/Medium/High	20	10%	5%	1 per day	1 per day[2]	TBD
Sediment	PFAS	Low/Medium/High	20	10%	5%	1 per day	1 per day[2]	TBD
Soil	PFAS	Low/Medium/High	65	10%	5%	1 per day	1 per day[2]	TBD

Notes:

1. Number of samples collected will vary based the number of days to conduct field activities. Frequencies listed for QC samples will be collected during field activities.
2. Equipment blanks will be collected with samples involving reusable equipment. No equipment blanks will be collected with samples that are collected with dedicated/disposable equipment.

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UFP-QAPP Worksheet #21: Field SOP References Table

SOP Reference Number	Responsible Organization	Title	Equipment Type or Instrument	Comments
EA-SOP-001	EA	SOP No. 001 for Sample Labels, November 2018	Labels	Delineates protocols for the use of sample labels
EA-SOP-002	EA	SOP No. 002 for Chain-of-Custody Form, November 2018	Laboratory supplied chain-of-custody	Delineates protocols for use of chain-of-custody forms
EA-SOP-003	EA	SOP No. 003 for Subsurface Utility Clearance, July 2018	Historical site plans, dig permit documentation	Delineates protocols for subsurface utility clearance
EA-SOP-004	EA	SOP No. 004 for Sample Packing and Shipping, September 2018	Coolers and shipping materials (bags, tape)	Delineates protocols for packing and shipping of environmental samples for laboratory for analysis Note: vermiculite will not be used in packing coolers
EA-SOP-005	EA	SOP No. 005 for Field Decontamination, September 2018	Various, including but not limited to PFAS-free water, Buckets, brush, decontamination reagents	Describes procedures for decontamination of sampling equipment and site personnel
EA-SOP-007	EA	SOP No. 007 for Surface Water Sampling, March 2020	Sample containers, peristaltic pump, tubing, water quality meter	Delineates protocols for surface water sampling
EA-SOP-008	EA	SOP No. 008 for Trimble Geo 7X Global Positioning System Units, March 2021	GPS unit	Describes protocols for using a GPS unit
EA-SOP-010	EA	SOP No. 010 for Water Level and Well Depth Measurements, September 2021	Water Level Meter / interface probe	Delineates protocols for the collection of water levels and well depth measurements
EA-SOP-011	EA	SOP No. 011 for Photoionization Detection, May 2020	PID, calibration materials	Defines field procedures for using a PID
EA-SOP-016	EA	SOP No. 016 for Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists, July 2019	Logbooks, field checklists and appropriate field forms	Delineates protocols for filling out field logbooks
EA-SOP-019	EA	SOP No. 019 for Monitoring Well Installation, October 2019	Drill rig, well materials	Delineates protocol for installing monitoring wells
EA-SOP-021	EA	SOP No. 021 for Sediment Sampling, March 2019	Stainless steel scoops, spoons	Delineates protocols for sediment sampling
EA-SOP-025	EA	SOP No. 025 for Soil Sampling, December 2014	Hand auger, DPT drill rig, stainless steel, scoops, spoons	Delineates protocols for soil sampling
EA-SOP-028	EA	SOP No. 028 for Well and Boring Abandonment, January 2021	Bentonite, topsoil	Defines protocols for well and boring abandonment

SOP Reference Number	Responsible Organization	Title	Equipment Type or Instrument	Comments
EA-SOP-039	EA	SOP. No 039 for Sample Preservation and Container Requirements, September 2018	Sample containers, ice, sample coolers	Defines the preservatives and techniques for preserving environmental samples
EA-SOP-042	EA	SOP No. 042 for Disposal of Investigation-Derived Material, January 2014	DOT drums, labels, markers	Defines the required steps for disposing of IDW generated during field activities
EA-SOP-043	EA	SOP No. 043 for Multi-Probe Water Quality Monitoring Instruments, June 2020	Multi-probe instrument, calibration materials, accessories (batteries, charger, case), operations Manual	Defines the calibration and operation of a meter used during low flow sampling techniques
EA-SOP-047	EA	SOP No. 047 for Direct-Push Technology Sampling, December 2014	DPT drill rig	Defines field procedures for sampling using direct push technology
EA-SOP-048	EA	SOP No. 048 for Low Flow Sampling, December 2014	Peristaltic pump, water quality meter and flow through cell, water level meter	Defines field procedures for purging and sampling using low flow sampling techniques
EA-SOP-064	EA	SOP No. 064 for Sediment Boring Logs, March 2020	Field forms	Defines protocols for collecting sediment samples via drilling, core or grab Provides guidance on standard log completion and sediment classification
EA-SOP-073	EA	SOP No. 073 for Sampling for Per- and Polyfluorinated Alkyl Substances, June 2019	PFAS-free water, supplies, and equipment	Delineates protocols for collecting environmental samples for analysis of PFAS

Note:
SOPs for lysimeter installation and sampling will be included in an addendum to this UFP-QAPP, if applicable.

UFP-QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

This worksheet documents procedures for performing testing, inspections, and QC for all field equipment. References to the applicable activity and SOPs are included. Where appropriate, the failure response will prescribe a Corrective Action. All information summarized in this worksheet will be recorded in the field notes and field logs/forms.

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
PFAS-free Source Water	Not applicable	Not applicable	PFAS analysis of source water for drilling and decontamination	Not applicable	Once (prior to field activities)	PFAS concentration < 1/10th the screening level or not detected at the LOD	Source alternate water for drilling and decontamination activities; Complete verification of alternate source water.	Field personnel	EA-SOP-005
Multi-probe Water Quality Meter	Calibrate with pH, conductivity, ORP, DO, turbidity standards	Decontaminate and protect in hard case. Keep instrument clean, see manufacturer's specifications, and keep battery charged for operation.	Field test in accordance with the manual	Inspect for external damage (connections, liquid crystal display screen, etc.)	Daily, before use, and when unstable readings occur	Within calibration standard(s) range	Recalibration or replacement of equipment	Field personnel	EA-SOP-043
GPS equipment	Calibrate in accordance with the manual	Protect in hard case. Keep instrument clean, see manufacturer's specifications, and keep battery charged for operation.	Field test in accordance with the manual	Inspect for external damage	Daily check shots 'pre' and 'post' use	Field checks: horizontal: 1.0 meter; vertical 2.0 meters between known and measured points For post-processed data: horizontal quality – 0.15 meter; vertical quality – 0.15 meter	If daily QC checks do not meet acceptance criteria, return equipment to vendor for repair or work with the vender to rectify the issue.	Field personnel	Equipment manual, EA-SOP-008
Water Level Meter	Not applicable. Operate in accordance with the manufacturer's instructions	Decontaminate between wells	Field test in accordance with the manual	Inspect tape for kinks and cuts, inspect probe for dirt, check batteries	Daily	Response	Replace battery if no response during test button check.	Field personnel	EA-SOP-010
PID	Calibrate with calibration gas of known concentration	Clean and inspect instrument before use. Clean UV lamp lens with lens cleaning cloth/solution as needed to maintain operation.	Field checks per manual	Inspect for external damage/electrical cord integrity	Daily	Instrument calibrates to within 5% of calibration gas concentration.	Clean lamp lens and recalibrate. Operator correction or return to rental agency/manufacturer	Field personnel	Equipment manual, EA-SOP-011,
Peristaltic Pump	None	Charge battery	Field checks per manual	Inspect for external damage	Daily	Pumping at required flow pressure and rate for sample recovery	Operator correction or return to manufacturer	Field personnel	Equipment manual
Submersible pump	None	Decontaminate	Field checks per manual	Inspect for external damage	Daily	Pumping at required flow pressure and rate for sample recovery	Operator correction or return to manufacturer	Field personnel	Equipment manual

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UFP-QAPP Worksheet #23: Analytical Standard Operating Procedures

The analytical SOPs summarized below are provided in **Appendix G**. Methods represent those currently certified by the laboratory and may undergo revision during periodic UFP-QAPP review. UFP-QAPP revisions will be submitted for approval.

Lab SOP No.	Title, Revision Date and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument/ Equipment	Modified for Project Work? (Y/N)
Pace Analytical					
ENV-SOP-BTRO-0149	Draft Method 1633, 06/07/2022, Revision 2	Definitive	Aqueous and Solid/PFAS	Agilent 6495 Triple Quad LC/MS/MS	N
ENV-SOP-BTRO-0044	TOC in Solids and Wastes by Combustion Analyzer, 09/30/21, Revision 02	Definitive	Solid/TOC	Shimadzu TOC-V CSH or TOC-V CPH analyzer	N
ENV-SOP-BTRO-0037	pH and ORP in Waters, Solids, and Wastes, 09/30/21, Revision 02	Definitive	Solid/pH	Orion 720A pH Meter, Combination Electrode	Y[1]
ENV-SOP-SHRT-0158	Grain Size Analysis, 11/11/2020, Revision 00	Definitive	Solid/Grain Size Analysis	Balance	N
ENV-SOP-SHRT-0046	Cation Exchange Capacity EPA 9081, 11/10/2020, Revision 01	Definitive	Solid/CEC	ICP-OES	N
ENV-SOP-SHRT-0157	Anion Exchange Capacity - New Zealand P Retention 11/11/2020, Revision 01	Definitive	Solid/AEC	ICP-OES	N
ENV-SOP-BTRO-0140	TCLP SPLP by EPA 1311 & 1312	Definitive	Solid/Liquid/ Multiphasic Wastes	pH meter	N

1) pH determination is intended to be an in-situ analysis. Pace Gulf Coast performs test remote to field operations.

Notes:
ICP = Inductively coupled plasma

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UFP-QAPP Worksheet #24: Analytical Instrument Calibration

The calibration procedures, criteria, and corrective actions specified for PFAS analysis by LC/MS/MS in this worksheet are in compliance with Table B-24 of the DoD QSM. The analytical SOPs referenced below are provided in **Appendix G**. Methods represent those currently certified by the laboratory and may undergo revision during periodic UFP-QAPP review. UFP-QAPP revisions will be submitted for approval. Note: Calibration of instruments for IDW characterization is not included in this worksheet.

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
Pace Analytical – Gulf Coast Laboratory, Baton Rouge, Louisiana						
LC/MS/MS	Mass Calibration, Mass Calibration Verification	Instrument must have a valid mass calibration prior to any sample analysis and updated on an as-needed basis (e.g., QC failures, ion masses fall outside of the ± 0.5 amu of the true value, major maintenance or the instrument is moved). Mass calibration is verified after each mass calibration, prior to initial calibration (ICAL).	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass Calibration Verification must meet manufacturer's acceptance criteria.	If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. Flagging is not appropriate. Problem must be corrected.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149
LC/MS/MS	Ion Transitions (Precursor → Product)	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) If a qualitative or quantitative standard containing an isomeric mixture (branched and linear isomers)	NA Flagging is not appropriate.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
			of an analyte is commercially available for an analyte, the quantification ion used must be the quantification ion identified in Table 2 of EPA Draft Method 1633 unless interferences render the product ion unusable as the quantification ion. 2) In cases where interferences render the product ion unusable as the quantification ion, project approval is required before using the alternative product ion.			
LC/MS/MS	Initial Calibration (ICAL)	At instrument set-up, after major maintenance, and after initial calibration verification (ICV) or continuing calibration verification (CCV) failure, prior to sample analysis.	One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or 1/x2) is allowed for linear and non-linear regressions. Option 1: Calculate the relative standard deviation (RSD) of the RR or RF values of the six initial calibration standards for each native compound and isotopically labeled compound. The RSD must be ≤ 20% to establish instrument linearity. Option 2: Calculate the relative standard error (RSE) of the six	Correct problem, then repeat ICAL. Flagging is not appropriate. No samples shall be analytes until the ICAL has passed.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
			initial calibration standards for each native compound and isotopically labeled compound. The RSE for all method analytes must be ≤ 20% to establish instrument linearity. Commercial PFAS standards available as salts are acceptable providing the measured mass is corrected to the neutral acid concentration. Results shall be reported as the neutral acid with appropriate CAS number.			
LC-MS/MS	Instrument blank	Immediately following the highest standard analyzed, daily prior to sample analysis, and after each bracketing CCV.	Concentration of each analyte must be ≤½ the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
				this acceptance criteria (>1/2 LOQ), they must be reanalyzed.		
LC/MS/MS	Initial calibration verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ± 30% of their true value.	Correct problem and verify second source standard; rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149
LC/MS/MS	Instrument Sensitivity Check (ISC)	Daily. At the beginning of each analytical sequence, prior to sample analysis.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values.	Correct problem, rerun ISC. If problem persists, repeat ICAL.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149
LC/MS/MS	Continuing Calibration Verification (CCV)	Daily prior to sample analysis (ISC); after every 10 field samples; at end of analytical sequence.	All analytes must be within ± 30% of their true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
				samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all samples since the last acceptable CCV.		
LC-MS/MS	LOD/LOQ verification	Quarterly	LOD meets method qualitative requirements; LOQ is recovered within LCS criteria.	Perform instrument maintenance and repeat failed LOD or LOQ study passing two consecutive tests or perform new DL study.	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149
LC-MS/MS	Bile Salt Standards	Daily prior to analysis of all matrices (aqueous, solid, tissue, and AFFF)	The retention time of the bile salt(s) peak must fall out of the retention time window of PFOS by at least one minute.	NA	Analyst, supervisor, QA manager	ENV-BTRO-SOP-0149
TOC	Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	$R^2 \geq 0.99$	Correct problem, then repeat ICAL.	Analyst, Supervisor, QA Manager	BTRO-0044
TOC	Independent Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ±10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Analyst, Supervisor, QA Manager	BTRO-0044
TOC	Continuing Calibration Verification (CCV)	Daily before sample analysis, after every 15 field samples, and at	All reported analytes within ± 10% of true value	Immediately analyze two additional consecutive	Analyst, Supervisor, QA Manager	BTRO-0044

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
		the end of the analysis sequence.		CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.		
TOC	Continuing Calibration Blank (CCB)	Analyzed after every 10 samples or more frequently and at the end of analytical batch	Concentration must be less than the LOQ	Correct problem; recalibrate instrument	Analyst, Supervisor, QA Manager	BTRO-0044
Orion 720 pH Meter	Calibrate meter	Daily before use.	92-108%	Recalibrate meter.	Analyst, Supervisor, QA Manager	BTRO-0037

Instrument/ Equipment	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	SOP Reference
Orion 720 pH Meter	QC Check Buffer	Immediately after calibration and with every 20 samples.	0.05 pH units of the true value.	Recalibrate meter.	Analyst, Supervisor, QA Manager	BTRO-0037
Grain Size	Sieve – Visual inspection	Every use	No clogging or tears in mesh	Remove from service	Analyst, Department Manager	ENV-SOP-SHRT-0158

Notes:

%RSD = Percent relative standard deviation.
amu = Atomic mass unit(s).
C = Carbon.
CCB = Continuing calibration blank.
CCV = Continuing calibration verification.
ICAL = Initial calibration.
ICB = Initial calibration blank.
ICV = Initial calibration verification.
MDL = Method detection limit.
mg = Milligram(s).
NA = Not applicable

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UFP-QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

The analytical SOPs referenced below are provided in **Appendix G**. Methods represent those currently certified by the laboratory and may undergo revision during periodic UFP-QAPP review. UFP-QAPP revisions will be submitted for approval.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference
Pace Analytical – Gulf Coast Laboratory, Baton Rouge, LA								
LC/MS/MS	Clean ESI chamber.	PFAS	NA	Weekly or as needed	NA	NA	Analyst	ENV-BTRO-SOP-0149
LC/MS/MS	Replace delay column.	PFAS	Peak shape and resolution; LC pressure profiles	Biannually or as needed	NA	NA	Analyst	ENV-BTRO-SOP-0149
LC/MS/MS	Replace analytical column.	PFAS	Peak shape and resolution; ICAL or senstivity problems	Biannually or as needed	NA	NA	Analyst	ENV-BTRO-SOP-0149
LC/MS/MS	Replace guard cartridge.	PFAS	Visible blockage and/or dirt on frit	Weekly or as needed	NA	NA	Analyst	ENV-BTRO-SOP-0149
TOC	Change injection needle, change catalyst	TOC	Monitor instrument performance via continuing calibration verification.	As needed or replace as necessary, loss of sensitivity or failing resolutions, erratic response.	No maintenance is required as long as instrument QC meets criteria.	Perform instrument maintenance, clean injection needle, change catalyst.	Analyst, Supervisor, QA Manager	BTRO-0044
Orion 720 pH Meter	Check electrode	pH	Flush and refill electrode; clean electrode with methanol.	As needed.	No instrument error message	Clean or replace as necessary	Analyst, Supervisor, QA Manager	BTRO-0037
Sieves	Cleaning	Grain Size	Visual inspection for clogs or tears	Each use	N/A	Remove from service	Analyst, Department Manager	ENV-SOP-SHRT-0158

Notes:
HPLC = High-performance liquid chromatography

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UFP-QAPP Worksheet #26 & #27: Sample Handling, Custody, and Disposal

To ensure sample authenticity and data defensibility, a proper sample handing system will be followed from the time of sample collection to final sample disposal.

Sampling Organization: EA Engineering, Science, and Technology, Inc., PBC

Laboratory: Pace Analytical – Gulf Coast, Baton Rouge, LA
Pace Analytical – Sheridan, WY

Method of sample delivery (shipper/carrier): Overnight shipping (Federal Express or USPS)

Number of days from reporting until sample disposal: Minimum 30 days after final report sent to client (EA); unless there is a written request to hold them longer.

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample labeling	EA, Field Personnel	EA SOP001
Chain-of-custody form completion	EA, Field Personnel	EA SOP002
Sample packing and shipping	EA, Field Personnel	EA SOP004
Shipping coordination	EA, Field Personnel	EA SOP004
Sample receipt, inspection, and login	Laboratory Staff/PM	Laboratory SOPs
Sample custody and storage	Laboratory PM	Laboratory SOPs
Sample disposal	Laboratory Waste Manager	Laboratory SOPs

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory)

Sample Collection: Analytical samples will be collected using clean nitrile gloves and placed in laboratory supplied bottle ware containing appropriate preservatives, as defined in Worksheet #19 and #30.

QA/QC samples (duplicates, MS/MSD sample sets, trip blanks, and equipment blanks) will be collected as detailed in Worksheet #20.

Sample Identification

Weatherproof sample labels with sample identification numbers will be affixed to each sample container. The sample identification number will uniquely identify the sample in relation to a specified sampling location. A sample identification system has been developed to provide uniform classification and to assist project personnel to interpret data reports and field notes. The sample identification system for initial phase field investigation samples is presented in Worksheet #18. Sample identification systems for the second and third phase field investigation samples will be detailed in an addendum to this UFP-QAPP.

The identification protocol for samples collected during the initial phase of RI fieldwork is as follows:

- Each sample location will begin with the five-digit ERPIMS facility identification code (NIGRA) and AFFF area number

    - NIGRA01 for FT007P: AFFF Area 1 Former Fire Training Area (Site 9), Outfall 7
    - NIGRA04 for SS707P: AFFF Area : Building 700, Outfall 4
    - NIGRA05 for SS015P: AFFF Area 5 Blue Angels Crash Site
    - NIGRA06 for SS101P: AFFF Area 6 Fox Row/Taxiway Alpha, Outfalls 5 and 9

- At each location, an event code P1RI for Phase I RI will be added to the sample identification

- At each location, a media identifier will be added to the sample identification

    - SS = surface soil sample (less than 6 inches bgs)

    - SD = sediment sample

    - SW = surface water sample

- At each location, a numerical identifier (01, 02, 03, etc.) will be added to the sample identification. If additional samples for a specific media are collected at an AFFF site, the numerical identifier will continue in sequential order from the last used identifier.

- Following the media and numerical identifier, the date (MMDDYY) and depth (if applicable) will be added.

Example sample identifiers are as follows:

- For the first surface water and sediment samples collected at AFFF Area 1 on 5 May 2023, the sample identifiers would be NIGRA01-P1RI-SW01-050523 and NIGRA01-P1RI-SD01-050523

- For the fifth surface water and sediment samples collected at AFFF Area 1 on 5 May 2023, the sample identifiers would be NIGRA01- P1RI-SW05-050523 and NIGRA01-P1RI-SD05-050523

- For the first and fifth surface soil samples collected at AFFF Area 1 on 5 May 2023, the sample identifiers would be NIGRA01-P1RI-SS01-050523 and NIGRA01-P1RI-SS05-050523.

QA/QC samples (duplicates, field blanks, and equipment blanks) will be labeled using the following naming convention:

- Each sample will begin with the five-digit ERPIMS facility identification code (NIGRA)

- An event code P1RI for Phase I RI will be added to the sample identification
- A media identifier will be added to the sample identification
    - SS = surface soil sample (less than 6 inches bgs)
    - SD = sediment sample
    - SW = surface water sample
- A QA/QC sample type code will be added to the sample identification. A numerical identifier (01, 02, 03, etc.) will be added to the sample identification if more than one QA/QC sample is collected each day
    - DUP for field duplicates
    - FB for field blanks
    - EQB for equipment blanks
- The date (MMDDYY) will be added to the sample identification

Example QA/QC sample identifiers are as follows:

- For two surface soil duplicates collected 5 May 2023, the sample identifiers would be NIGRA-P1RI-SSDUP01-050523 and NIGRA-P1RI-SSDUP02-050523
- For the surface soil, surface water, and sediment field blanks collected on 5 May 2023, the sample identifiers would be NIGRA-P1RI-SSFB-050523, NIGRA-P1RI-SWFB-050523, and NIGRA-P1RI-SDFB-050523
- For the surface soil, surface water, and sediment equipment blanks collected on 5 May 2023, the sample identifiers would be NIGRA-P1RI-SSEQB-050523, NIGRA-P1RI-SWEQB-050523, and NIGRA-P1RI-SDEQB-050523.

MS/MSDs will be labeled identical to the parent sample and noted on the chain-of-custody in order for the lab to distinguish which sample identification number contains additional volume.

Sample Tracking

Sample tracking will start at the point of collection with log entries. Log entries will be recorded legibly with ink, updated daily, and maintained at the site. Information to be recorded in the field log will include the project name and number; a unique, sequential sample number for each sample taken; sampling date and time; method of sampling; preservation techniques; analyte classes of interest; significant observations made during the sampling process; results of any field measurements; and printed name and signature of the person performing the sampling.

Each sample will be labeled with ink; labels will include the following information:

- Sample identification
- Sampling date and time
- Name of sampler
- Analysis requested
- Preservation technique

Sample Custody and Documentation

Each sample will be tracked by secure chain-of-custody protocol, until receipt at the laboratory. Chain-of-custody documentation is required for each sample to track collection, shipments, laboratory receipt, custody, and disposal. Each individual who has the samples in their possession will sign the chain-of-custody record. A sample is considered to be in custody under the following conditions:

- It is in actual possession or in view of the person who collected the sample.
- It is locked in a secure area.
- It is placed in an area restricted to unauthorized personnel.

Upon completion of sample collection, logging, and preservation, each sample identification number will be entered on the chain-of-custody record. The chain-of-custody records will identify sample-specific information (sample identification number, date/time collected, sampler, matrix, preservation, and turnaround time for analysis) and a listing of the analytical parameters required on each sample.

The chain-of-custody record will accompany the samples throughout the shipping and analytical process. When transferring possession of samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody record. This record will document transfer of custody of samples from the sampler to another person or to the laboratory. Upon arrival at the laboratory, the samples in the cooler will be checked against the chain-of-custody record by laboratory personnel. If discrepancies are noted, the samples in question will be segregated and field personnel will be immediately notified. The person accepting the delivery will sign and date the chain-of-custody.

The original chain-of-custody record will accompany the sample shipment, and copies will be retained by the EA PM for the project file. All participating laboratories will follow their documented, internal chain-of-custody procedures.

Sample Packaging and Shipping

On-site personnel will be responsible for ensuring that adequate sample containers are available for the work scheduled.

Samples will be placed on ice in sample coolers immediately after collection to ensure proper preservation. A temperature blank will be included with samples as required to document sample temperature upon laboratory receipt. Each cooler will be cleaned and lined with absorbent padding and bubble wrap (if applicable). Double-bagged ice will be packed around the samples. A completed chain-of-custody form will be placed in a sealed plastic bag and taped to the inside lid of one of the coolers for each shipment. Coolers will be sealed with tape and a custody seal will be attached to protect the integrity of the samples.

Environmental samples will be shipped to the laboratory via overnight delivery service within 24 hours of sample collection. Samples will be packaged and shipped in a manner that will ensure the safety and accountability of each sample, and the procedures implemented will be in accordance with applicable federal and local requirements. The persons packing and shipping environmental samples should review and be aware of state, federal, NYSDOT, and International Air Transport Association regulations governing environmental and hazardous sample packaging. The person(s) shipping the samples is responsible for complying with applicable packaging, labeling, and shipping requirements.

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UFP-QAPP Worksheet #28: Analytical Quality Control and Corrective Action

This worksheet presents the QC samples and their respective acceptance limits. The purpose of this worksheet is to ensure that the selected analytical methods are capable of meeting project-specific MPC, which are based on project quality objectives/DQOs). There are no analytical quality control tables for grain size by ASTM Method D422, porosity by ASTM Method D2937, and permeability by ASTM Method D5084.

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Table 28-1. Quality Control Samples Table: PFAS By EPA Method 1633 (Pace Analytical)

Matrix	Soil / Sediment / Groundwater / Surface water / Porewater
Analytical Group	PFAS
Analytical Method/SOP	Draft EPA Method 1633/ENV-SOP-BTRO-0149

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Project-Specific MPC
Ion Transitions (Precursor-> Product)	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) If a qualitative or quantitative standard containing an isomeric mixture (branched and linear isomers) of an analyte is commercially available for an analyte, the quantification ion used must be the quantification ion identified in Table 2 of EPA Draft Method 1633 unless interferences render the product ion unusable as the quantification ion. Guidance criteria for select analytes: PFOA: 413 ⟶ 369 PFOS: 499 ⟶ 80 PFHxS: 399 ⟶ 80 PFBS: 299 ⟶ 80 4:2 FTS: 327 ⟶ 307 6:2 FTS: 427 ⟶ 407 8:2 FTS: 527 ⟶ 507 NEtFOSAA: 584 ⟶ 419 NMeFOSAA: 570 ⟶ 419 2) In cases where interferences render the product ion unusable as the quantification ion, project approval is required before using the alternative product ion.	Flagging is not appropriate. Provide technical justification in the Case Narrative.	Section Supervisor	Chemical fragmentation Comparability/ Accuracy	As discussed in SOP
Ion Ratio	All analytes detected in a sample.	Must meet all the requirements of EPA Draft Method 1633.	Document and discuss the failure in the Case Narrative. Apply I-flag to the result associated with the failure.	Section Supervisor	Comparability/ Accuracy	Same as QC Acceptance Criteria
Spiking standards	All analytes	Must contain linear and branched isomers if available commercially	NA. Flagging not appropriate	Section Supervisor	NA	NA
Extracted Internal Standard (EIS) Compounds	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) Isotopically labeled analogs of analytes must be used when they are commercially available. 2) QC samples and field samples must recover within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary in-house acceptance criteria of 20-150% must be used until in- house limits are generated in accordance with Sections 9.4.1 and 9.4.2 of EPA Draft Method 1633.) The lower limit of in- house acceptance criteria cannot be <20%.	Repeat the analysis using a fresh aliquot of the extract. If failure does not confirm, report the second analysis. If the failure confirms, follow the requirements listed in EPA Draft Method 1633, Section 15.3.2. If EIS recoveries still fall outside of the acceptance range, the client must be contacted for additional measures to be taken. Document and discuss the failure in the Case Narrative. Apply Q-flag to the result associated with the failure.	Analyst / Section Supervisor	Individual sample preparation efficiency control	Within 20-150% of target value.

Matrix		Soil / Sediment / Groundwater / Surface water / Porewater				
Analytical Group		PFAS				
Analytical Method/SOP		Draft EPA Method 1633/ENV-SOP-BTRO-0149				
QC Sample	**Number / Frequency**	**Method / SOP Acceptance Criteria**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Project-Specific MPC**
Non-extracted Internal Standard (NIS) Compounds	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633, the following must be met: 1) NIS areas must be greater than 30% of the average area of the calibration standards in undiluted sample extracts and sample extracts that required additional NIS to be added. 2) NIS areas corrected for the dilution factor must be greater than 30% of the average area of the calibration standards in diluted samples when additional NIS was not added post dilution of the extract.	Repeat the analysis using a fresh aliquot of the extract. If failure does not confirm, report the second analysis. If the failure confirms, examine the project-specific requirements. Contact the client as to additional measures to be taken. Document and discuss the failure in the Case Narrative. Apply Q-flag to the result associated with the failure.	Analyst / Section Supervisor		Same as QC Acceptance Criteria
MB	One per preparatory batch (1 per batch of 20 samples)	In addition to the requirements of EPA Draft Method 1633, the following must be met: No analytes detected > ½ LOQ or > 1/10th the amount measured in any associated sample or 1/10th the regulatory limit, whichever is greater.	Correct the problem. If required, re-extract and reanalyze MB and all QC samples and field samples processed with the contaminated blank. Samples may be re-extracted and analyzed outside of holding times, as necessary for corrective action associated with QC failure. Examine the project-specific requirements. Contact the client as to additional measures to be taken. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Analyst / Section Supervisor	Accuracy/ Bias Contamination	Same as QC Acceptance Criteria
LCS and Low-Level Laboratory Control Standard (LLLCS)	One set per preparatory batch (1 set per batch of 20 samples)	In addition to the requirements of EPA Draft Method 1633 the following must be met: 1) Analyte recoveries must be within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary inhouse acceptance criteria of 40-150% must be used until inhouse limits are generated in accordance with Section 14.5.4 of EPA Draft Method 1633. 2) The lower limit of inhouse acceptance criteria cannot be < 40%.	In addition to the requirements of EPA Draft Method 1633, the following must be met: Samples may be re-extracted and analyzed outside of holding times, as necessary for corrective action associated with QC failure. Examine the project-specific requirements. Contact the client as to additional measures to be taken. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Analyst / Section Supervisor	Accuracy/bias	Laboratory % Recovery Control Limits
MS and MSD	One MS/MSD pair per prep batch (1 per batch of 20 samples).	In addition to the requirements of EPA Draft Method 1633, the following must be met: Analyte recoveries must be within in-house LCS limits if project limits are not provided; otherwise, project limits must be met. RPD ≤ 30% (between MS and MSD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If the analyte(s) are not listed, use inhouse LCS limits if project limits are not specified. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	Analyst / Section Supervisor	Accuracy/ Precision	Laboratory % Recovery Control Limits / RPD Control Limits

Matrix		Soil / Sediment / Groundwater / Surface water / Porewater				
Analytical Group		PFAS				
Analytical Method/SOP		Draft EPA Method 1633/ENV-SOP-BTRO-0149				
QC Sample	**Number / Frequency**	**Method / SOP Acceptance Criteria**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Project-Specific MPC**
Bile Salt Standards	Daily, prior to analysis of all matrix types (aqueous, solid, tissue, and AFFF).	All EPA Draft Method 1633 requirements for evaluation of the relationship of the retention time of the bile salt peak(s) to the retention time window of PFOS must be met for all matrix types. The retention time window of PFOS applies to the retention time of all isomers of PFOS. No samples shall be analyzed until acceptance criteria for the bile salt standard(s) has been met. The retention time of the bile salt(s) peak must fall out of the retention time window of PFOS by at least one minute.	N/A	Analyst / Section Supervisor	N/A	N/A

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Table 28-2. Quality Control Samples Table: Total Organic Carbon (TOC)

Matrix	Soil
Analytical Group	Total Organic Carbon
Analytical Method/SOP	EPA SW-846 Method 9060A / ENV-SOP-BTRO-0044

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Project-Specific MPC
MB	One per preparatory batch of 20 or fewer samples	No analytes > ½ LOQ or >1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Supervisor, QA Manager	Bias/Contamination	Same as Acceptance Criteria
LCS	One LCS per preparatory batch of 20 or fewer samples	69-128% Recovery	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Results within acceptance limits
MS	One per preparatory batch of 20 or fewer samples	69-128% Recovery	Flag outliers	Analyst, Supervisor, QA Manager	Accuracy/Bias	Results within acceptance limits
MSD or Sample Duplicate (SD)	One per preparatory batch of 20 or fewer samples	RPD ≤ 20% (between MS and MSD or sample and duplicate).	Flag data	Analyst, Supervisor, QA Manager	Accuracy/Bias	Results within acceptance limits

Table 28-3. Quality Control Samples Table: pH

Matrix	Soil					
Analytical Group	pH					
Analytical Method/SOP	EPA 9045D / ENV-SOP-BTRO-0037					
QC Sample	**Number / Frequency**	**Method / SOP Acceptance Criteria**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Project-Specific MPC**
MB	One per batch, maximum of 20 samples.	The absolute values of all analytes must be <1/2 LOQ or <1/10th the amount measured in any sample.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank.	Analyst, Supervisor, QA Manager	Bias/Contamination	Same as method
SD	One per batch, maximum of 20 samples. Flashpoint: duplicate any sample with a result <170°F.	within 0.1 pH unit	If RPD is greater than the stated limit, investigate the source of the error and correct the problem. Reanalyze all samples in the batch. If there is insufficient sample for reanalysis, qualify data and explain in the case narrative	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as method
QC Check Buffer (pH only)	Before sample analysis, after every 20 samples and at the end of analysis	Within ±0.05 pH of true value.	Recalibrate the meter and reanalyze samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as method

Table 28-4. Quality Control Samples Table: Cation Exchange Capacity

Matrix	Soil					
Analytical Group	Cation Exchange Capacity					
Analytical Method/SOP	EPA SW-846 Method 9081 / ENV_SOP_SHRT_0046 00					
QC Sample	**Number / Frequency**	**Method / SOP Acceptance Criteria**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Project-Specific MPC**
MB	One per digestion batch of up to 20 samples	No results >1/2 LOQ or >1/10 the amount measured in any sample.	Rerun once in a new tube. If >RL, re-digest and reanalyze samples. Note exceptions under criteria section.	Lab Manager / Analyst	Accuracy/Bias Contamination	Method blank
Laboratory Duplicate	Every 20 samples, at least one per prep batch	RPD ≤ 20%	Flag the data and document in the case narrative.	Lab Manager / Analyst	Precision and Accuracy/Bias	Laboratory Duplicate
LCS	One per batch of samples.	70% - 130% recovery	Refer to ENV-SOP- SHRT-0046 for Corrective Actions.	Lab Manager / Analyst	Precision and Accuracy/Bias	Laboratory Control Sample

Table 28-5. Quality Control Samples Table: Anion Exchange Capacity

Matrix		Soil				
Analytical Group		Anion Exchange Capacity				
Analytical Method/SOP		New Zealand P Retention / ENV-SOP-SHRT-0157				
QC Sample	**Number / Frequency**	**Method / SOP Acceptance Criteria**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Project-Specific MPC**
MB	One per digestion batch of up to 20 samples	<0.05 parts per million	Address issue and re-run blank until acceptable result is achieved, prior to analyzing samples.	Lab Manager / Analyst	Accuracy/Laboratory Contamination	<RL
Check Soil	One per digestion batch of up to 20 samples	90-110% of true value	Address issue and re-run check soil until acceptable result is achieved, prior to analyzing samples.	Lab Manager / Analyst	Accuracy	Within 10%
Lab Duplicate	10% of project samples	RPD ≤ 10%	Flag the data.	Lab Manager / Analyst	Precision	RPD ≤ 10%

UFP-QAPP Worksheet #29: Project Documents and Records

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location**
Field logbook or data collection sheets	Field Personnel	EA Field Manager	Project File
Chain-of-Custody Forms	Field Personnel	EA Field Manager	Project File
Shipping Records	Field Personnel	EA Field Manager	Project File
Daily Quality Control Reports	EA Field Manager	EA Field Manager, QA Officer or Representative	Project File
Log of Daily Notice Field Activity	EA Field Manager	Field Manager	Project File
Deviations/Field Change Request Forms or notifications[2]	EA Field Personnel	EA PM, Deputy PM, Field Manager with concurrence from project team	Project File
Corrective Action Reports	EA PM, Deputy PM, Field Manager	EA CQCS / QA Officer or Representative	Project File/Reports
Correspondence	EA Field Personnel	EA PM, Deputy PM, Field Manager	Project File

Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location**
Laboratory sample receipt logs	Laboratory check-in staff	EA Database Administrator	Laboratory Files
Chain-of-Custody Forms	Laboratory check-in staff	EA Database Administrator/Project Chemist	Project File/Reports
Instrument Maintenance and Calibration Logs	Laboratory Analyst	Laboratory QA Manager	Laboratory Files
Sample Preparation Analysis Worksheets/Logs	Laboratory Analyst	Laboratory QA Manager	Laboratory Files
Chromatograms/raw data	Laboratory Analyst	Laboratory QA Manager	Project File/Reports
Sample and QC Sample Results	Laboratory Analyst	Lab QA Manager/EA Project Chemist	Project File/Reports
Correspondence	Laboratory Staff	EA Project Chemist	Project File

Project Assessments			
Record	**Generation**	**Verification**	**Storage Location**
Phase IIa Data Validation Checklist	EA Project Chemist	EA Database Administrator	Project File/Reports
Data Validation Report	Data Validator	EA Project Chemist	Project File/Reports
Corrective Action Documentation	EA Field Manager/ Project Chemist	EA Project Manager, EA CQCS, QA Officer or Representative	Project File
Independent Technical Review Certification	Technical Reviewer	EA Field Manager	Project File
Inspection Checklists	EA Field Manager	EA PM	Project File
Non-Conformance Form	EA PM	EA Program Manager	Project File

Laboratory Data Deliverable					
Record	**Groundwater**	**Surface Water**	**Pore Water**	**Soil**	**Sediment**
Narrative	X	X	X	X	X
Chain-of-Custody Forms	X	X	X	X	X
Summary Results	X	X	X	X	X
QC Results	X	X	X	X	X
Level IV Data Package	X	X	X	X	X
EQuIS and ERPIMS Electronic Data Deliverables	X	X	X	X	X

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[2] Deviations/Field Change Requests may be caused by utilities, changes to site conditions, or accessibility issues and these changes may be required without advance warning while the sampling team is in the field sampling. The EA Team will discuss Deviations/Field Change Requests with NFARS installation personnel and make every effort to discuss with USACE and NFARS prior to implementing changes in the field.

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UFP-QAPP Worksheet #31, #32, & #33: Assessments and Corrective Action

This worksheet is used to document responsibilities for conducting project assessments, responding to assessment findings, and implementing corrective action. Appropriately scheduled assessments allow management to implement corrective action in a timely manner, thereby correcting non-conformances and minimizing their impact on DQOs/Project Quality Objectives.

Assessments:

Assessment Type	Responsible Party and Organization	Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
PM Review	PM/ EA	Monthly (for field efforts that are longer than 1 month)	TBD	Email documenting findings	7 days after assessment
Review of Chain-of-Custody forms	Field Manager / Field Geologist / Data Manager / EA	Daily	TBD	Email documenting findings	Within 24 hours
Laboratory Data Assessment (validation)	Data Validator	Once	TBD	Validation report	Within 1 month after receipt of data
Daily Quality Control Audits	PM / Deputy PM/ Field Manager / QA Officer or Representative / EA	Daily	TBD	Daily QC Report	Within 24 hours
Field Technical System Audits	PM / Deputy PM / Field Manager / QA Officer or Representative / EA	Daily	TBD	Email/ Daily QC Report	7 days after assessment
Field Performance Audits	PM / Deputy PM / Field Manager / QA Officer or Representative / EA	Weekly	TBD	Email/ Daily QC Report	7 days after assessment
Laboratory	Laboratory QA Manager	Per QA Manual	TBD	Email	Determined internally

Assessment Response and Corrective Action:

Assessment Type	Person(s) Responsible for Responding to Assessment Findings	Nature of Corrective Action Response Documentation	Timeframe for Response	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
PM Review	Field Manager / Field Geologist / EA	Daily QC Report/ Email	24 hours after notification	Field Manager / QA Officer / Field Geologist / EA	EA PM / Deputy PM/ Field Manager / QA Officer or Representative /
Review of chain-of-custody forms	Field Manager / Field Geologist / EA	Daily QC Report/ Email	24 hours after notification	Field Manager / QA Officer / Field Geologist / EA	Project Chemist / EA
Laboratory Data Assessment (validation)	Project Chemist/ EA	Email	Up to 1 Week after notification	Laboratory QA Manager	Project Chemist/ EA
Daily Quality Control Audits	Field Manager / Field Geologist / EA	Daily QC Report/ Email	24 hours after notification	Field Manager / QA Officer / Field Geologist / EA	PM / Deputy PM/ Field Manager / QA Officer or Representative / EA
Field Technical System Audits	Field Manager / Field Geologist / EA	Daily QC Report/ Email	24 hours after notification	Field Manager / QA Officer / Field Geologist / EA	PM / Deputy PM/ Field Manager / QA Officer or Representative / EA
Field Performance Audits	Field Manager / Field Geologist / EA	Daily QC Report/ Email	24 hours after notification	Field Manager / QA Officer / Field Geologist / EA	PM/ EA
Laboratory	Laboratory Analysts	Email to file	Immediate correction – written documentation due within 1 week	Laboratory QA Manager	Laboratory PM

UFP-QAPP Worksheet #34: Data Verification and Validation Inputs

This worksheet is used to list the inputs that will be used during data verification, validation, and usability assessment. Inputs include all required documents (e.g., contracts, SOPs, planning documents), field records (both hard-copy and electronic), and interim and final reports. Data verification is a completeness check that all specified activities involved in data collection and processing have been completed and documented, and that the necessary records (objective evidence) are available for data validation. Data validation is the evaluation of conformance to stated requirements.

Data Verification and Validation Inputs for Sampling

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved planning documents	x	
2	Contract	x	
4	Field SOPs	x	
5	Laboratory SOPs	x	
Field Records			
6	Field logbooks/Field Sheets	x	x
7	Tailgate safety meeting record	x	x
8	Equipment calibration records	x	x
9	Chain-of-custody records	x	x
10	Sampling drawings/surveys	x	x
11	Relevant correspondence	x	x
12	Change orders/deviations	x	x
13	Field audit reports	x	x
14	Field corrective action reports	x	x
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	x	x
16	Case narrative	x	x
17	Internal laboratory chain-of-custody	x	x
18	Sample receipt records	x	x
19	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	x	x
20	Communication records	x	x
21	Project-specific proficiency testing/sample results (if applicable)	x	x
22	LOD/LOQ establishment and verification	x	x
23	Standards traceability	x	x
24	Instrument calibration records	x	x
25	Definition of laboratory qualifiers	x	x
26	Results reporting forms	x	x
27	QA/QC sample results	x	x
28	Corrective action reports	x	x
29	Raw data	x	
30	Electronic data deliverable	x	x

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UFP-QAPP Worksheet #35: Data Verification Procedures

This worksheet documents procedures that will be used to verify project data. Data verification is a completeness check to confirm that all required activities were conducted, all specified records are present, and the contents of the records are complete. The referenced EA field SOPs are provided in **Appendix B**.

Records Reviewed	Requirement Documents	Process Description	Frequency	Responsible Person
Field logbooks	EA-SOP-016	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed, and results are documented.	Daily End of Activity	EA Task Manager EA PM
Chain-of-custody forms	EA-SOP-002	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected. Verify that all required signatures and dates are present. Check for transcription errors.	Daily End of Activity	EA Field Team EA Project Chemist or designee
Laboratory Deliverable	UFP-QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the chain of custody forms to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Before release Upon receipt	Lab QA Manager EA Project Chemist or designee
Electronic data	UFP-QAPP	Electronic laboratory data and field data.	Daily	EA Database Administrator/EA PM

Records Reviewed	Requirement Documents	Process Description	Frequency	Responsible Person
Daily and Weekly QC Report	UFP-QAPP, Quality Control Plan	All QC reports are complete for each field day/week.	Daily/Weekly	EA Task Manager
Audit Reports, CA Reports	UFP-QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that CA was implemented according to plan.	As required	CQCS

UFP-QAPP Worksheet #36: Data Validation Procedures

Data validation is an analyte- and sample-specific process for evaluating compliance with contract requirements, methods/SOPs, and method performance criteria. The validation to be performed for each data type is summarized in this worksheet.

The PFAS data for groundwater, surface water, soil, and sediment will be validated by Environmental Data Services, Ltd. to a 90% Stage 2b standard and a 10% Stage 4 standard with recalculation of appropriate data for each sample delivery group, including DoD QSM Table B-24 requirements. Samples for Stage 4 validation will be selected from those samples with elevated PFAS concentrations, relative to other project samples. Other chemical data will undergo Stage 2A validation. Grain size, porosity and permeability data will undergo data verification for completeness and compliance to project objectives. Data collected for IDW characterization will not undergo data validation. Validation results will be reviewed by the Project Chemist.

Data Validator: Environmental Data Services, Ltd.

Analytical Group/Method:	PFAS by EPA Method 1633
Data deliverable requirements:	EQuIS and ERPIMS Electronic Data Deliverables and Stage 4 PDF Data Package
Analytical specifications:	Worksheet #28, SOPs (Worksheet #23)
Measurement performance criteria:	Worksheet #12
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	10%
Percent of results to be recalculated:	10%
Validation procedure:	DoD *General Data Validation Guidelines*; DoD Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24
Validation code:	90% S2BVM, 10% S4VM
Electronic validation program/version:	NA

Notes:
PDF = Portable document format

Data Validator: EA

Analytical Group/Method:	TOC by EPA SW-846 Method 9060A; pH by EPA SW-846 Method 9045D; cation exchange capacity by EPA SW-846 Method 9081; anion exchange capacity by New Zealand P Retention Method
Data deliverable requirements:	EQuIS and ERPIMS Electronic Data Deliverables and PDF Data Package including QC data
Analytical specifications:	Worksheet #28, SOPs (Worksheet #23)
Measurement performance criteria:	Worksheet #12
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	0%
Percent of results to be recalculated:	0%
Validation procedure:	DoD *General Data Validation Guidelines*
Validation code:	S2aVM (Stage 2a Validation Manual)
Electronic validation program/version:	NA

The following qualifiers will be used to indicate QC deficiencies and will be defined in the data tables. Potential impacts on project specific DQOs will be discussed in the data validation report.

Qualifier	Definition
U	The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample.
J	The reported result was an estimated value with an unknown bias.
J+	The result was an estimated quantity, but the result may be biased high.
J-	The result was an estimated quantity, but the result may be biased low.
UJ	The analyte was not detected and was reported as less than the LOD or as defined by the customer. However, the associated numerical value is approximate.
X	The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The presence or absence of the analyte cannot be substantiated by the data provided. Acceptance or rejection of the data should be decided by the project team (which should include a project chemist), but exclusion of the data is recommended.

UFP-QAPP Worksheet #37: Data Usability Assessment

This worksheet documents procedures that will be used to perform the data usability assessment (DUA). The DUA is performed at the conclusion of data collection activities, using the outputs from data verification and data validation (Worksheets #35 and #36).

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

- Robert Casey, EA PM
- Samantha Saalfield, EA Project Chemist

A third-party data validation will be performed by Environmental Data Services, Ltd. on the PFAS data generated by Pace Analytical. If any data are X-qualified (recommended for exclusion) during validation, EA will coordinate with the data usability assessment team to determine whether these data should be rejected or qualified as estimated prior to submittal of data reports for each phase of field activities.

Subsequent to validation, a data usability assessment will be performed and will include the following:

- Step 1
    - Review the project's objectives and sampling design.
    - Review the key outputs defined during systematic planning (i.e., Project Quality Objectives or DQOs and MPC) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.
- Step 2
    - Review the data verification and data validation outputs.
    - Review available QA reports, including the data verification and data validation reports. Look for patterns, trends, and anomalies.
    - Review deviations from planned activities (e.g., number and locations of samples, damaged samples, and SOP deviations) and determine their impacts on the data usability. Assess data quality indicators including precision, accuracy, representativeness, completeness, comparability, and sensitivity, as described in detail below. Evaluate implications of unacceptable QC sample results.
- Step 3

  - Verify the assumptions of the selected statistical method.
  - Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.

- Step 4
  - Implement the statistical method.
  - Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in soil are below the action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.

- Step 5
  - Document data usability and draw conclusions.
  - Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

SUMMARY OF DATA QUALITY INDICATORS

The data usability assessment will include a summary of whether the data achieved the project DQOs, as well as a data quality and usability statement. A description of each data quality indicator is found under each parameter heading below. Precision, accuracy/bias, representativeness, comparability, and completeness, as well as sensitivity, are the data quality indicators used to validate and assess the data produced during the project. Each data quality indicator is described below including a definition of the terminology, the referenced process for calculating the indicator, and the referenced measurement performance criteria for this project. Specific data quality indicators and their specific measurement performance criteria to be evaluated for data usability are presented on Worksheet #12, Worksheet #15, Worksheet #19 & #30, Worksheet #24, and Worksheet #28.

To measure and control the quality of analyses, certain QA parameters are defined and utilized in data analysis activities. These QA parameters are defined below. The assigned subcontract laboratory will generally follow the QA/QC criteria specified in the applicable EPA method.

Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms. QC measures for precision include field duplicates, laboratory duplicates, MSDs, and analytical replicates.

To meet the needs of the data users, project data must meet the measurement performance criteria for precision specified in UFP-QAPP Worksheets #12 and #28 and supporting worksheets. Precision may be the result of one or more of the following: field instrument variation, analytical measurement variation, poor sampling technique, sample transport problems, or spatial variation (heterogeneous sample matrices). To identify the cause of imprecision, the field sampling design rationale and sampling techniques will be evaluated by the reviewer, and both field and analytical duplicate/replicate sample results will be reviewed. The process for calculating precision will be in accordance with the UFP-QAPP Manual, Section 2.6.2.1 (EPA 2005).

Duplicate precision is stated in terms of RPD or absolute difference between two measurements. Measurement of precision is dependent upon sampling technique and analytical method. Field duplicate and laboratory duplicate samples will be used to measure precision for project samples. Both sampling and analysis will be as consistent as possible. For a pair of measurements, RPD (or absolute difference) will be used, as presented below:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{\frac{(D_1 + D_2)}{2}} \times 100$$

where: D_1 and D_2 = the two replicate values.

RPD will meet QA requirements listed in this UFP-QAPP and the DoD QSM.

If poor precision is indicated in both the field and analytical duplicates/replicates, then the laboratory may be the source of error. If poor precision is limited to the field duplicate/replicate results, then the sampling technique, field instrument variation, sample transport, and/or spatial variability may be the source of error. If data validation reports indicate that analytical imprecision exists for a particular data set or sample delivery group, then the impact of that imprecision on usability will be considered prior to use.

Analytical Accuracy/Bias

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) that are due to sampling and analytical operations. Examples of QC measures for accuracy include MS, LCS, equipment blanks, and surrogates. In order to meet the needs of the data users, project data must meet the measurement performance criteria for accuracy/bias specified in UFP-QAPP Worksheets #12 and #28. The process for calculating accuracy/bias will be in accordance with the UFP-QAPP Manual, Section 2.6.2.2.

Sources of error include the sampling process, field contamination, preservation, handling, shipping, sample matrix, sample preparation, and analysis technique. Analytical accuracy will be assessed through surrogate spike, MS, laboratory control and/or quality check samples, where applicable. In general, accuracy is measured in terms of percent recovery (%R):

$$\%\mathrm{R} = \frac{(\mathrm{SSR} - \mathrm{SR})}{\mathrm{SA}} \times 100$$

where:
SSR = spike sample result
SR = sample result
SA = spike added to spiking matrix

Percent recoveries will meet the QA requirements listed in the RPD will meet QA requirements listed in this UFP-QAPP and the DoD QSM.

Representativeness

Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that is dependent upon the proper design and implementation of the sampling program and proper laboratory protocol. The process for calculation representativeness will be in accordance with the UFP-QAPP Manual, Section 2.6.2.4.

The sampling protocol created for this project was designed to provide data representative of site conditions. During the development of the sampling protocol, consideration was given to the past history of the site, existing analytical data, physical setting, and processes. representativeness will be satisfied by determining that the UFP-QAPP is followed, proper sampling techniques, preservation, and handling are used, proper analytical procedures are followed, and holding times for the samples are not exceeded in the laboratory.

This UFP-QAPP discusses how the QA/QC activities (review of sampling design and SOPs, field sampling technical systems audits, split sampling, and analysis audits, etc.) and QC sample data will be reviewed to assess sample representativeness. For samples collected, if field duplicate precision checks indicate potential spatial variability, additional scoping meetings and subsequent sampling may be needed in order to collect data that are more representative of the site.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was planned to be obtained. In order to meet the needs of the data users, project data must meet the measurement performance criteria for data completeness specified in UFP-QAPP Worksheets #12.

A completeness check will be done on the data generated by the laboratory. The completeness criterion for this project is 100% for each analyte/matrix, particularly for PFOA/PFOS/PFBS. Completeness will be calculated for each analyte in each matrix (UFP-QAPP Manual Section 2.6.2.6). For each target analyte in each matrix, completeness will be calculated as the number of valid (usable) data points for the target analyte in samples of the subject matrix, divided by the total number of samples of the subject matrix analyzed for the target analyte.

Following the completion of the analytical testing, the percent completeness for each target analyte in each matrix will be calculated by the following equation:

$$\text{Completeness (\%)} = \frac{\text{number of usable data}}{\text{number of samples collected for each parameter analyzed}} \times 100$$

The completeness acceptance criterion for samples collected in the field will be 100% of the quantity of samples planned for collection in the UFP-QAPP. Corrective action may be implemented to re-collect samples where necessary and possible (e.g., modifying a planned sample location, sample jars broken during shipment). Laboratory notification of sample receipt and conditions will be used to evaluate, as soon as possible, whether any problems during sample shipment would necessitate recollection of samples.

Comparability

Comparability is the degree to which different methods, data sets, and decisions agree or can be represented as similar. Comparability describes the confidence (expressed qualitatively or quantitatively) that two data sets can contribute to a common analysis and interpolation.

The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data. The procedures used will be EPA methodologies or other standard test methods, which are well recognized and commonly used for environmental investigations.

Desired Method Sensitivity

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Examples of

QC measures for determining sensitivity include laboratory fortified blanks, a MDL study, and calibration standards at the quantitation limit. To meet the needs of the data users, project data must meet the measurement performance criteria for sensitivity specified in Worksheet #12 and SLs specified in Worksheet #15 of this UFP-QAPP.

Depending upon the use of the data and the type of test parameter, specific QLs will be required. Worksheet #15 lists the SLs for the chemical parameters of interest for this work. The analytical methods used for this project should have sensitivities below these criteria.

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Appendix A

Project Planning Session Meeting Minutes

FINAL MEETING MINUTES

Purpose: NFARS Phase I PFAS RI – Technical Project Planning Meeting No. 1

Location: Virtual Meeting via Microsoft Teams

Date: 27 October 2022; 1400 EST

Attendees	Organization/TO Role
Steven Moeller	NYSDEC- Project Manager
Jim Sullivan	NYSDOH
Lindsay Mairs	AFCEC-Remedial Project Manager
Tom Heins	USACE – New York District – Project Manager
Alison Hines	USACE – Baltimore District – Technical PM
Genna Rohleder	USACE – Project Geologist
Kiera Hearn	USACE – Project Chemist
Bob Casey	EA – Project Manager
Frank DeSantis	EA – Deputy Project Manager
Amanda Kohn	EA – Field Task Manager
Joe Von Uderitz	EA – Technical/Geologist

Items discussed are summarized below:

1. Introductions

- USACE, EA, NYSDEC, and NYSDOH personnel introduced themselves

2. PFAS SI and RI Phases

- NYSDEC and NYSDOH confirmed they have seen the SI.

- EA noted sites are moving into the RI process and will be screening the SI data against the new or recently released EPA RSLs for the six PFAS compounds.

- EA showed a geologic cross section that was developed as part of the evaluation process; where groundwater impacts are currently known.

- EA and Air Force to evaluate the multimedia at the site including surface soil, sediment, and groundwater through a Phase I RI evaluation; planning on putting in some monitoring wells.

- EA/USACE/Air Force is currently at the kick-off stage, but planning to go through phases: doing groundwater gauging events, updating the CSM, subsurface soil with soil borings, surface water sampling, groundwater samples via transects, and monitoring the well network for any observed impacts. As EA goes through each phase, they will identify any data gaps and see if any additional media needs to be further delineated.

- EA to conduct periodic TPP meetings with NYSDEC and NYSDOH, and reporting and review the phases with the Air Force and USACE.
- EA is using the Draft EPA 1633 method for the RI.
- The current schedule is having a full Phase I RI report by January 2026; subject to change depending on how things progress at the site

3. **Documents**

- EA has developed a PMP (internal document with the government) and is starting the UFP-QAPP (will serve as the work plan) and an APP.
- EA plans to refine the CSM to hopefully eliminate any data gaps and fully delineate PFAS impacts in environmental media at the installation.
- EA plans to deliver the UFP-QAPP to Air Force and USACE just before Thanksgiving and after incorporating comments, will develop a Draft Final UFP-QAPP (end of March 2023)

4. **Other**

- EA plans to schedule TPP meetings to further discuss field events and discussion of the summary of the findings
- Steve Moeller asked if bedrock groundwater would be sampled during the RI; Robert Casey noted that if the data and CSM suggest bedrock impacts then bedrock wells will be considered to fully delineate potential groundwater impacts.
- Discussion on public interest/public meeting; Steve Moeller asked if the government intended to start up a RAB. Lindsay Mairs stated that Air Force will notify the public and if enough interest is generated then a RAB will form; Air Force has a methodology for determining interest based on population size of the geographic area where the installation is located. Lindsay Mairs also noted that the MAP meetings will still be conducted and serve a similar purpose as a RAB.
- Two additional sites that will still need an SI and may be include in this RI based on the results of the SI. They were not currently presented in this meeting (but they are a part of the contract) because they are not technically listed as sites yet, but still moving forward with the SI.

5. Action Items

Issue	Responsible Party	Due Date	Status
Provide UFP-QAPP	EA	Just prior to Thanksgiving	In Progress
Provide APP	EA	TBD	In Progress

Attachment – TPP No. 1 Presentation Slide Deck

Niagara Falls Air Reserve Station

Phase I Remedial Investigation of Per- and Polyfluoroalkyl Substances (PFAS)

Contract No. W912DR19D0005
Task Order No. W912DR22F0247

Department of the Army
Baltimore District, USACE

Technical Project Planning
October 27, 2022
Virtual Meeting

US Army Corps of Engineers
BUILDING STRONG®

EA Engineering, Science, and Technology, Inc., PBC

Agenda

- Project Delivery Team Introductions
- Phase I PFAS RI Scope of Work Overview
  - SI Sites moving into CERCLA RI phase
  - Observed Impacts
- Phased RI Technical Approach
  - Work Planning
  - Gauging, Surface Soil, Surface Water, Sediment Sampling
  - Surface / Subsurface Soil and Groundwater Grab Sampling; additional Surface Water and Sediment Sampling
  - Data Gap Soil and/or Groundwater Grab Sampling
  - Monitoring Well / Lysimeter Install and Sampling
  - RI Reporting
- Deliverables / Milestones Schedule – detailed schedule separate
- Questions

Project Delivery Team

- **Air Force**
  - Lindsay Mairs – AFCEC Base RPM
  - Melvin Alli – AFCEC PM
  - J. Seb Gillette – CZTE PFAS SME
  - Shannon Garcia – CZTE PFAS SME
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SI Sites moving into CERCLA RI Phase

AFFF Investigation Area	Name	Highest Detection in Soil (µg/kg)	Depth to Water (ft bgs)	Highest Detection In GW (ppt)	Highest Detection in Sediment (µg/kg)	Highest Detection in SW (ppt)
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SS706P	AFFF Area 3 Building 706	PFBS: ND PFOA: 0.0038 PFOS: 0.0056	5.63 - 5.64	PFBS: 0.022 J PFOA: 0.011 J PFOS: 0.14 J PFOA+PFOS: 0.161 J	Not sampled	Not sampled
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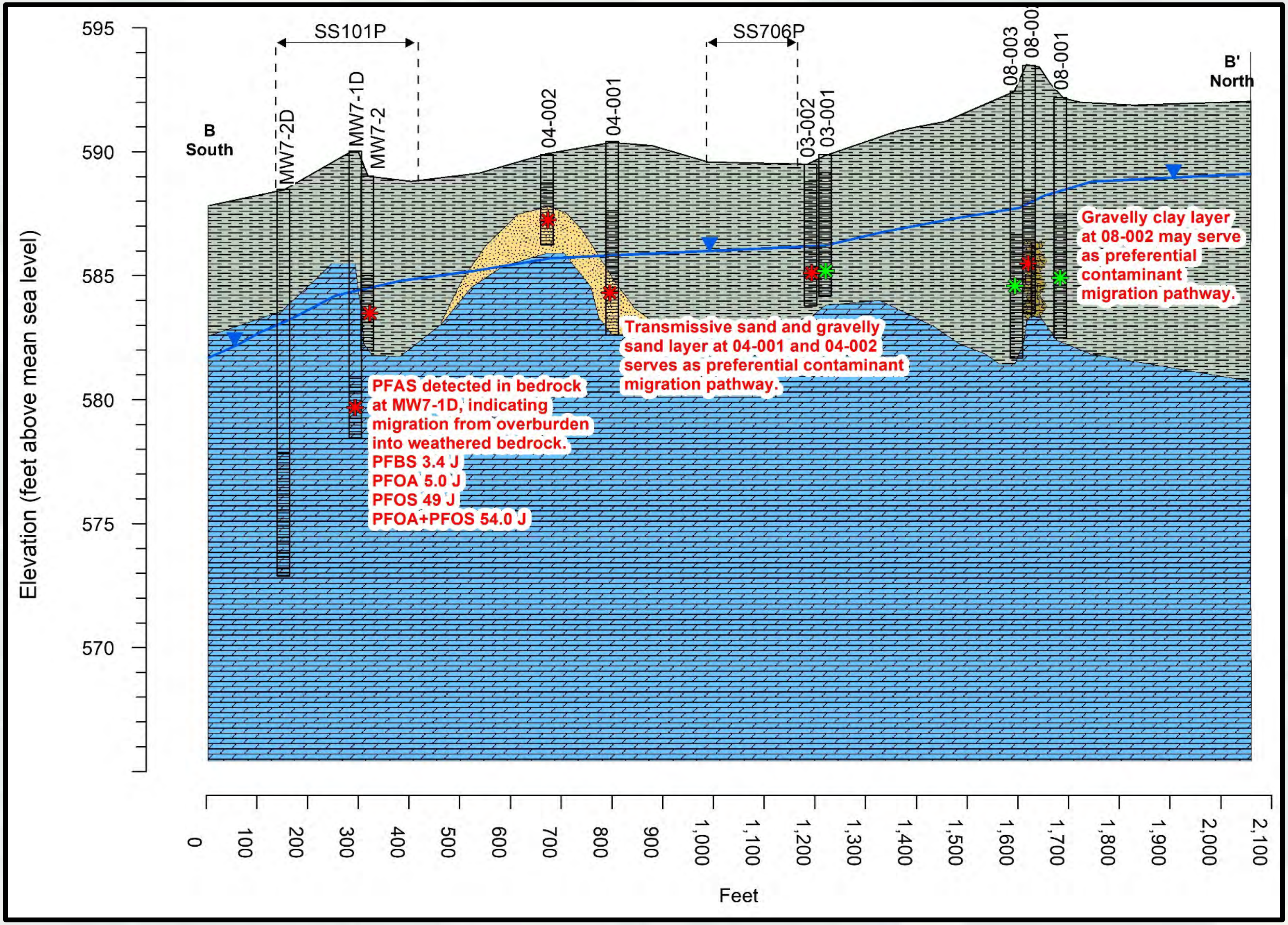
SI Sites moving into CERCLA RI Phase

EA Engineering, Science, and Technology, Inc., PBC

Geologic Cross-Section



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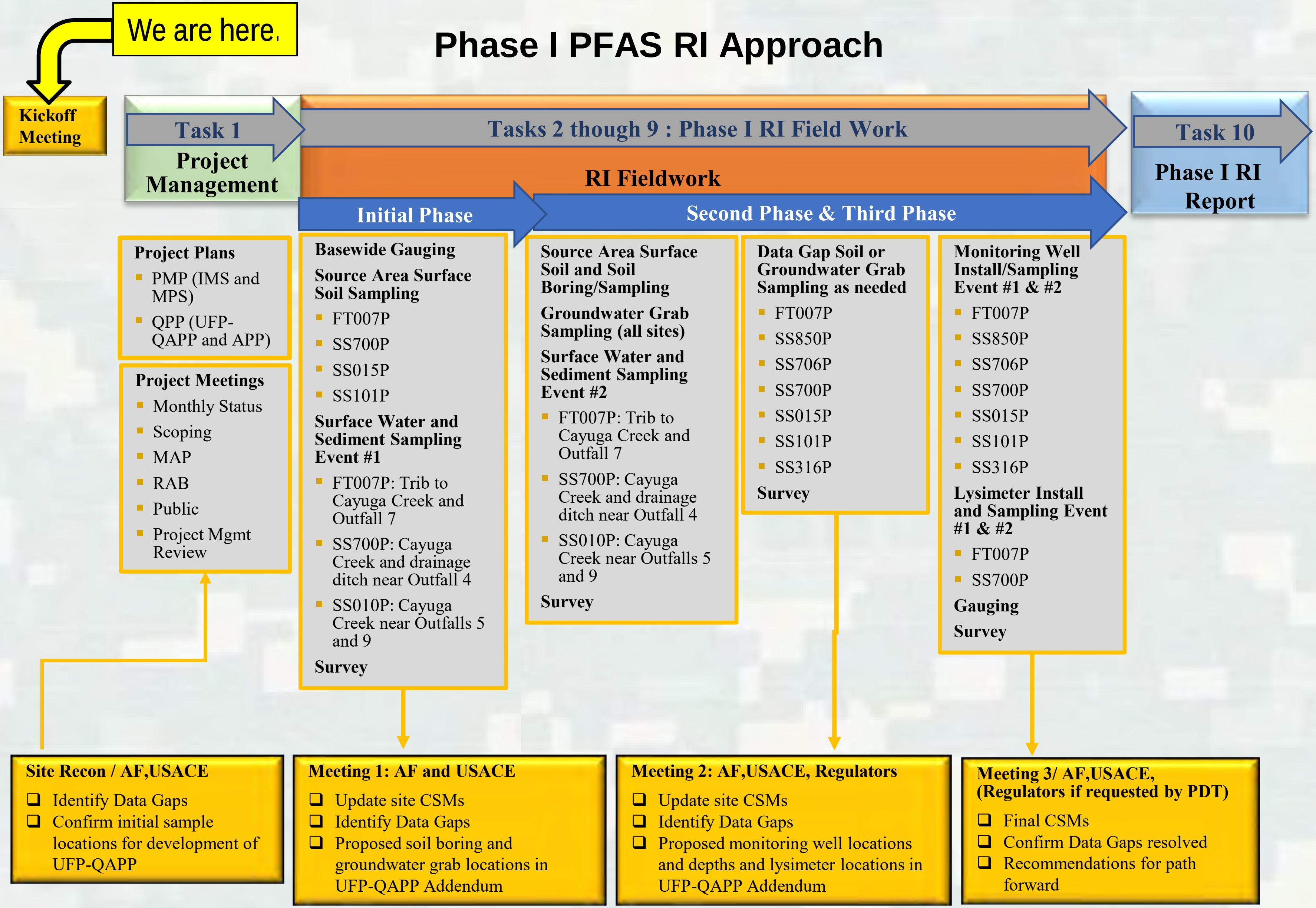
EA Engineering, Science, and Technology, Inc., PBC

Phase I PFAS RI Approach



We are here.

Kickoff Meeting

Task 1
Project Management

Tasks 2 though 9 : Phase I RI Field Work

RI Fieldwork

Initial Phase

Second Phase & Third Phase

Task 10
Phase I RI Report

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- PMP (IMS and MPS)
- QPP (UFP-QAPP and APP)

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Source Area Surface Soil Sampling
- FT007P
- SS700P
- SS015P
- SS101P

Surface Water and Sediment Sampling Event #1
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Survey

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Site Recon / AF,USACE
- ☐ Identify Data Gaps
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- ☐ Update site CSMs
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- ☐ Proposed soil boring and groundwater grab locations in UFP-QAPP Addendum

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- ☐ Recommendations for path forward

Proposed Phase I RI Approach

- **Planning Documents –** UFP-QAPP is under development
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  - **Third Phase –** Monitoring Well Installation, Groundwater Sampling (2 rounds), Lysimeter Installation and Sampling (2 rounds)
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Questions?

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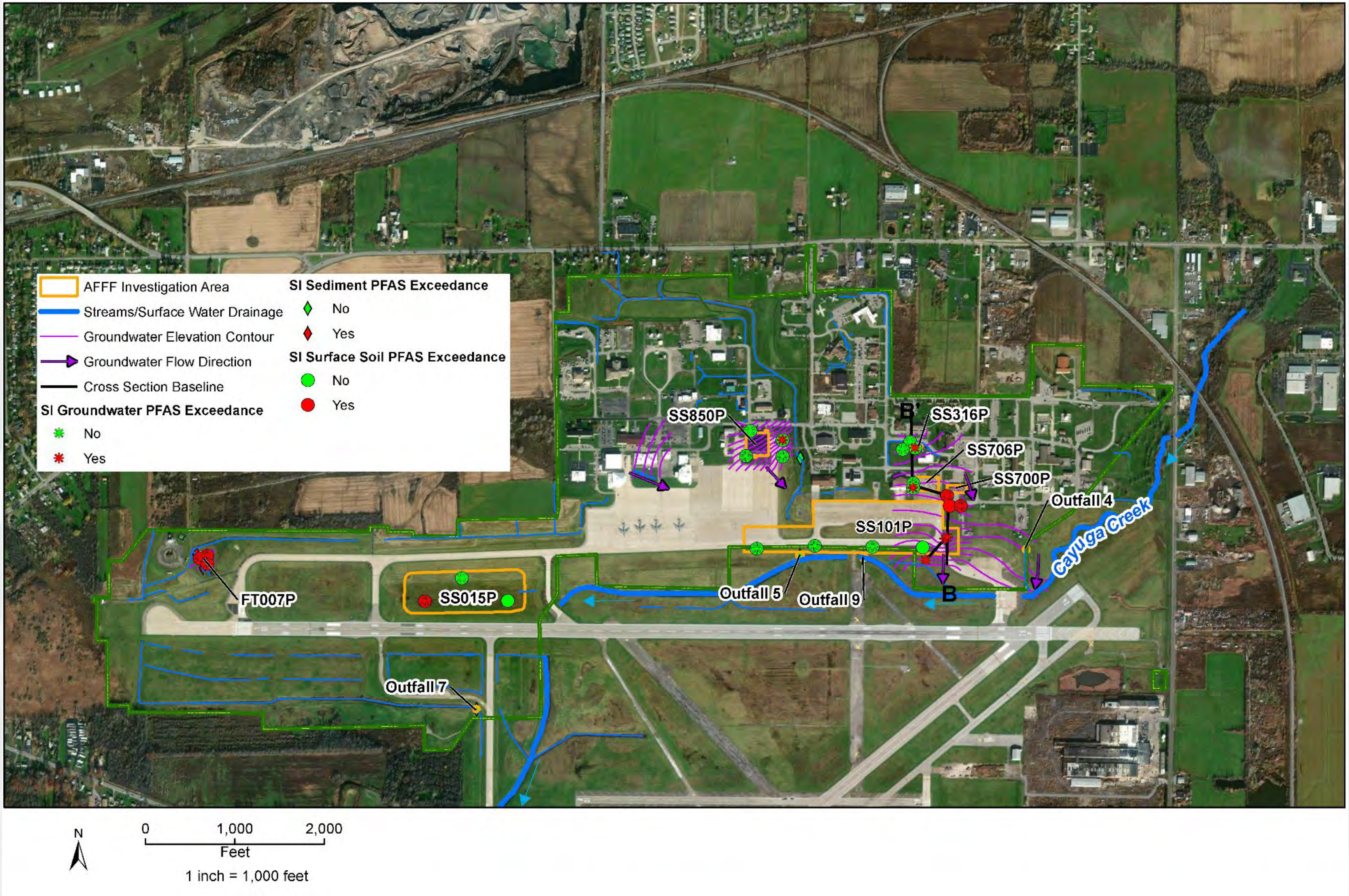

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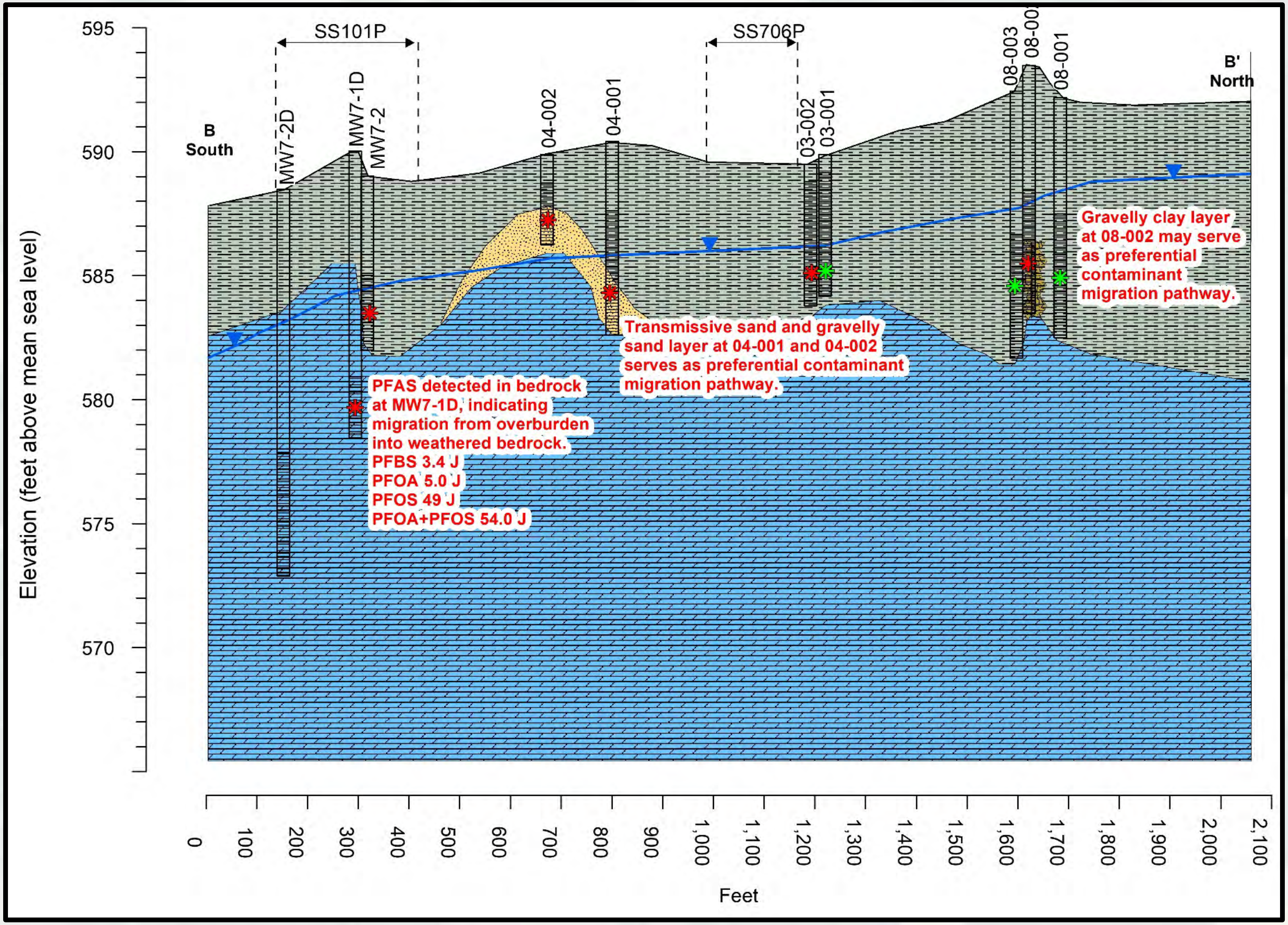

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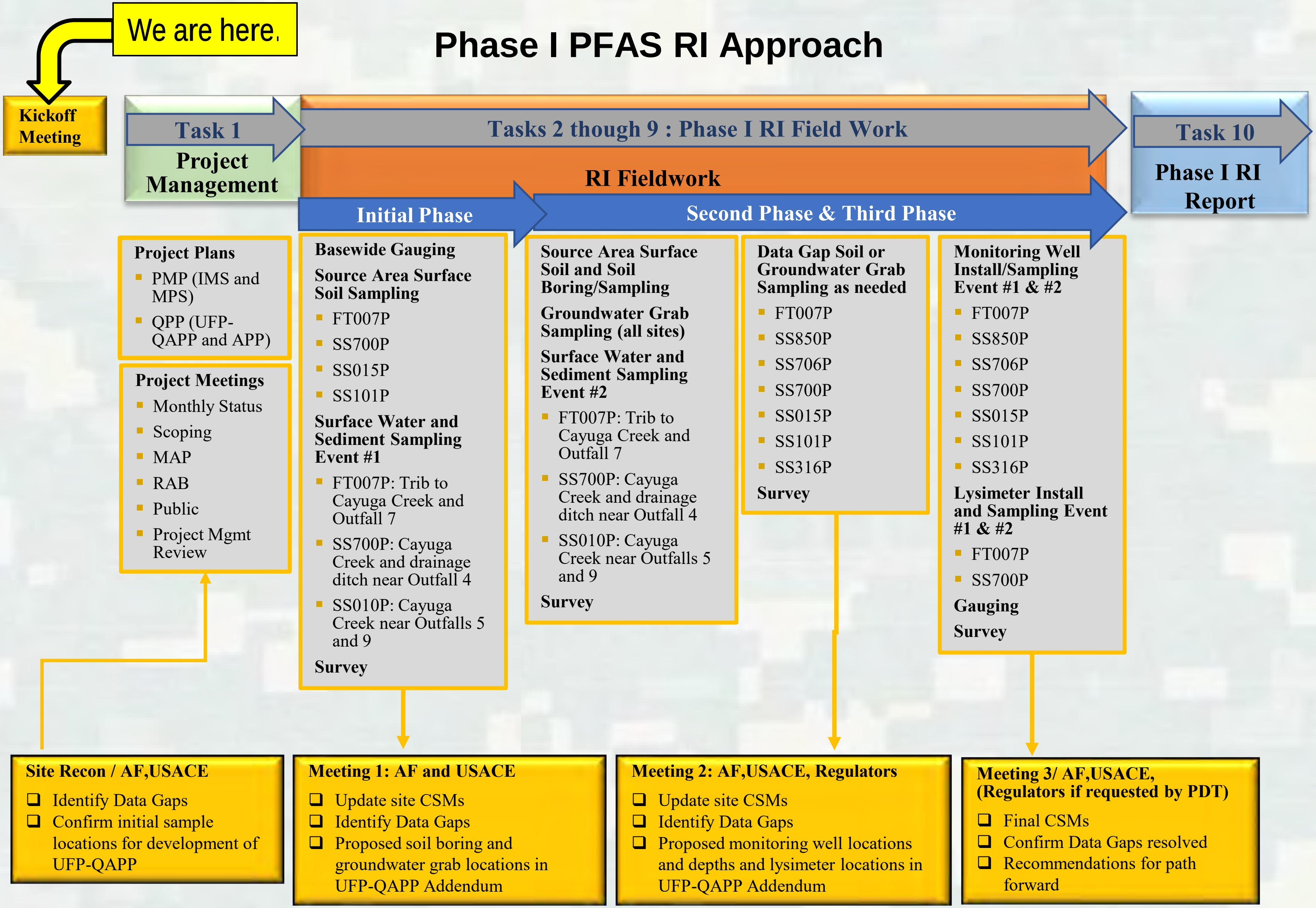

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Questions?

Appendix B

Field Standard Operating Procedures

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APPENDIX B
FIELD STANDARD OPERATING PROCEDURES (SOPs)

TABLE OF CONTENTS

Standard Operating Procedure No. 001
for
Sample Labels

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 01
November 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 001	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

Page

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	November 2018	Systematic review and update	Dan Hinckley Sheena Styger Sanita Corum	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. An example label is provided below. Other formats with similar levels of detail are acceptable. Some project software including Scribe (U.S. Environmental Protection Agency (EPA)-associated projects) and FUDSchem (U.S. Army Corps of Engineers-associated projects) can generate pre-prepared labels thus minimizing efforts in the field.

NOTE: It is important to review with the Project/Program Manager to determine if client or project-specific modifications to this SOP are required. For example, if using EPA laboratories, case numbers may be assigned in lieu of having site or project names on the label.

PROJECT NAME _____________ PROJECT NUM. ___________
SAMPLE LOCATION/SITE ID ____________________________
DATE: ____/____/____ TIME: _____:_____
ANALYTES: METALS VOC EXPLOSIVES ORGANICS OTHER
FILTERED: [NO] [YES]
PRESERVATIVE: [NONE] [HNO_3] [OTHER ______]
SAMPLER: ____________________

2. MATERIALS

The following materials may be required:

- Sample label
- Indelible marker.

3. PROCEDURE

The following sections describe how to use the sample labeling system.

3.1 LABEL INFORMATION

As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

- Project name (do not include if there is a project or client-specific requirement to exclude)
- Project Number (or Case Number, as applicable)
- Location/site identification—enter the media type (i.e., well number, surface water, soil, etc.) sampling number, and other pertinent information concerning where the sample was taken
- Date of sample collection
- Time of sample collection
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with laboratory *prior to start of work)*
- Whether filtered or unfiltered (water samples only)
- Preservatives (water samples only)
- Number of containers for the sample (e.g., 1 of 2, 2 of 2).

3.2 ROUTINE CHECK

Double-check the label information to make sure it is correct. Detach the label, remove the backing, and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

3.3 RECORD INFORMATION

Record the sample number and designated sampling point in the field logbook, along with the following sample information:

- Time of sample collection (each logbook page should be dated)
- Location of the sample
- Organic vapor meter or photoionization meter readings for the sample (when appropriate)
- Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)
- Number of containers required for each sample

- Whether the sample is a quality assurance sample (split, duplicate, matrix spike/matrix spike duplicate, or blank).

3.3.1 Logbook Entry

A typical logbook entry might look like this:

- 7:35 a.m. Sample No. MW-3. Photoionization Detector = 35 parts per million.
- Petroleum odor present. Sample designated MW-3-001.

NOTE: Duplicate samples may be given a unique sample designation rather than the actual sample number with an added prefix or suffix. This will prevent any indication to the laboratory that this is a duplicate sample thus making it “blind” to the laboratory. This fictitious sample number must be listed in the logbook along with the actual location of the sample.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

If “blind” field duplicate samples have been called for, then no indication of which samples are duplicates is to be provided to the laboratory.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 002
for
Chain-of-Custody Form

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 01
November 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 002	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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1. SCOPE AND APPLICATION

A chain-of-custody record (attached) is used as physical evidence of sample custody and as a permanent record for each sample collected. A chain-of-custody record documents the exchange and transportation of samples from the field to the laboratory. The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for use of the chain-of-custody form. Three example forms are provided as Figures SOP002-1 (EA's standard electronic chain-of-custody form), SOP002-2 (EA's Toxicology Laboratory chain-of-custody form), and SOP002-3 (U.S. Environmental Protection Agency [EPA] Scribe chain-of-custody form). Other formats with similar levels of detail are acceptable.

Most EPA projects utilize sampling and chain-of-custody instructions as documented in EPA's Samplers Guide (2014), which includes the use of Scribe, an in-house software program used to establish computer records of all environmental data and includes generation of chain-of-custodies. Using Scribe requires training, and the software and guidance can be found at the following link: https://response.epa.gov/site/site_profile.aspx?site_id=ScribeGIS. Training on Scribe is necessary and can be obtained through the Scribe weblink.

All new U.S. Army Corps of Engineers projects require the use of Formerly Used Defense Sites chemistry database (FUDSchem), which can be found at the following link: http://fudschem.com/public/framework/bannerhtml.aspx?dsn=systm&idhtml=10642&themesuffix=default&banner=banner_fudschem.jpg. This software will generate chain-of-custody forms specific to the sampling session. As with Scribe, FUDSchem training is necessary.

It is essential that chain-of-custody forms be completed properly, and that sample relinquishment be signed and dated appropriately. Laboratories use chain-of-custodies as their statement of work and, if it is not correct, the samples will not be analyzed appropriately. Sample custody documentation assures that the particular samples have been in secure locations, and that none of them have been tampered with, thus assuring appropriate results.

2. MATERIALS

The following materials may be required: chain-of-custody form and indelible ink pen.

3. PROCEDURE

- Give the site name and project name/number.
- Enter the sample identification code.
- Indicate the sampling dates for all samples.
- List the sampling times (military format) for all samples.

- Enter the total number of containers per cooler.
- List the analyses/container volume.
- Obtain the signature of sample team leader.
- State the carrier service and airbill number, analytical laboratory, and custody seal numbers (if applicable).
- Sign, date, and time the “relinquished by” section. Be sure the carrier signs and enters dates and time of acceptance of the samples.
- Upon completion of the form, retain a copy or portable document format, and affix the laboratory copy to the inside of the sample cooler in a zip-seal bag to protect from moisture, to be sent to the designated laboratory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency (EPA). 2014. Sampler’s Guide, Contract Laboratory Program Guidance for Field Samplers. EPA/540/R014/013, Directive 92400.2-147. October.

Figures

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Figure SOP002-1 EA Chain-of-Custody Form

Company Name:	Project Manager or Contact: Phone:	Parameters/Method Numbers for Analysis	Chain-of-Custody Record EA Laboratories 231 Schilling Circle Hunt Valley, MD 21031 Telephone: (410) 584-7000
Project No. Dept.: Task:	Project Name:		
Sample Storage Location:	P.O. No.:		**Report Deliverables:** **1 2 3 4 D E** **EDD: Yes/No** **DUE TO CLIENT: _________**
Page of	**Report No.:**		

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																**LPM**:
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
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Company Name:	Project Manager or Contact: Phone:	Parameters/Method Numbers for Analysis	Chain-of-Custody Record EA Laboratories 231 Schilling Circle Hunt Valley, MD 21031 Telephone: (410) 584-7000
Project No. Dept.: Task:	Project Name:		
Sample Storage Location:	P.O. No.:		**Report Deliverables:** **1 2 3 4 D E** **EDD: Yes/No** **DUE TO CLIENT: _________**
Page of	**Report No.:**		

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																

Samples by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	Airbill Number:	Sample Shipped by: (Circle) Fed Ex. Puro. UPS Hand Carried Other:

Cooler Temp. _______C pH: ___ Yes ___ No Comments: Custody Seals Intact ___ Yes ___ No

NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.

Figure SOP002-2 EA Toxicology Laboratory Chain-of-Custody Form

Client:

Project Manager:

Phone:

Project Contact:

Phone:

Project Name:

Project#:

Page 1 of 1

Sample Collected		Matrix		SAMPLE IDENTIFICATION	No. of Containers																							
Date	Time	Sediment	Water																									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time

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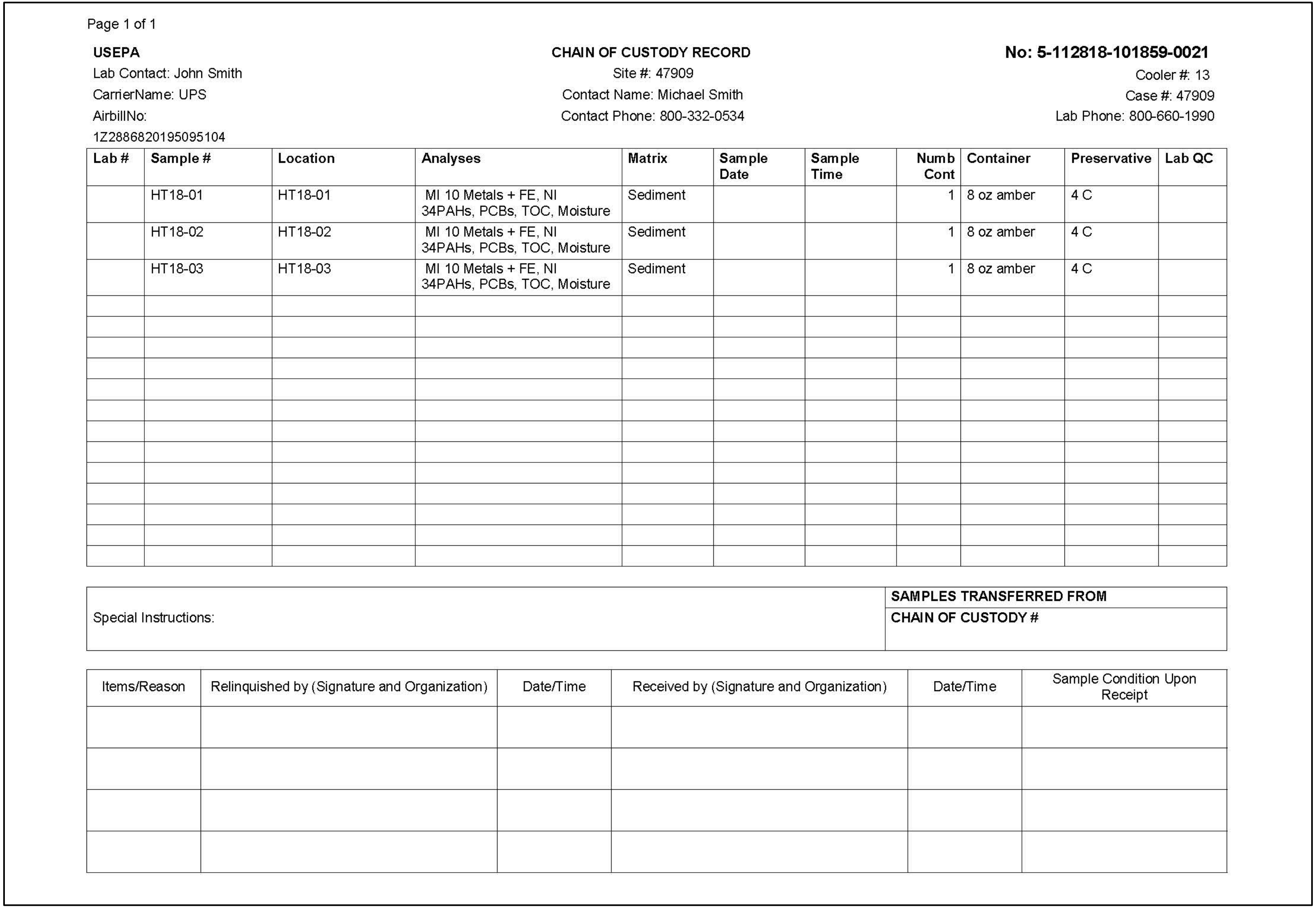
Figure SOP002-3 EPA Scribe Chain-of-Custody Form



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USEPA
Lab Contact: John Smith
CarrierName: UPS
AirbillNo:
1Z2886820195095104

CHAIN OF CUSTODY RECORD
Site #: 47909
Contact Name: Michael Smith
Contact Phone: 800-332-0534

No: 5-112818-101859-0021
Cooler #: 13
Case #: 47909
Lab Phone: 800-660-1990

Lab #	**Sample #**	**Location**	**Analyses**	**Matrix**	**Sample Date**	**Sample Time**	**Numb Cont**	**Container**	**Preservative**	**Lab QC**
	HT18-01	HT18-01	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-02	HT18-02	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-03	HT18-03	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	

Special Instructions:	**SAMPLES TRANSFERRED FROM** **CHAIN OF CUSTODY #**

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt

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Standard Operating Procedure No. 003
for
Subsurface Utility Clearance

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
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Hunt Valley, Maryland 21031

Revision: 01
July 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 003	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	June 2018	Systematic review and update	Matt Bowman	Pete Garger

1. SCOPE AND APPLICATION

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to prevent injury to workers and damage to subsurface structures (including tanks, pipe lines, water lines, gas lines, electrical service, etc.) during ground disturbance activities (including drilling, augering, sampling, use of direct-push technologies, excavation, trenching, concrete coring or removal, fence post installation, grading, or other similar subsurface operations).

1.2 LIMITATIONS

The procedures set forth in this document are general guidance, but may not be entirely applicable to particular sites based on the site-specific considerations. The Project Manager is responsible for making a site-specific evaluation of each site to determine how subsurface utility clearance procedures should be utilized or modified. If safety or other site-specific considerations require a modified or different procedure, the Project Manager should review the modified procedure with the Business Unit Director, Profit Center Manager, or Senior Technical Reviewer. Evaluation support of modified procedures may be provided by the Corporate Health and Safety Director or the Lead Construction Quality Engineer.

Special considerations may be required for utility location activities at complex or challenging project sites (underwater utilities, hazardous waste sites, etc.). Additional subsurface utility clearance procedures should be added as appropriate for difficult sites. When health and safety risks to workers or potential utility damage cannot be effectively managed through utility location, clearance, and protection measures, the Project Manager must consider the modification of ground disturbance activities (e.g., establishing a safe offset from high risk utilities). In these cases, detailed coordination with the client and/or regulatory staff is likely required.

1.3 SCOPE

This SOP provides minimum guidance for subsurface utility clearance activities, which must be followed prior to and during ground disturbance activities at EA project sites. Even after completing the subsurface utility clearance activities required in this SOP, all ground disturbance activities should proceed with due caution.

Deviations from this SOP may be provided on an exception basis for specific situations, such as underground storage tank systems removals, verified aboveground/overhead services/lines, undeveloped land/idle facilities, shallow groundwater conditions, soil stability, or well construction quality assurance/quality control concerns, etc.

EA or its subcontractors are responsible for, and shall ensure that, all ground disturbance activities are completed safely, without incident, and in accordance with applicable federal, state, and local regulations.

This SOP shall not override any site-specific or consultant/contractor procedures that are more stringent or provide a greater degree of safety or protection of health or the environment.

2. PROCEDURES

The EA Project Manager or his/her designee must complete the Subsurface Utility Clearance Checklist (Attachment A) in conjunction with the following procedures. The checklist must be completed before initiating any ground disturbance activities. The completed checklist must be submitted to the appropriate team individuals, subcontractors, and/or the client and included in the project files.

2.1 SAFETY

A Health and Safety Plan must be available onsite and followed by all contractors and subcontractors.

Work areas should be defined and secured with safety cones, safety tape, construction fence, other barriers, or signs as appropriate.

Site work permits must be obtained as required by site procedures. Based on site conditions or classification, the use of intrinsically-safe equipment may be required.

To ensure the safety of all onsite personnel and subsurface structure integrity, consideration should be given to de-energizing and locking out selected site utilities or temporarily shutting down a portion of or the entire facility.

2.2 SUBSURFACE UTILITY LOCATION ACTIVITIES

To gather all relevant information about potential subsurface structures prior to ground disturbance activities, the project team should pursue multiple lines of evidence on the type, location, depth, size, material of construction, and status (active/abandoned) of all utilities within and near the area planned for ground disturbance activities. A minimum of three lines of evidence should be obtained and documented; however, additional lines of evidences should be secured when possible. Lines of evidence may include the following:

- Historical Site Information
- Public Utility Mark-Out (One Call – 811)
- Private Utility Mark-Out
- Site Inspection
- Client/Facility Interviews and Coordination.

2.2.1 Historical Site Information

The most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) should be obtained, as available.

NOTE: As-built drawings may not accurately depict the locations and depths of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

EA should obtain any other site information such as easements, right-of-ways, historical plot plans, fire insurance plans, tank (dip) charts, previous site investigations, soil surveys, boring logs, and aerial photographs, etc. as relevant to the planned ground disturbance activities. Where applicable, EA should also contact contract personnel who may have historical site knowledge.

2.2.2 Public and Private Utility Mark-Outs

EA must ensure that a thorough mark-out at the site is completed to locate electrical, gas, telephone, water, sewer, low voltage electric lines, product delivery pipelines, fiber optic, and all other subsurface utilities/services.

- Where available, public utility companies must be contacted to identify subsurface utilities. (This can be accomplished through the One-Call system in most instances.) Attachment B provides a brochure for the 811 Utility Locate Call Center.

- In addition, where available and warranted by site conditions, a private utility/pipeline mark-out company should be contracted to perform an electronic subsurface survey to identify the presence of suspected hazardous or critical subsurface utilities and structures. In some cases, this is necessary to confirm public utility mark-outs in the vicinity of planned ground disturbance activities.

EA will review all available site plan subsurface information with the private mark-out company to assist in locating utilities and other subsurface structures.

NOTE: Mark-outs may not accurately depict the exact locations of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

Where possible, EA personnel are encouraged to be onsite at the time of subsurface mark-outs. This is to ensure accuracy and understanding of subsurface utility structures identified and provides an opportunity to exchange information with mark-out company personnel regarding planned work activities.

Subsurface utility structures should be marked throughout the entire work area(s) with adequate materials (e.g., site conditions may require paint and tape/flags). Ground disturbance activities must be started within 30 days of mark-out, unless local ordinances specify a shorter time period.

If activities are not started within required time period or markings have faded, mark-outs must be redone.

EA personnel will record time and date of mark-out request and list all companies contacted by the service and confirmation number. This information should be available for review onsite and checked off after visual confirmation of markings.

2.2.3 Site Inspection

To compare the site plan to actual conditions based on information gathered in other lines of evidence, a site inspection should be performed to identify potential signs of subsurface utilities. These signs may include:

- Signage identifying subsurface utilities
- Asphalt patching or paving scars
- Pull boxes, junction boxes, valve box covers, or manhole covers
- Sewer drains and clean-out traps
- Meters and light poles
- Piping or conduit on the walls or roofs of buildings
- Linear ground depressions
- Markings from previous utility mark-out efforts
- Other utilities including fire hydrants, on/below grade electrical transformers, splice cages, sprinkler systems, steam lines (including insulated tanks that may indicate steam lines), and cathodic protection on lines/tanks.

EA will document all findings and update the site plan with this information. In some regions, it may be more effective and efficient to conduct the site inspection at the same time the contractor performing the ground disturbance activity is mobilized to the site. The site inspection may include others as determined by the consultant/contractor and the Project Manager.

2.2.4 Client/Facility Interviews and Coordination

Knowledgeable client and facility staff familiar with site utilities should be interviewed to obtain information and documentation on potential subsurface utility locations, depth, etc. Results of these interviews should be documented and included with the Subsurface Utility Clearance Checklist. On third party sites, close coordination with the site owner’s representatives for mark-outs, review of as-builts, and other information reviews should be conducted prior to any ground disturbance work. Project Managers are encouraged to provide updated as-built information to the client.

EA will review the selected ground disturbance locations with the client. EA will not proceed with the subsurface activities until the plan has been discussed with the client. During execution of the project, if subsurface activities are required outside of the area previously approved by the client, EA will submit these changes to the client for approval prior to execution.

2.2.5 Ground Disturbance Activity Sequence

When practical, EA will plan ground disturbance activities starting at the point farthest from the location of suspected underground improvements. This is done to determine the natural subsurface conditions and to allow EA site personnel to recognize fill conditions.

Experience has shown that the following warning signs may indicate the presence of a subsurface structure:

- Warning tape (typically indicative of underground services).
- Pea gravel/sand/non-indigenous material (typically indicative of tanks or lines).
- Red concrete (typically indicative of electrical duct banks).
- The abrupt absence of soil recovery in a hand auger. This could indicate pea gravel or sand that has spilled out of the auger. This may not be indicative in areas where native soil conditions typically result in poor hand auger recoveries.
- Any unexpected departure from the native soil or backfill conditions as established by prior onsite digging.

If any of these conditions is encountered by EA site personnel, digging should stop and the client should be contacted.

3. UTILITY PROTECTION MEASURES DURING GROUND DISTURBANCE ACTIVITIES

After mobilization, but prior to the primary ground disturbance activities, the physical location of subsurface utilities should be cleared and verified whenever possible and practical. The clearance method used to clear and verify the subsurface utilities should be compatible with the inherent associated risk given the type of facility/property, subsurface utility material of construction, utility depth, soil stratigraphy, and the location of the ground disturbance activity, such that required delineation is obtained. It should be noted that in areas where there is paving, sufficient paving should be removed to allow clear visibility of the subsurface conditions during clearance activities. The following is a list of potential clearance methods that may be used on a job site:

- Vacuum digging
- Probing
- Hand digging
- Hand augering
- Post-hole digging.

EA personnel will evaluate the potential for electrical shock or fire/explosion for each subsurface disturbance project and will evaluate as necessary the use of non-conductive or non-sparking tools (i.e., fiberglass hand shovels, and thick electrically insulating rubber grips on hand augers or probes). The potential need for the use of non-conductive materials, electrical safety insulated gloves, and footwear will also be evaluated on a case-by-case basis.

For drilling, direct-push technology, fence post installation, or other borehole installation, the area to be delineated will exceed the diameter of the largest tool to be advanced and sufficiently allow for visual inspection of any obstructions encountered.

3.1 SUBSURFACE CLEARANCE PROCEDURES FOR TRENCHING/ EXCAVATION ACTIVITIES

For trenching and excavation activities, appropriate subsurface clearance methods should be conducted along the length and width of the excavation at a frequency sufficient to ensure adequate precautions have been applied to the entire work area. The frequency and density of investigations will be based on site knowledge, potential hazards, and risks of the work area to surrounding locations.

Whenever subsurface structures are exposed, EA will cease work and mark the area (e.g., flags, stakes, cross bracing) to ensure the integrity of these exposed structures is maintained during subsequent trenching/excavation/backfilling.

During ground disturbance activities, EA and its subcontractors should consider the use of spotters to monitor the excavation for signs of subsurface utilities (pipes, conduits, cables, bedding material, warning tape, tracing wire, soil material changes, etc.) to provide early warning in the event unknown subsurface utilities are encountered. The decision to use spotters should be based on the risk of encountering unknown subsurface utilities, utility hazards associated potential unknown utilities that could be encountered (electrical, natural gas, etc.), and the physical and environmental hazards to have a spotter in proximity to the excavation. Spotters, if used, should be briefed on the potential physical and utility hazards that may be present at the site and the signs of subsurface utilities that they should be monitoring for during ground disturbance activities.

Uniform color codes for marking of underground facilities are provided in Attachment C.

Attachment A

Subsurface Utility Clearance Checklist

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SUBSURFACE UTILITY CLEARANCE CHECKLIST

Site Identification: ____________________

Project Consultant/Contractor: ____________________

Section 1: Safety, Preparation Tasks, and Mark-Outs

Activity	Yes	No	N/A	Comments including Justification if Response Is No or Not Applicable
Health and Safety Plan is available and all contractors and subcontractors are familiar with it.				
All applicable local, state, and federal permits have been obtained.				
Site access/permission has been secured.				
Most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) obtained.				
Reviewed site information to identify subsurface structures relevant to planned site activities (easements, rights-of-way, historical plot plans, fire insurance plans, tank dip charts, previous site investigations, soil surveys, boring logs, aerial photographs, etc.).				
Utility mark-outs have been performed by public utility company(s). Mark-outs clear/visible.				
Subsurface structure mark-outs performed by private mark-out company. Mark-outs clear/visible.				
Additional Activities: Were dig locations reviewed with site representative?				

Section 2: Initial Site Visit and Selecting Ground Disturbance Locations

Activity	Yes	No	N/A	Comments, including Justification if Response Is No or Not Applicable
Location of all aboveground indicators of subsurface utilities/services that may be leading to or from buildings within the planned work area has been identified.				
Location of utility mark-outs by all utility companies previously contacted has been identified within required time period.				
Location of all subsurface structure mark-outs by private mark-out company has been identified within required time period.				
Location of area lights/signs and associated subsurface lines identified.				
Location of all phones and associated subsurface lines identified.				
Location of all drains and associated interconnecting lines identified.				
Location of all electrical junction boxes and associated interconnecting lines identified				
Location of all natural gas meters or connections and all interconnecting lines identified				

Completed by: ____________________
Name

Signature: ____________________ ____________
Company Date

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Attachment B

811 Utility Locate Brochure

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ALWAYS CALL BEFORE YOU DIG

One free, easy call gets your utility lines marked AND helps protect you from injury and expense.

Know what's below. Always call 811 before you dig.
Visit call811.com for more information.

811®
Know what's **below.**
Call before you dig.

INSERT
CALL CENTER
LOGO HERE

U.S. Department
of Transportation

Building Your Quality of Life

JOHN DEERE

TRAVELERS

Common Ground Alliance

811®
Know what's **below.**
Call before you dig.

Q: WHAT IS 811?

A: 811 is a new federally-mandated N-11 number designated by the FCC to consolidate all local "Call Before You Dig" numbers and help save lives by minimizing damages to underground utilities. One easy phone call to 811 quickly and easily begins the process of getting underground utility lines marked. Local One Call Center personnel will then notify affected utility companies, who will continue to mark underground lines for free.

Q: WHY SHOULD I CALL 811 BEFORE EVERY DIG?

A: Calling 811 will help save lives and protect infrastructure. Knowing where underground utility lines are buried before each digging project begins helps protect you from injury, expense and penalties. The depth of utility lines varies and there may be multiple utility lines in the same area. Even simple digging projects can damage utility lines and can disrupt vital services to an entire neighborhood, harm diggers, and potentially result in expensive fines and repair costs. Marked lines show diggers the approximate location of underground lines and help prevent undesired consequences.

Q: I'M JUST A HOMEOWNER, NOT A CONTRACTOR—IS 811 FOR ME?

A: Calling 811 is for professional excavators and do-it-yourself homeowners. A recent national survey revealed that roughly half of Americans are "active diggers" who have done (or are planning to do) some type of digging project at home. Whether you are a professional excavator or an avid do-it-yourselfer, you need to call 811 before every dig every time.

Q: WHO IS PROMOTING AWARENESS OF 811?

A: The national 811 campaign is a project of The Common Ground Alliance (CGA), working with its 1,400 individual members, member organizations, sponsors and 811 campaign national launch partners. CGA is a member-driven association dedicated to ensuring public safety, environmental protection, and the integrity of services by promoting effective damage prevention practices. In recent years, the association has established itself as the leading organization in an effort to reduce damages to all underground facilities in North America through shared responsibility among all stakeholders.

Attachment C

Uniform Color Codes for Marking of Underground Facilities

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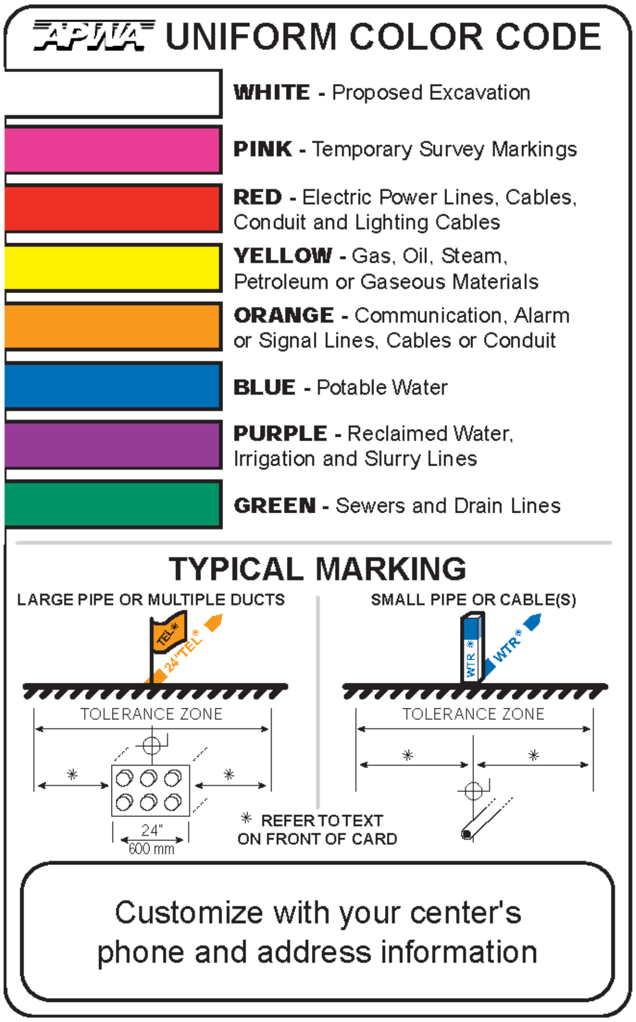


APWA UNIFORM COLOR CODE

WHITE - Proposed Excavation

PINK - Temporary Survey Markings

RED - Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials

ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

BLUE - Potable Water

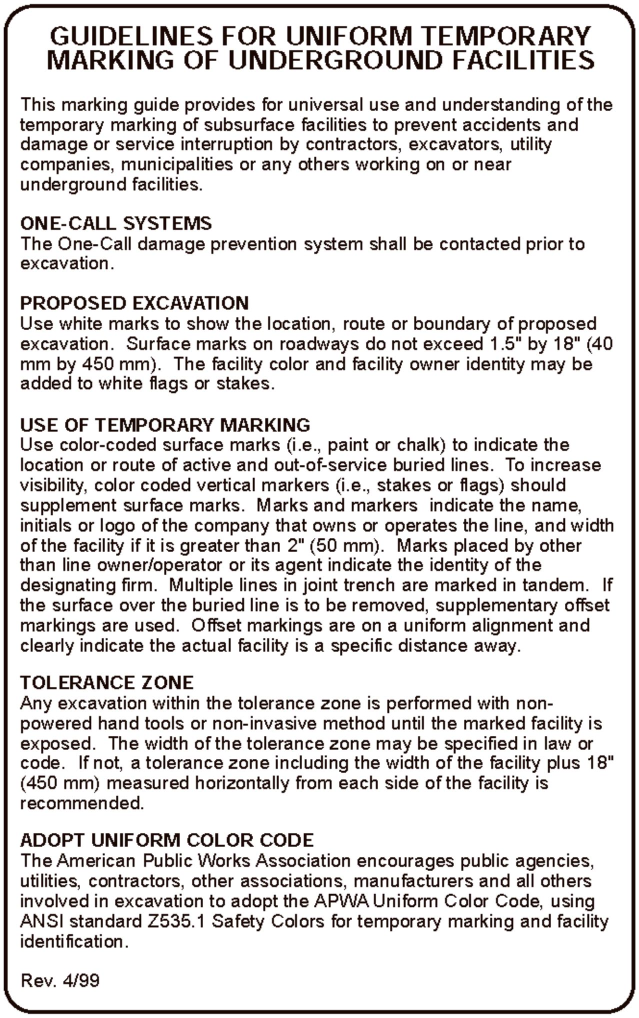
PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING

* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information



GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS
The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION
Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING
Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE
Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE
The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

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Standard Operating Procedure No. 004
for
Sample Packing and Shipping

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 01
September 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 004	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	September 2018	Systematic update and review	Cristina Radu Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of environmental samples to the laboratory for analysis. Additional requirements are applicable when shipping samples under the U.S. Environmental Protection Agency's Superfund Contract Laboratory Program.

NOTE: Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated could require shipment as dangerous goods; procedures for shipping of such samples are not covered in this SOP.

2. MATERIALS

The following materials may be required:

- Clear tape
- Custody seals
- Ice
- Packing material
- Plastic garbage bags
- Sample documentation
- Waterproof coolers (hard plastic)
- Zip-seal plastic bags.

3. PROCEDURE

Refer to SOP Numbers (Nos.) 001, 002, 016, and 039 as applicable.

Samples will be placed in clean, bubble-wrap lined sample coolers with double-bagged ice immediately after collection to ensure proper preservation. Most sample analyses require that the sample material is maintained at 2-6 degrees Celsius (°C). It is also important to ensure that sample containers are maintained at all times at the temperature required by the analytical method used to analyze the sample media; as such, samples should be retained in a chilled cooler during the inventory, quality control, and packaging process.

Check cap tightness and wipe down outside of each sample container. Verify that information on sample labels is correct and matches chain-of-custody forms. Ensure that both waterproof labels and indelible ink are used to label sample containers. Clear tape should be placed completely over the label. Wrap breakable sample containers in bubble wrap. Enclose each sample in a clear zip-seal plastic bag.

Prepare cooler for shipping. Empty any water that has accumulated in coolers from melting ice. Securely seal all valves and/or drain holes in the shipping container, both inside and out, with duct tape to prevent leakage in the event of sample container breakage or melting ice.
Place several layers of bubble wrap on top of absorbent material and line the cooler sidewalls with bubble wrap. Line cooler with open garbage bag.

Prepare sample containers for shipping as follows:

- ***Glass Containers***—Wrap each glass sample container in bubble wrap or closed cell foam sheets. It is acceptable to package up to three 40-milliliter vials in one bubble wrap bag that is usually provided by the analytical laboratory. Enclose sample containers in a clear zip-seal plastic bag.

- ***Polyethylene Containers***—Place sample containers in clear zip-seal bags.

- ***Zip-Seal Bags***—Double-bag the samples to ensure that moisture will not reach the label.

Place all the sample containers upright inside garbage bag. Do not stack glass containers or lay them on their sides. Add additional bubble wrap between and around sample containers as needed to ensure containers do not shift during transport. If a second garbage bag was used, tie the (inner) garbage bag to isolate samples.

Double bag and seal loose, fresh ice to prevent melting ice from soaking the packing material. Fill gallon-size or larger zip-seal bags with fresh ice about two-thirds full and squeeze excess air out of the bags before sealing. Turn bag upside down and place in a second zip-seal bag, also removing excess air. Prepare sufficient bags to cover sample containers and ensure that the proper temperature (2-6° C) is maintained during transport.

Place ice on top of sample containers. Ensure that packing material does not insulate samples from ice. Do not use loose ice in sample coolers. Do not use bagged ice as packing material between or around sample bottles. Tie the garbage bag ensuring that the cooler lid will close securely.

Place a temperature blank into the cooler. The temperature blank consists of a plastic bottle containing either potable or deionized water. Temperature blanks are typically provided by the analytical laboratory. If temperature blanks are not provided, field staff must add a clean container filled with deionized water; ensure the cap is tight and container is labeled before placing in cooler.

If aqueous volatile organic analyte samples are being submitted, ensure a trip blank sample set is placed in each cooler containing volatile organic analyte samples. Trip blanks are used to check for contamination of volatile organic compound samples during handling, storage, and shipment from field to laboratory. The trip blanks consist of volatile organic analyte vials filled with deionized water and are typically provided by the analytical laboratory. Ensure that the trip blank samples and analyses are included on the chain-of-custody record.

Make copies of sample documentation (chain-of-custody forms or other field records) and retain in field files for record. Enclose the original field documentation forms in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

Seal coolers with signed and dated custody seals such that if the coolers were opened, the custody seals would be broken. Place clear tape over the custody seals to prevent damage to the seals.

Tape the cooler shut with packing tape over the hinges and custody seals. Tape should be wrapped around the cooler a minimum of five times. Ship all samples via overnight delivery on the same day they are collected if possible. Project-specific shipping requirements (e.g., Saturday delivery, communication with the receiving laboratory, etc.) should be discussed with the sample manager or project manager during project planning.

After samples are packaged within shipping containers, place shipping labels clearly on the outside of the container; clearly mark the number of containers in the shipment on the shipping label. Mark each cooler as “1 of 2,” “2 of 2,” etc.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

The project manager and field team leader are responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample meets or is suspected to meet the definition of “dangerous goods” per the Dangerous Goods Regulation of the International Air Transport Association, then that sample must be handled according to the instructions given for that material. Dangerous goods must be prepared for shipping only by personnel trained and certified by International Air Transport Association in dangerous goods shipment.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 005
for
Field Decontamination

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 02
September 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-*specific* variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 005	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling, or that enter a hazardous waste site, must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure (SOP) describes the normal decontamination of sampling equipment and site personnel. Specific projects and programs may have additional decontamination requirements. Refer to the planning document(s) for additional site-specific requirements.

As a good practice, sampling at a site should be conducted moving from least to most impacted locations to minimize the potential for cross-contamination. It is advisable to use disposable tools and personal protective equipment to the extent possible such that decontamination is not necessary. If disposable equipment cannot be used, all attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

1.1 MATERIALS

The following materials may be required:

0.01 normal (N) hydrochloric acid	Non-phosphate laboratory detergent (Liquinox)
0.10 N nitric acid	Plastic garbage bags
Aluminum foil or clean plastic sheeting	Plastic sheeting, buckets, etc. to collect washwater and rinsates
Approved water (deionized, potable, etc.)	Pressure sprayer, spray bottles, brushes, laboratory wipes, disposable cloth (shop towel or similar)
High performance liquid chromatography (HPLC)-grade water[a]	Reagent grade alcohol[b]

Notes:

(a) For the purpose of this SOP, HPLC-grade water is considered equivalent to “deionized ultra-filtered water,” “reagent-grade distilled water,” and “deionized organic-free water.” The end product is water that is pure with no spurious ions or organics to contaminate the sample. The method of generation is left to the individual contractor.

(b) For the purpose of this SOP, the term “reagent grade alcohol” refers to either pesticide grade isopropanol or reagent grade methanol.

1.2 PROCEDURE

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination procedures are conducted in the Contaminant Reduction Zone, which may or may not be contiguous to the Exclusion Zone. The Contaminant Reduction Zone should be located on a level, preferably paved surface, either in an area upwind of the investigation/sampling area or in an area believed to be free of surface contamination. Care must be employed when moving contaminated tools and equipment to the Contaminant Reduction Zone to prevent the spread of contamination.

Specially designated and properly built decontamination pads may be built at a centralized location to accommodate larger pieces of equipment. The pads are built such that any water produced during the decontamination process can be contained and pumped into investigative-derived waste holding containers (i.e., frac tank, 55-gallon drum, etc.) for waste profiling and disposal.

For other field equipment, the Contaminant Reduction Zone may be a mobile decontamination station set up in the vicinity of the Exclusion Zone or sampling location. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

1.2.1 Sample Bottles

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Ensure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

1.2.2 Personnel Decontamination

Review the Health and Safety Plan for the appropriate decontamination of site personnel and reusable personal protective equipment, such as protective suits used at highly contaminated sites, respirators, safety boots, safety glasses, etc. Decontamination will be conducted in a designated Contaminant Reduction Zone as per the Health and Safety Plan and the general decontamination procedures outlined further in this SOP.

1.2.3 Non-Dedicated Equipment

Reasonable attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination shall be conducted at a central decontamination station (i.e., decontamination pad) or at the sampling location.

Decontamination stations should be located on a level, preferably paved surface, either in an area upwind of the investigation area or in an area believed to be free of surface contamination. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

Used decontamination solutions will be disposed of properly according to the site-specific Health and Safety Plan or applicable planning documents.

1.2.3.1 Field Monitoring and Testing Equipment

Water quality meters and temperature, pH, conductivity, redox, and dissolved oxygen probes will be cleaned per the manufacturer's instructions. If no such specifications exist, remove gross contamination and triple rinse probe with HPLC-grade water. If downhole probes are used, wipe the wetted portion of the cable with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination and rinse with approved water.

Electronic water level indicators, weighted tapes, measuring tapes transducers, level loggers, etc. will be decontaminated after each use as follows:

- Wipe the wetted or contaminated portion of the tape or cable and the probe with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape or cable is clean.

- Wipe with a second wipe or cloth or rinse with HPLC-grade water to remove soap residue.

- Dry tape with a third cloth (or laboratory wipe) and rewind into case or on spool, or re-coil tape.

Other field monitoring or measuring equipment such as beakers and graduated cylinders used to measure flow rates; flow-through cells used for monitoring water quality parameters; piezometers used to determine water levels; packers, mechanical slug device, and downhole equipment used during aquifer (hydraulic) testing; etc. will be decontaminated by washing with a non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse.

1.2.3.2 Bladder Pumps

Non-dedicated bladder pumps with disposable bladders will be decontaminated as follows:

- Disconnect tubing from pump.

- Completely disassemble the pump, being careful to note the initial position of and retain any springs and loose ball checks.

- Discard the pump bladder.

- Clean all parts in the same manner as provided in Section 1.2.3.1.

- Install a new Teflon® bladder and reassemble pump.

- Store pump in a clean, dedicated polyvinyl chloride, polytetrafluorethylene (PTFE), or low density polyethylene (for perfluorooctanesulfonic acid/per- and polyfluoroalkyl substances sampling) storage container.

1.2.3.3 Grundfos Redi-Flow® or Similar Submersible Pumps

Non-dedicated Grundfos Redi-Flow® and similar pumps will be disassembled and decontaminated per the manufacturer's instructions on an as-needed basis (i.e., where high concentrations and an elevated risk of cross-contamination exist). Due to the challenges associated with pump decontamination, if possible, consider designating one pump for sampling in highly contaminated areas and a second pump for sampling non-impacted areas or areas with lower contaminant concentrations. In most cases, the pumps will be decontaminated following the procedures below.

The pump and support cable/electrical wires that come in contact with water will be decontaminated via pumping as detailed below. To avoid electrical shock, always disconnect power from the pump when handling the pump body during decontamination procedures.

- Disconnect sample tubing from pump.

- Decontaminate the wetted portion of the cable/electrical wires by washing with non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse. Coil cable/electrical wires on spools or clean plastic sheeting.

- Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).

- Transfer pump to rinse bucket filled with approved water. Rinse by pumping no less than nine volumes or a minimum of 5 minutes of approved water.

- Rinse pump exterior with reagent grade alcohol.

- Rinse pump exterior with HPLC-grade water.

- Rinse pump exterior with 0.10 N nitric acid solution

- Rinse pump exterior with HPLC-grade water.

- Allow pump to air dry.

- Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Prior to reusing pump, rinse exterior again with HPLC-grade water.

1.2.3.4 Other Liquid Sampling Equipment

Other sampling equipment used to collect surface water, groundwater, non-aqueous phase liquid (NAPL), or other liquid samples includes but is not limited to PTFE double-check valve bailers, dip samplers (whether bucket, long-handled, or short-handled), discrete interval stainless-steel samplers, ball check valves and foot valves, and labware (i.e., beakers, graduated cylinders, vials, and other containers that are used to hold samples for field measurements/screening and water chemistry). This equipment will be decontaminated after each use as follows:

- Discard all ropes, tubing, etc. used in sampling in a properly marked sealable container, or as directed by the Health and Safety Plan. NOTE: No tubing is to be used in conjunction with a bailer in collecting samples.

- Wash sampling equipment with non-phosphate laboratory detergent and approved water solution using appropriate brush(es), laboratory wipes, or disposable cloth (shop towel or similar) to remove gross (visible) contamination.

- Rinse with approved water.

- Rinse with reagent grade alcohol.

- Rinse with HPLC-grade water.

- Rinse with 0.10 N nitric acid solution using a spray bottle. This rinse may be eliminated if inorganic compounds such as metals are not being sampled/are not a contaminant of concern.

- Rinse with HPLC-grade water.

- Allow equipment to air dry. If sampling equipment has just been used for purging and is being decontaminated prior to sampling, do not air dry. Double rinse with HPLC-grade water and proceed to collect samples.

- Wrap equipment in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Rinse equipment with HPLC-grade water immediately prior to re-use.

1.2.3.5 Solid Materials Samplers

Solid materials samplers include soil and sediment sampling probes, augers, trowels, shovels, sludge samplers, and other sampling equipment (e.g., core tubes, grab samples, core catchers, core liners, scoops, spoons, etc.), which will be decontaminated as follows:

- Scrub the sampler to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent (steam cleaning may be substituted for detergent scrub).

- Rinse off detergent with approved water.

- Rinse sampler with reagent grade alcohol.

- Rinse sampler with HPLC-grade water.

- For non-metallic samplers only, rinse sampler with 0.10 N nitric acid solution.

- For non-metallic samplers only, rinse sampler with HPLC-grade water.

- Allow sampler to air dry.

- Wrap sampler in aluminum foil or clean plastic sheeting, or store in a new zip-seal bag (size permitting) or clean, dedicated polyvinyl chloride or PTFE storage container.

- Rinse sampler with HPLC-grade water immediately prior to re-use.

For larger sediment sampling equipment, if sediment can be collected from the interior of a sampling device and away from potentially contaminated surfaces of the sampler, a site water rinse may be sufficient between stations. A site water rinse may also be sufficient for vessel surfaces between sample locations. However, all tools and equipment coming into contact with the sample should be decontaminated in accordance with the procedures above. Washwater from decontamination activities should be collected and disposed of properly.

1.2.3.6 Other Sampling and Measurement Probes

Soil (or sediment) gas sampling probes will be decontaminated as solids sampling devices.

1.2.3.7 Drilling Rigs, Sediment Sampling Vessels, and Other Heavy Equipment

All drilling rigs, sediment sampling vessels, and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry when there is a likelihood that contamination has accumulated on tires and as spatter or dust on the way from one site to the next.

- Place contaminated equipment in an enclosure (i.e., existing wash pad, decontamination pad, etc.) designed to contain all decontamination residues (water, sludge, etc.).

- Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.

- Water used will be taken from an approved source.

- Containerize decontamination fluids in 55-gallon drums; sample; characterize; and, based on sample results, dispose of all decontamination residues properly.

Other heavy equipment includes use of backhoes, excavators, skid steers, etc. If heavy equipment is utilized during field activities (i.e., a backhoe for test pitting), the bucket should not come in contact with soil to be sampled. If the bucket contacts the soil to be sampled, then it should be decontaminated between sample locations, following the same procedures as listed above for a drill rig.

1.2.3.8 Ice Chests and Reusable Shipping Containers

Scrub exterior/interior with approved brush and Liquinox detergent. Rinse off detergent with approved water. Let air dry and properly store until re-use.

NOTE: If container/ice chest is severely contaminated, clean as thoroughly as possible, render unusable, and properly dispose of.

2. PRECAUTIONS

Segregate all waste streams as specified in the sampling documents and store investigation-derived waste properly. Dispose of all washwater, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the Health and Safety Plan or applicable planning documents.

Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

3. REFERENCES

Site-specific Health and Safety Plan and/or applicable planning documents.

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Standard Operating Procedure No. 007
for
Surface Water Sampling

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 02
March 2020

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PROJECT-SPECIFIC VARIANCE FORM

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☒ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 007	
SOP Section	**Variance**
3	**high-density polyethylene (HDPE) and/or silicone tubing (known to be PFAS free)**
	for sampling for PFAS

Frank DeSantis (Deputy)

Project Manager (Name)

17 August 2023

Project Manager (Signature)

Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
02	March 2020	Systematic Review and Update	Jason Stroup Kevin Kowalk	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for sampling surface water. This procedure can be applied to the collection of surface water samples from marine and estuarine systems, streams, rivers, ditches, lakes, ponds, and lagoons. Surface water samples provide an indication of the amount of contaminant in the surface water. It is, therefore, important to collect a representative sample.

2. MATERIALS

The following materials may be required:

0.45-micrometer (μm) disposable filters	Sample bottles
Cooler with ice	Short-handled dip sampler (PTFE or stainless steel)
Long-handled dip sampler (polytetrafluoroethelyne [PTFE] or stainless steel)	Stainless steel or PTFE-lined bucket
Peristaltic pump	Niskin bottle (or similar sampling device)
Disposable peristaltic head tubing	Disposable Teflon and/or Teflon lined poly tubing

3. PROCEDURE

For all surface water samples, use a Global Positioning System to record sampling coordinates and mark the sampling locations on a site map. Photograph (if cameras are allowed onsite) and describe each location, place a numbered stake above the visible high-water mark on the bank closest to the sampling location, and/or mark adjacent trees with surveyor’s flagging. The photographs and descriptions must be adequate to allow the sampling station to be relocated at some future date by someone other than the original sampling crew. Use a long-handled dip sampler where access is poor or non-contact with water is suggested in the Health and Safety Plan.

Sampling should be performed deliberately and methodically to minimize disturbance of bottom sediments, yet as quickly as possible to ensure a representative sample. If wading in a stream, sample upstream at the sampling location to prevent disturbance of the stream bottom from impacting the sample. To prevent contamination of the exterior of the sample container, and/or potential contamination of the surface water sample by laboratory contaminants on the exterior of the bottle, the sample container should never be dipped into the water; rather, a decontaminated sampling device should be used to collect unfiltered samples.

Sampling with the PTFE or stainless steel sampler (long-handled or measuring cup-type):

- Remove the cap from the sample bottle.
- Dip a sample of surface water using the sampler.

- Tilt sample bottle and gently pour sample from sampler into the bottle. Allow the sample to trickle down the side of the bottle. Avoid aerating the sample.

- Add preservative as required. Replace cap, and place in cooler immediately.

Sampling with stainless steel or PTFE-lined bucket:

- Remove cap from sample bottle.

- Gently dip collection bucket in the water. Fill bucket and carefully lift from water body.

- Tilt sample bottle and gently pour sample from sampler into the bottle. Allow the sample to trickle down the side of the bottle. Avoid aerating the sample.

- Add preservative as required. Replace cap, and place in cooler immediately.

– OR –

- Use smaller sampling cup to transfer sample from bucket to sample bottle as described above.

Sampling with a Niskin bottle (or similar device):

- Prepare the bottle for deployment by placing the ends of the bottle in the open position and lock the ends into the trigger mechanism.

- Lower the bottle to the desired depth of sampling (on either a wire cable or rope).

- Place a messenger (triggering device) on the cable/rope and deploy by allowing free-fall down the cable/rope.

- Bring the bottle back to the surface and pour sample into a sample container.

Sampling with a peristaltic pump and Teflon® or Teflon® lined tubing:

- Cut a length of Teflon® tubing to the depth of sampling specified by the client or project-specific Sampling and Analysis Plan.

- Insert one end of the tubing into the intake hose on the peristaltic pump.

- Place a stainless steel weight on the tubing and lower to the specified depth;

- Cut a length of tubing and insert into the output (out-flow) hose on the peristaltic pump.

- After applying power to the peristaltic pump, proceed to pump site water through the tubing apparatus. The hose volume should be pumped approximately five times through the tubing before sampling.

- Fill the required sample containers.

- If filtering is required, obtain filtered sample by placing a 0.45-µm in-line filter on the end of the output tube and fill the required sample containers.

Both filtered and unfiltered samples may be required for metals analyses. Bulk samples for filtration will be collected using the stainless steel or PTFE-lined bucket method described above. Sample filtration must be performed immediately upon retrieval of the bulk sample as follows.

Filtration will be performed immediately after collecting sample. Set up filtration equipment prior to collecting sample. Filtration may be accomplished by gravity or, if necessary due to slow filtering, a peristaltic pump will be used to pressure filter the sample. Vacuum filtration will not be used due to the possibility of analyte volatilization.

Gravity filtration will be accomplished as follows:

- Using decontaminated forceps, place a 0.45-µm membrane in a decontaminated filter funnel.

- Slowly pour sample into the funnel and collect filtrate directly into appropriate sample container(s).

- Add preservative(s) as required by project-specific Sampling and Analysis Plan. Immediately cap container and place in cooler.

- Dispose of filter membrane.

Pressure filtration will be accomplished as follows:

- Using previously assembled disposable tubing, 45-µm in-line filter, and peristaltic pump, filter sample from collection bucket into appropriate container.

- Adjust pump rate to avoid aeration of sample.

- Fill container, add preservative as required immediately cap container, and place in cooler.

- Dispose of filter and tubing.

4. MAINTENANCE

Refer to manufacturer's specifications for maintenance procedures on generators and pumps.

5. PRECAUTIONS

The following precautions should be taken:

- Avoid disturbing bottom sediments.
- Consult the Health and Safety Plan prior to collecting any samples for personal protective equipment such as dermal and respiratory protection and personal flotation devices when sampling in or near deep water or from boats.
- Always decontaminate the sampling and filtration equipment, and change gloves between sampling locations to minimize the risk of cross-contamination.

6. REFERENCES

None.

Standard Operating Procedure No. 008
for
Trimble Geo 7X Global Positioning System Units

Prepared by

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Revision: 00
September 2021

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☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 008	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
00	September 2021	Updates for SOP finalization	Mark Dhruv	Frank Barranco Jason Samus Beth Shrayshuen

1. INTRODUCTION

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide EA personnel responsible for Trimble Geo 7X data collection activities the guidance necessary to maintain company-wide uniformity of the setup of the Geo 7X, data collection, naming conventions, quality control (QC) procedures, and deliverables.

1.2 RESPONSIBILITY

EA personnel assigned geographic information system (GIS) tasks will be responsible for adhering to the standards included in this SOP and for ensuring that all Global Positioning System (GPS) data collection efforts meet contract-specific requirements and specifications. In accordance with EA's QC procedures and Senior Technical Review policy, GPS data deliverables should be reviewed by the appropriate Senior Technical Reviewer.

2. EQUIPMENT

During data collection, the Geo 7X will be used to collect positional data and Trimble Pathfinder Office software will be used to transfer and correct the data. This will require that Windows Mobile Device Center is installed on your computer.

2.1 HARDWARE

2.1.1 Geo 7X Handheld

The Geo 7X is a handheld, highly accurate sub-foot Global Navigation Satellite System (GNSS) collector. Using a Real-Time Kinematic connection, the data can be corrected in real-time or the data can be post-processed using differential correction to correct the data to sub-meter accuracy.

Before data collection, be sure that the following equipment is included in the case:

- Two charged batteries
- Chargers
- Data transfer cord
- Micro secure digital card.

2.2 SOFTWARE

2.2.1 Trimble Pathfinder Office

The Trimble GPS Pathfinder Office software is a powerful software package of GNSS post-processing tools incorporating differential correction technology, designed to develop GIS information that is consistent, reliable, and accurate from GNSS data collected in the field.

3. GEO 7X SETUP

Depending on your intended usage, contact EA's GIS personnel if existing features need to be loaded onto the unit. If new features are to be collected, be sure that the proper coordinate system is selected on the unit.

3.1 COORDINATE SYSTEM

Choose Setup from the dropdown menu to apply the coordinate system for which you will be collecting or viewing data. Be sure to select an appropriate coordinate system and units of measure that meet project specifications.

4. DATA TRANSFER

Before field efforts begin, data can be transferred from GIS Shapefiles to the unit. GIS personnel are responsible for formatting the shapefiles, setting the appropriate coordinate system for the data, and preparing aerial imagery for the background image on the unit.

After field efforts, GIS personnel should transfer the data as soon as possible from the unit to their computer for post-processing.

5. DATA COLLECTION

Before data collection begins, the equipment will need to be geospatially verified at a known National Geodetic Survey monument and the GPS status should be verified that the location falls in range of the benchmark. Geospatial data can be collected as either a new feature point, line, or polygon or added to an existing file. Positional accuracies may be affected by trees, canopy cover, buildings, and time of day. Military and Government installations, in particular, are known to regulate the accuracy of GPS data collection. Therefore, contracts from these types of facilities may contain GPS accuracy requirements.

5.1 VERIFY EQUIPMENT ACCURACY

Go to the National Geodetic Data Explorer to find known reference monuments near project location. Open the Datasheet for the reference monuments to ensure they still exist and have been recently verified for their accuracy. Choose the best Horizonal and Vertical control points in the project area. Save the coordinates for your best control point options. Include backup options in case you need them. Check in at a known National Geodetic Survey GS GPS benchmark before data collection begins and at the end of data collection. Compare the coordinates of the observed points with the known control point’s datasheet coordinates. Current location, positional accuracies and a sky plot of the satellites can be viewed under the status dropdown.

5.2 NEW FILE

If data are being collected as a new file, name the file with the EA Project Number, Site Name, and current date (MMDDYYYY). Select the appropriate feature for the data being collected. For point features, collect at least 30 positions per point for maximum accuracy.

5.3 EXISTING FILE

Data can also be collected from an existing file. Select the appropriate feature for the data being collected and, for point features, collect at least 30 positions per point for maximum accuracy. For an existing file, it is a best practice if the data collection period does not span more than 3 days.

6. DATA POST-PROCESSING

Once the data have been collected and transferred off the unit, the data can be post-processed to increase its accuracy. Note that you must allow at least 24 hours between data collection and post-processing for the continuously operating reference stations to update their data.

6.1 DIFFERENTIAL CORRECTION OF THE TRIMBLE FIELD DATA

Differential correction techniques are used to enhance the quality of location data gathered using GPS receivers. Select the Provider with the closest distance that has an integrity index value. The closer to 100, the better. After processing, a text file correction report will be created. Review this report for the corrected positional accuracy. If the positional accuracies are falling outside of project specified ranges, review that the data were properly collected and processed.

7. EXPORTING DATA

Once the data have been differential corrected, they can be exported to a shapefile for use in GIS. GIS personnel will export the data in the proper coordinate system and include attributes for the following:

- Position Dilution of Precision
- Horizontal Dilution of Precision
- Correction Status
- Date/Time Recorded
- Feature/Data File Name
- Total/Filtered Positions
- GPS Week/Second.

8. VERIFICATION OF DATA ACCURACY

In GIS, define the projection of the data to be in the same coordinate system it was exported from. Create a map that shows the spatial layout of the data with an aerial background. Verify collected features are in their proper locations.

Standard Operating Procedure No. 010
for
Water Level and Well Depth Measurements

Prepared by

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Revision: 02
March 2021

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 010	
SOP Section	Variance

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	September 2018	Systematic update and review	Cristina Radu Amanda Kohn	Matthew Bowman
02	March 2021	Added "Relative Elevation Survey" section	AnnMarie Ricchino	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to present the protocols for measuring depth to groundwater, presence and thickness of non-aqueous phase liquid (NAPL), and well depth in groundwater wells. This procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities that may disturb the water level (i.e., purging or aquifer testing).

2. MATERIALS

The following materials may be required:

- Electronic sounding device with calibrated cable or tape measured at 0.01-foot increments (i.e., water level meter or oil/water interface probe) OR transducer and datalogger
- Plastic sheeting
- Photoionization detector or intrinsically safe flame ionization detector
- Materials required for decontamination per SOP Number (No.) 005
- A leveling rod and an auto level equipped with a telescope tube and tripod if conducting a relative elevation survey
- Well construction diagrams, well records, and/or survey information
- Field forms (i.e., well gauging forms, well assessment forms, purge logs) and/or field logbook.

3. PROCEDURE

3.1 PRELIMINARY STEPS

Compile well construction data/forms, survey information, and historical data, if available, prior to field mobilization. The type and length of electronic sounding device to be used will be based on the monitoring well diameter, well installation depth, and the presence/absence of NAPL. Oil/water interface probes will be used in all wells for the first round of sampling, regardless of site history.

When planning on measuring depth to water at a site where product may be present in wells, the wells should be segregated between potentially contaminated and not contaminated categories.

The sequence of well gauging should be established to minimize the potential of cross contamination by generally gauging clean wells first.

Ensure that the electronic sounding device is working prior to mobilization by submerging the probe in a container of potable or deionized water. Keep the indicator probe in its protective case when not in use. Locate the well and verify its position on the site map. Record on the applicable field form(s) or in the field logbook whether positive identification was obtained, including the well number/identification and any identifying marks, codes, or tags contained on the well casing or protective casing.

3.2 RELATIVE ELEVATION SURVEY

A relative elevation survey of groundwater monitoring wells is essential to produce accurate groundwater elevation measurements. This task requires a minimum of two people and necessitates the use of an auto level equipped with a telescope tube and tripod (referred to as the instrument) as well as a leveling rod. The telescope tube is designed to impose a set of cross hairs on the image viewed through the telescope, which will intersect with a numbered graduated line on the leveling rod when held in its line of site.

All measurements should be taken relative to an accurately surveyed and clearly visible elevation reference point on the monitoring well. For consistency, the reference point shall be located on the north side of the inner well casing and be clearly visible with a notch or some other permanent method. The proper steps to conduct the relative elevation survey are as follows:

- The survey process is started from a benchmark (BM) of known elevation or that has been assigned an arbitrary elevation. This can be a monitoring well or other known location.

- The instrument should be set up within 300 feet of the BM to reduce the potential of reading errors.

- A check should be done to ensure the bubble is in the center of the small bullseye level located on the instrument, indicating a horizontal line of sight. (Large adjustments can be made using the legs of the tripods whereas smaller adjustments can be made using the leveling screws.)

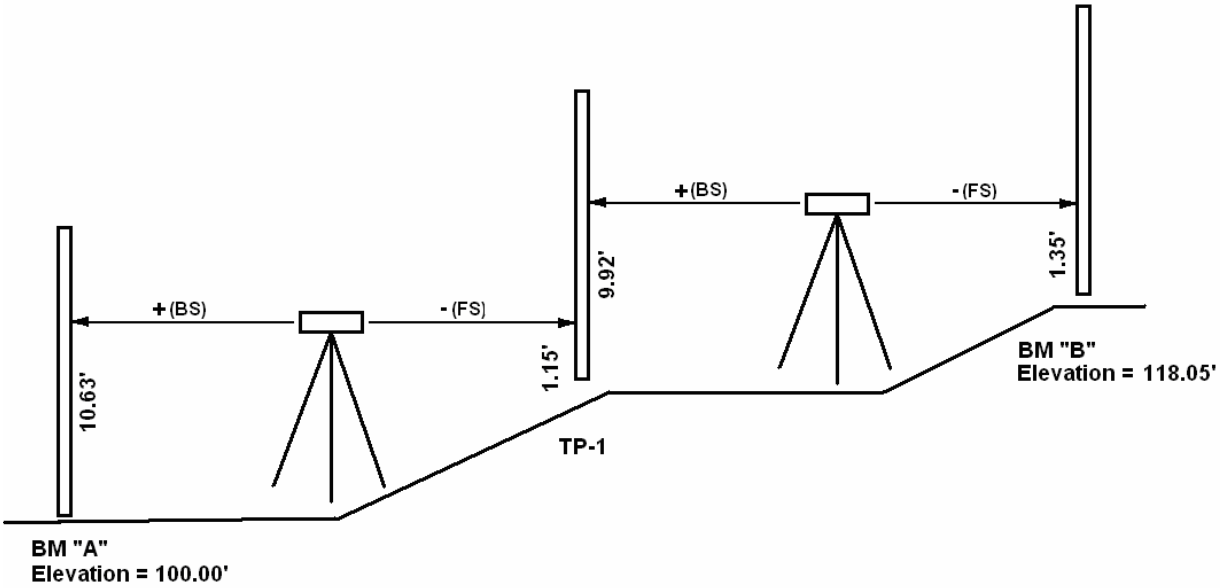
- The rod person will hold the rod vertically on the BM with the face of the rod containing the numbered graduations facing the instrument. The instrument person will look through the telescope and take note of the graduated line reading where the crosshairs intersect. This reading is the backsight (BS).

- The BS reading should be added to the known BM elevation to calculate the height of instrument (HI).

- Once the HI is known, multiple points can be determined from that setup if a rod reading is visible on the point. If the instrument person is unable to observe a rod reading on the point, establishment of a turning point (TP) is necessary.

- To establish a TP, keep the instrument in its current setup location and move the leveling rod to the chosen TP location. Take a rod reading and note it as a foresight (FS). Subtract the FS reading from the HI to determine the elevation of that TP. The instrument can then be moved ahead, and the entire process repeated with the TP as the new BM (Figure 1 provides an example diagram and accompanying notes below). Be sure to mark TP locations on a map of the site. If multiple TPs are established during surveying, number them accordingly (e.g., TP1, TP2, etc.).

- If a line of levels is run involving two or more setups, run a line of levels back to the original BM or to another BM to check for accuracy of work.



Surveying notes				
STA.	**BS (+)**	**HI**	**FS (-)**	**Elev.**
BM A	10.63	110.63		100.0
TP-1			1.15	109.48
TP-1	9.92	119.40		
BM B			1.35	118.05

Figure 1. Differential leveling instrument setup and elevation calculations including one turning point (Archuleta and Gilbert 2000).

Leveling Term	Definition
Benchmark (BM)	Monument or point with known elevation
Backsight (BS)	Rod reading taken on a point of known elevation (always add to determine elevation)
Foresight (FS)	Rod reading taken on a point to determine the elevation at that point (always subtract from HI to determine elevation)
Height of Instrument (HI)	The elevation of the level line sight projected by the instrument
Turning Point (TP)	Intermediate reference point used when it is necessary to move the instrument ahead while running a line of levels

3.3 WELL HEADSPACE SCREENING

Refer to the Health and Safety Plan or applicable planning documents to determine if well headspace screening is required. At a site where historical information is available, well headspace screening may be omitted.

Headspace screening will be conducted using an organic vapor meter (photoionization detector or flame ionization detector). All headspace screening should be performed at arm’s length and from the upwind side of the well, if possible. Refer to SOP Nos. 011, 023, or 024 as appropriate.

Screen the ambient air in the breathing area around the wellhead and record the reading on the applicable field form(s) and/or in the field logbook. Once the breathing area is deemed safe, unlock/open the well protective casing to get access to the wellhead. Re-screen the ambient air again to determine if organic vapors may have accumulated.

Screen the air in the wellhead (headspace) for gross organic vapors. This will indicate the presence of gross volatile contaminants as well as potential sampler exposure. Most well casings are covered with a cap, some are outfitted with pump assemblies, while some may not have a cap at all. If a cap is present, sample the air in the wellhead for gross organic vapors by lifting the well cap only high enough for the organic vapor meter probe to be entered into the well casing. If a pump assembly is present on top of the casing, locate the gauging port, remove the cap, and insert the probe to make the measurement. If a cap is not present, insert the probe in the well casing. Record the reading on the applicable field form(s) and/or in the field logbook.

If volatiles are detected, allow the well to vent for 60-90 seconds and re-screen and record the headspace readings. If the second reading is lower than the first, use the second reading to determine whether respiratory protection will be required during subsequent activities.

3.4 WELL ASSESSMENT

Once the breathing zone at the wellhead is deemed safe or applicable respiratory protection is donned if needed, conduct the well assessment. Record the well assessment information on applicable field forms (well assessment form) or in the field logbook.

Assess and record the condition of the well casing, well pad and bollards, well cover, and any equipment (pump assembly). Record any observations and remarks regarding the completion characteristics and well condition (i.e., evidence of cracked casing or surface seals, security of the well [locked cap], or evidence of tampering). Note if there are discrepancies between current well condition/completion and well construction diagrams/records or well survey data (i.e., damage or modifications to the well including but not limited to frost heaving, broken or otherwise damaged casing, conversion to/from flush mount or stick-up, installation or removal of polyvinyl chloride collar or other material on inner casing, installation or removal of a pump assembly, etc.).

Next, locate the measurement reference point from where water, NAPL, and well depth measurements will be performed. This reference point should be scribed, notched, or otherwise noted and the elevation included in the documentation of the well survey data. It is critical that the actual survey point is known and used consistently throughout monitoring events.

If no reference marks are present or if changes have been made to the well casing since the survey, measure depths based on the highest point of the well casing. If there is no high point, measure depths to the northern side of either the well polyvinyl chloride casing or the pump assembly cover. Permanently mark the measurement location for future survey and/or measurement purposes. Determine the new reference point elevation by measuring the distance from a known surveyed point (surveyed elevation of the protective casing or ground surface). Record this difference on the applicable field form(s) or in the field logbook for use in groundwater elevation calculations.

3.5 LIQUID LEVEL AND WELL DEPTH MEASUREMENTS

Typically, a complete round of static liquid levels and monitoring well depths is conducted as one of the first steps during groundwater monitoring. However, if monitoring wells are to be sampled for per- and polyfluoroalkyl substances, gauging should be completed after groundwater sampling to mitigate the possibility of cross-contamination.

Equipment should be decontaminated prior to first use in the field and after each use. Refer to SOP No. 005 for decontamination procedures. Keep all equipment and supplies protected from gross contamination; use clean plastic sheeting and keep the electronic sounding device probe in its protective case when not in use.

Measure NAPL and water levels and well depths as detailed in the subsections below. When measuring depths, grasp the cable with the thumb and forefingers at the top of the casing and record the depth based on the measurement reference point detailed in Section 3.3.

Gauging information including dates/times, water depths, NAPL depths and thicknesses, and well depths will be recorded on applicable field forms (i.e., well gauging form, well assessment form, purge form, etc.) and/or in the field logbook.

3.5.1 Non-Aqueous Phase Liquid Level Measurements

Always perform NAPL checks for the following conditions:

- The first time a well is sampled
- In wells installed in or near areas with suspected or confirmed NAPL contamination
- If headspace test reveals presence of volatiles.

Use an oil/water interface probe to determine the presence and thickness of NAPL. An oil/water interface probe will have a different alarm tone (continuous or intermittent) for NAPL versus water. The air/liquid interface depth measurements will be more accurate if the probe is lowered into liquid. The NAPL/water depths will be more accurate if the probe is moved from water into NAPL. Always lower and raise the interface probe slowly to prevent undue mixing of media. Complete all measurements as follows:

- Upon removing the well cap as a part of headspace screening described in Section 3.2, ensure that enough time (a couple of minutes) has passed for the air pressure in the well to have equalized with atmospheric pressure.

- Turn the interface probe on and test the alarm and liquid indication light.

- Remove the indicator probe from the protective case. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the alarm sounds and the liquid indication light comes on.

- If light non-aqueous phase liquid (LNAPL) is detected on top of the water column, record the depth of the initial level/first alarm (top of the product layer). Continue to slowly lower the probe until it passes into the water phase. Slowly retract the probe until the NAPL alarm sounds and record the product/water interface depth (base of the product layer). Calculate and record the LNAPL thickness.

- Continue to slowly lower the interface probe through the water column to check for the presence of dense non-aqueous phase liquid (DNAPL). If DNAPL is encountered, measure and record the product interface depths (top and base of the DNAPL layer[s]) and calculate and record the DNAPL thickness(es).

- Continue lowering the probe until the base of the well is encountered. Measure the depth of the well as detailed in Section 3.5.3.

- Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. While raising the probe, wipe the wetted portion of the tape with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. If there is a discrepancy in depths, clean the probe sensors and re-measure the depths.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.5.2 Water Level Measurements

If a well has been sampled previously and no NAPLs were present, or if none of the preceding NAPL check conditions are met, the NAPL check may be omitted and an electronic water level detector can be used to measure water levels.

- Upon removing the well cap, ensure that enough time (a couple of minutes) has passed for the air pressure in the well to have equalized with atmospheric pressure.

- Turn the water level meter and test the alarm and liquid indication light. Adjust the sensitivity scale as needed.

- Remove the water level indicator probe from the case, and slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the alarm sounds and the liquid indication light comes on. Very slowly, raise and lower the probe until the point is reached where the alarm just sounds. Record the depth to water.

- Slowly raise the probe and wipe the wetted portion of the tape (if any) with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.5.3 Well Depth Measurements

The depth of a well is a stable value established during well construction; changes in well depth are usually indicative of a potential problem with the well. Fluctuations in well depth may be caused by either settlement of fine-grained material (i.e., silt) at the bottom of the well or damage to the well casing or screen.

Do not attempt to measure the depth of a well when a dedicated pump is installed in the casing. The weighted tape or the electric water level indicator will likely get snagged onto the tubing and damage the pump assembly. The depth of the well should also not be measured in wells in which passive diffusion samplers have been deployed; tag the bottom of the well after the samplers have been removed and before their re-deployment for the next sampling round.

A weighted tape is the preferred tool for measuring well depths. For shallow wells, an electronic water level indicator probe may be employed. In deeper wells, a weight may be attached to the probe to aid in measuring the well depth. Well depths will be measured as follows:

- Lower the probe until it is resting on the bottom of the well. Slowly pull upward on the tape until a tug can be felt while lifting the probe off the well bottom.

- Record the depth of the well. If the tape distance markings on the electronic sounding device are not marked to the end of the probe (i.e., markings are referenced to an electrode in the middle of the probe), add the length of the probe beneath the electrode to the measured depth to obtain the true depth of the well.

- Compare the recorded depth to the installation depth in the well construction diagram/record and note any discrepancies. If discrepancies exist, re-measure the well depth. Note the presence of sediment at the base of the well (i.e., hard bottom versus soft bottom).

- Withdraw the probe and tape. While raising the probe, wipe the wetted portion of the tape with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination.

- Decontaminate the measuring tape and probe between well locations as detailed in SOP No. 005 to minimize the potential of cross contamination.

3.6 TRANSDUCERS AND DATALOGGERS

Transducers and dataloggers may be used for depth to water measurements in wells where water level fluctuations over time are to be measured, such as tidal fluctuation studies (SOP No. 045) and aquifer (hydraulic) tests (SOP No. 033). Note that transducers are inappropriate for measuring well depth.

No calibration is necessary before use. Depending upon the device used, correction factors may be required for some measurements. Check instrument batteries prior to each use. Exercise care not to break the seals at the top of the electric water level indicator probe.

3.6.1 Transducers Deployment

Attach the transducer umbilical leads to the datalogger. Turn datalogger on. Program the transducer following instructions provided in the instrument user manual. Refer to the planning document(s) for site-specific parameters and recording frequency.

Measure and record the depth to water and well depth using an electronic sounding device as detailed in Sections 3.5.2 and 3.5.3. Slowly lower the transducer into the well until it is below the lowest possible piezometric level (typically 2-3 feet below the water table). Attach the cable grip to the well protective casing and/or tape the cable to the casing to prevent the transducer from falling further.

Record the following information and computations in the field logbook during transducer deployment:

- Date and time of deployment
- Weather
- Casing elevation
- NAPL surface elevation = casing elevation – depth to NAPL
- NAPL thickness = depth to bottom of NAPL – depth to top of NAPL
- Water level elevation = casing elevation – depth to water
- Well bottom elevation = casing elevation – depth to bottom (or read directly from tape)
- Method of measurement.

With the transducer deployed and the umbilical secured to the protective casing, ensure that the transducer unit is programmed to start logging at a desired date and time, or manually start logging. Record the logging start time. View real-time readings using the data logger and download a series of data using the data logger to verify proper operation. If the transducer is logging as desired, allow the transducer to continue logging. If the data are not logging as required in the planning documents, stop data collection, re-program the transducer, and restart logging.

3.6.2 Transducer Data Recording and Manipulation

Periodically check and download data per the manufacturer's instructions at the frequency detailed in the planning document(s) using a datalogger or computer and instrument software to download the transducer. If data are downloaded onto a datalogger, upload the data to a computer upon returning to the office.

Use the transducer manufacturer's software and transducer deployment information to make the following updates to the transducer data as needed:

- Correct the raw water pressure data files from the submersible transducer(s) for barometric effects

- Convert the transducer-reported values to equivalent feet of water over the sensor

- Normalize the transducer water levels as depths to groundwater in feet below the water level measuring point.

3.6.3 Transducer Retrieval

Upon completion of data collection, withdraw the transducer and cable from the well. Decontaminate the transducer and cable as detailed in SOP No. 005.

4. SPECIAL CONSIDERATIONS

Measurement of depth to water in new wells should only be performed after the water elevation in the well has stabilized. This may take as long as 72 hours; however, if the formation in which the well was installed is tight, the well may take even longer to achieve steady state. Ensure that steady-state conditions have been reached before making measurements as determined by the project geologist.

Electronic sounding devices may sometimes give erroneous readings due to water droplets along the side of polyvinyl chloride casing or on sample/pump tubing within a well. To check for erroneous readings, raise the probe above the point where the first sound was noted; a continued buzzer alarm indicates that the water table has not been reached. Shake the tape to remove water adhered to the tape and continue lowering to the water table.

5. CALIBRATION

No calibration is required. If more than one instrument is used at a site during the same gauging event, consider comparing the markings of the tapes on all instruments by stretching them on clean plastic sheeting to the anticipated length to be used. If the delta is known between the tapes, corrections of the measurements can be done at the time data are processed.

6. PRECAUTIONS

Depending upon the device used, correction factors may be required for some measurements. Check instrument batteries prior to each use. Exercise care not to break the seals at the top of the electric water level indicator probe.

7. REFERENCES

Archuleta, E. and A. Gilbert. 2000. *Basic Surveying*. Link: codot.gov/programs/tetp/construction-inspector-qualification/self-study-manuals/BasicSurveying.pdf.

Standard Operating Procedure No. 011
for
Photoionization Detector

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Revision: 01
May 2020

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 011	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	May 2020	Systematic Review and Update	Caron Mierczak Amy Sponaugle	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for field operations with a photoionization detector (PID). The PID uses an ultraviolet emitting lamp designed to detect, measure, and display the total concentration of airborne ionizable gases and vapors. This information is used as a field screening device for sampling and/or to determine health and safety control measures (i.e., protection and action levels) during project execution.

Any client-, project-, or site-specific variances to this SOP (if any) are documented on the Project-Specific Variance Form, located immediately after the SOP title page. Prior to using this SOP, field personnel should refer to the Project-Specific Variance Form to verify whether any variances are required.

The use of brand names in this SOP is not intended as an endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the manufacturer will provide applicable and comparable procedures for the maintenance and calibration of the instrument. Alternative procedures should be documented using the Project-Specific Variance Form. This SOP includes two standardized EA forms for environmental monitoring (Attachment A – Environmental Monitoring Record) and instrument calibration (Attachment B – Field Calibration Form).

2. MATERIALS

The following materials may be required:

Charging alternating current (AC)/direct current (DC) adapter and/or extra battery packs	Tedlar bag (optional)
Calibration gases – a span gas (typically 100 parts per million [ppm] isobutylene) and a zero gas (if required)	Tygon tubing
Regulator	Calibration adaptor (if needed)
PID (e.g., MiniRae 3000)	Microtip (if needed)
Field logbook or project-specific forms	Proper site-specific personal protective equipment (PPE)

3. STARTUP/CALIBRATION PROCEDURE

NOTE: The general startup/calibration procedures in this section are applicable for any brand of PID; however, since the MiniRae 3000 PID is a fairly common instrument, specific usage instructions for that instrument are also included in ***bold/italics***.

A. Turn the instrument on. ***For the MiniRae PID: Press and hold down the "MODE" button. When the display turns on, release the "MODE" button. The system logo should appear first, then "Start Up" and "Self-Test." Once the startup procedure is complete, the***

instrument shows a numerical reading screen with icons. This indicates that the instrument is fully functional and ready to use.

B. Perform Calibrations: A standard 2-point calibration has two steps: (1) measurement of a zero gas to determine the zero point of the sensor calibration curve, and (2) measurement of a span gas to determine the second point of the calibration curve. A canister of span gas with a regulator (flow-limiting or flow-matching) should be provided with the PID. Optionally, a Tedlar bag with the desired calibration gas can also be used. The calibration gas is typically 100 ppm isobutylene because it is near the midpoint ionization point of most volatile organic compounds (VOCs) and is not flammable or toxic at the low concentrations used for calibration. For the zero gas, usually clean outdoor air will be suitable. However, if any doubt exists as to the cleanliness of the background air, a filtering device (e.g., charcoal filter) or a commercial source of zero gas should be used.

If project-specific planning documents require a specific span gas, span gas concentration (span concentration should match the anticipated measurement concentration), and/or zero gas or filter, or if a multi-point span calibration is needed, these requirements should be documented in the Project-Specific Variance Form. Additionally, if the PID is calibrated with 100 ppm isobutylene, but field measurements need to be reported/quantified for a specific VOC (i.e., benzene), a correction factor needs to be applied to the measurements; this correction factor and the protocol for application should be specified in the Project-Specific Variance Form.

The general approach for a 2-point calibration using a span gas canister and clean outdoor air for the zero gas is as follows:

- Collect a measurement of the clean outdoor air. Confirm that the instrument reading is appropriate for zero-point calibration. Record this measurement (location and the result) in a field logbook or Project-Specific Form.

- Don PPE appropriate for the hazard potential of the span gas.

- Connect the regulator to the span gas bottle and connect tubing from the regulator to the instrument intake (use a calibration adaptor, if needed). Ensure that the regulator flow rate matches or exceeds the flow rate of the instrument pump.

- Turn on the span gas and collect a measurement. Confirm that the instrument reading is appropriate for calibration based on the known concentration of the span gas. Record this measurement result in a field logbook or project-specific form.

Span gas calibration readings should be close to the span gas concentration (within plus or minus 5 percent). If not, document the reading and discuss immediately with EA warehouse staff or manufacturer, as appropriate. Notify the Project Manager if the disparity cannot be resolved with the EA warehouse staff or manufacturer.

The instrument should be calibrated at least once a day (prior to starting work). Follow manufacturer recommendations for any additional calibration or bump tests required. Identify those additional calibration or bump testing requirements in the Project-Specific Variance Form. As identified previously in this SOP, a field calibration form has been provided in Attachment B.

For the MiniRae PID, press and hold the "MODE" and "N/-" buttons at the same time until you see the Password screen. In Basic User Level, you do not need a password, just press the "MODE" button. The Calibration Screen is now visible with Zero Calibration highlighted. Press the "Y/+" button to select Zero Calibration. You will see a message stating "Please apply zero gas….." Press the "Y/+" button to start zero calibration. A 30-second countdown begins and the screen displays "Zeroing.…" When zero calibration is complete, you will get the message "Zeroing is done! Reading = 0 ppm."

The instrument will then show the Calibration menu on its display with Span Calib highlighted. Press the "Y/+" button to enter Span calibration. The PID display screen will display the name of your span gas (isobutylene) and the span value in parts per million (100 ppm). Turn on your span gas canister fitted with a 500 cubic centimeters per minute regulator or a flow-matching regulator, and connect the regulator to the instrument using the proper sized tubing. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Press the "Y/+" button to initiate calibration. Span calibration starts and displays the message "Calibrating.…" There is a 30-second countdown for calibration and, upon completion, the message appears saying "Span is done! Reading = 100 ppm."

Remove the span gas from the inlet probe and remove the regulator from the span gas When you are done performing calibrations, press the "MODE" button. You will see the following message "Updating settings.…" Once the display reverts to normal, the instrument is calibrated and ready for use.]

C. Turn off the instrument. ***For the MiniRae PID: in order to turn the instrument off, press and hold the "MODE" button for 3 seconds. A 5-second countdown to shutoff begins. Once the countdown stops, release the "MODE" button. NOTE: If you remove your finger from the "MODE" button before the countdown has finished, it will cancel the shutoff operation and the instrument will continue normal operation.***

4. PROCEDURES

The PID can be used as a field screening device (e.g., for sampling) or for health and safety monitoring of field personnel. Don proper site-specific PPE before beginning work activities.

For screening purposes, the PID is typically used to determine VOC levels in soils or at the well head of groundwater monitoring wells. A microtip can be attached to the PID to filter soil particles from clogging the internal pump. In order to get an accurate measurement when screening soils, one of the following procedures should be used:

- Create a hole in the soil, turn on the PID and insert the tip into the hole, and collect a measurement.

- Fill a Ziploc® bag with soil, turn on the PID, and place the tip into the air space of the bag (ensure that the bag opening is sealed around the PID tip), and collect a measurement

- Fill a jar with soil, cover the jar opening with aluminum foil, turn on the PID and push the tip through the aluminum foil, and collect a measurement in the air space.

Readings should be recorded in a field logbook or project-specific field forms. **If there is a project-specific measurement protocol for soil, identify that protocol on the Project-Specific Variance Form. Otherwise, use one of the methods above.**

For monitoring well screening, the PID tip should be inserted into the well head immediately upon removal of the J-plug (the J-plug should be used to act as a seal over the PID as best as possible), and a measurement should be collected. Readings should be recorded in the field notebook or on Project-Specific Field Forms.

For health and safety monitoring, the PID is typically operated in continuous run mode to monitor the worker breathing zone, the general work area, and/or the work perimeter to assess VOC concentrations. PID measurements should be compared to project-specific action levels to determine whether those action levels have been exceeded and to assess whether PPE is appropriate. Measurements should be collected at determined intervals (e.g., every 10 minutes), at the start of new work activities, and/or when field conditions change. Low-level/high-level alarms for exceedances of project-specific action levels can be set, if required, using instructions in the instrument’s user manual.

5. BATTERY CHARGING

Typically, when an instruments’ battery charge falls below a preset voltage, the instrument will warn the user. If there is no warning mechanism, the user should periodically check the battery level to ensure continued usage. ***For the MiniRae PID: the instrument warns you by beeping once and flashing every minute, and the “empty battery” icon blinks on and off once per second. You should turn off the instrument within 10 minutes and recharge the battery.***

To charge a battery:

- Ensure that the instrument is turned off.

- Plug the AC/DC adapter's barrel connector into the instrument and then plug the AC/DC adapter into a wall outlet.

- The instrument will likely have a visual indicator during charging ***(for the MiniRae PID, the instrument will blink green to indicate charging).***

- Allow the battery to charge in accordance with manufacturer's instructions (typically, this is at least 8 hours).

- After charging, remove the charger, first from the outlet then from the instrument.

6. PRECAUTIONS

If an instrument does not carry an Intrinsic Safety Rating, it must not be used in a hazardous location where flammable concentrations of gases or vapors are present.

All calibration and field maintenance activities for the instrument, including battery charging, must be performed in a safe area away from hazardous conditions. Instrument servicing will only be conducted by the manufacturer or other authorized representative.

Do not open or mutilate battery cells. Do not defeat proper polarity orientation between the battery pack and battery charger. Substitution of components may affect safety rating.

Gas cylinders should be stored away from heat and other energy sources. Handle the cylinders carefully and do not allow them to drop from height. Ensure that the cylinders are securely stored (e.g., straps, etc.) when not in use. Prior to conducting calibration with span gas, don PPE appropriate for the potential hazard of the gas.

7. REFERENCES

None.

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Attachment A

Environmental Monitoring Record

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ENVIRONMENTAL MONITORING RECORD

SITE:
PROJECT NO.
INSTRUMENT:

SITE:
PROJECT NO.
INSTRUMENT:
CALIBRATION: Gas: Conc.: Span?

Time	Monitoring Location	Reading	Corrective Action Taken[(a)]

(a) Corrective actions taken must be documented whenever readings at or above action levels are reached.

Comments:

Recorded By:

Site Health and Safety Supervisor Date

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Attachment B

Field Calibration Form

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FIELD CALIBRATION FORM

SITE NAME:	
INSTRUMENT:	
INSTRUMENT ID NO.:	
OPERATOR:	
WEATHER:	
SPAN GAS TYPE:	
DATE:	
CALIBRATION NOTES:	
COMMENTS:	
SIGNATURE/DATE:	

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Standard Operating Procedure No. 013
for
Collection of Monitoring Well Samples

Prepared by

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225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 01
January 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 013	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	January 2019	Systematic update and review	Jason Stroup Scott Dobson	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the collection of groundwater samples from monitoring wells.

2. MATERIALS

The following materials may be required:

0.45-µM filters	Polyvinyl chloride bailer (for purging only)
Bladder pump (dedicated to one well only)	Sample bottles and labels
Conductivity meter	Stainless steel bailer (for purging and sampling)
Dissolved oxygen meter	Submersible pump and hose (for purging only)
Generator	Thermometer (optional)[1]
Logbook or book of field parameter forms	Transparent bailer with a double check valve
Peristaltic pump with tubing for filtering samples	Turbidity meter
pH meter with oxidation-reduction potential probe	Poly or Teflon® and/or Teflon® lined tubing **(PTFE or Teflon® should not be used when sampling for PFCs/PFAS)**
Photoionization detector organic vapor analyzer.	Variable speed, low flow submersible pump (e.g., Grundfos MP1 groundwater sampling pump) (for purging and sampling)
Variable speed peristaltic pump	Peristaltic head tubing
Plastic sheeting	Water level indicator
Polypropylene rope	Interface probe
NOTES: µM = Micrometer(s) L = Liter mL = Millimeter PFAS = Per- and polyfluoroalkyl substances PFC = Perfluorinated compound PTFE = Polytetrafluoroethelyne VOC = Volatile organic compound PTFE bailer with PTFE-coated stainless steel cable, double check valve top, and controlled flow bottom discharge attachment[2] for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles) (for purging and sampling)	

3. PROCEDURE

3.1 GENERAL

Groundwater sampling will follow these general steps:

---

[1] Temperature compensation and measurement capabilities are generally available as integral functions of pH meters and conductivity meters. If this is the case, a separate thermometer is not required.

[2] Although use of a controlled flow bottom discharge valve is historically preferred, use of such a device can cause aeration of the sample.

- Arrive onsite
- Set up apparatus (generators, pumps, etc.)
- Glove
- Organic vapor check, water level, and well depth measurements
- Sample non-aqueous phase liquids (NAPLs) (as required)
- Begin purge procedure
  - If using bailer to purge and sample, see Section 3.6
  - If using pump to purge and bailer to sample, see Section 3.7
  - If using bladder or low-flow pump to purge and sample, see Section 3.8
- Decontaminate/re-glove
- Take samples
  - If with bailer, see Section 3.6
  - If with bladder or low flow pumps, see Section 3.8
- Decontaminate/dispose of wastes, move equipment to next site.

NOTE: Sampling monitoring wells that contain PFAS have specific requirements that must be followed. Review SOP No. 073 prior to planning or conducting any sampling for PFAS.

3.2 GENERAL RULES FOR GROUNDWATER FIELD PARAMETER LOGBOOK

Use only one site or installation per logbook, and only one sampling location per page or form (if using pre-printed forms). The same logbook may be used for more than one sampling event. The first five pages will be reserved for index, general notes, etc. Sign and date each entry. The last five pages will be reserved for recording calibration data for the pH, temperature, turbidity, oxidation-reduction potential, dissolved oxygen, and conductivity meters. Use the page number or a separately recorded “Cal Reference Number” to refer to each calibration.

As appropriate, insert the cardboard flap under the form being filled out so that writing does not go through to the pages below. As appropriate, fill in the forms from front to back of the logbook, tearing out the white copy for each sample when the sample has been collected. This copy goes in the cooler with the sample, directly to the laboratory. The original copy must be torn out before you write on the back of the duplicate form. As appropriate, duplicate copies, index pages, and calibration sheets remain intact.

Reference SOP No. 016 for additional procedures and requirements for the use and maintenance of field logbooks for sampling.

3.3 GROUNDWATER SAMPLING GENERAL RULES

Groundwater samples will be collected from the least contaminated wells first, progressing to the most contaminated[3]. Upon arrival at the well site, immediately set up and organize the purging, sampling, and filtration equipment. If needed, due to muddy or contaminated ground, remoteness from sampling vehicle, and/or for placement of hose(s) and/or power cord if a pump is used, place clean plastic sheeting at, or around the well, to serve as a clean staging area for purging and sampling equipment, as conditions warrant. Care must be exercised not to step on plastic sheeting. If the well is remote from the sampling vehicle, set up the filtration equipment and place rope, wrapped bailer, and pre-labeled sample containers on the plastic sheet from the well. When a pump is to be used, situate the portable generator on level ground approximately 15 feet (ft) away from and downwind from the well. All generator maintenance (oil and fueling) is to be performed offsite. If the hose(s) and/or power cord of the pump are not on a reel, place the pump with its hose and power cord on the plastic sheeting downhill from the well.

Check well headspace for organic vapor, which may pose a health and safety hazard and indicate the presence of NAPL. Measure depth(s) to and thickness(es) of NAPL(s) as appropriate. Measure the depth to water and depth of well. From the water depth, well diameter, sand pack length, etc., calculate the equivalent volume (1 EV) of water in the well.

$$1\ \text{EV} = \text{volume in casing} + \text{volume in saturated sand pack}$$

Therefore, if the water table lies below the top of the sandpack, use the following equation:

$$1\ \text{EV} = (\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_w) * (0.0043)$$

If the water table lies above the top of the sandpack use this equation:

$$1\ \text{EV} = [(\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_s)] * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches
0.0043 gallons (gal)/inch $(\text{in.})^3$
Assumed filter pack porosity = 30 percent.

---

3. First round samples are to be collected from upgradient wells first, moving to downgradient wells under the assumption that upgradient wells will be less contaminated than downgradient wells. Results of first round analysis may mandate a change in sampling sequence.

Samples will always be collected in order of decreasing volatility (i.e., the samples to be analyzed for the volatile constituents should be collected first). Deliver the VOC sample to the vial by allowing the water to trickle down the inside wall of the vial at a rate no greater than approximately 100 mL/minute. Other samples may be delivered at a faster rate. Sampling rates will at no time exceed 1 L/minute. Procedures for each class of samples are contained in the site-specific Quality Assurance Project Plan.

When collecting samples for volatile analysis, care should be taken to prevent analyte loss by volatilization. The following procedures should be adhered to when collecting these samples:

- Avoid excessive aeration and agitation of sample.

- Fill vial so that a reverse meniscus is present by adjusting the flow rate from the sampling device.

- Place septum on vial so that the PTFE side is in contact with the sample. After the cap is on the bottle, check for air bubbles in the sample. If air bubbles are present, properly dispose of that sample and recollect the sample in the same vial or a new vial if prepreserved.

- Make sure vial is labeled and immediately transfer the vial to the cooler with ice.

Filtered and unfiltered samples will be taken for inorganics (metals) analyses, as appropriate. The samples will be filtered through an in-line 0.45-µM filter (preferred method), or by gravity through a 0.45-µM membrane placed in a filter funnel. Use forceps to place the membrane into the funnel and pour sample through funnel until appropriate volumes have been filtered.

If necessary, due to slow filtering, a peristaltic pump may be used to filter the sample through an in-line filter. Connect the pump to the generator, and attach tygon tubing to the bottom discharge valve on the bailer. Start pump and collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

— OR —

If a low flow pump is used collect the samples, filtered samples will be taken by installing a 0.45-µM filter in-line and pumping the water through the filter. Collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. If a flow-through cell is used to measure water quality parameters, collect samples before flow-through cell. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

Unfiltered samples will be collected by slowly pouring the sample water into the appropriate sample container, being careful not to agitate or cause bubbles to form. Do not overfill bottles. Make sure sample bottle is labeled and the cap is on tightly, then place the sample in cooler with ice immediately.

All samples will be delivered to the laboratory as soon as possible. If possible, samples will be shipped on the same day as they are collected. If samples must be retained due to weekend sampling (Friday through Sunday), the laboratory will be notified as to the time sensitive nature of the samples.

3.4 SAMPLING OF NON-AQUEOUS PHASE LIQUIDS

If NAPLs are detected in the well, a sample from all layers must be collected prior to any purging activities. NAPLs may be indicated by the presence of volatiles in the well headspace, and confirmed by the oil/water interface probe.

Collecting light non-aqueous phase liquid (LNAPL) will be accomplished using a transparent bailer with a double check valve. This bailer will be slowly lowered until the bottom of the bailer is 1-2 in. below the LNAPL-water interface, then slowly withdrawn. Verify that the interface was sampled by visual inspection of the bailer contents through the side of the bailer. Measure the thickness of the LNAPL in the bailer and note in the Field Logbook. Sample for laboratory analysis. An additional field verification may be performed by decanting the remainder of the contents of the bailer into a glass jar, adding a hydrophobic dye such as Sudan IV, or Redoil, shaking the sample and looking for coloration of NAPL. Alternate field tests are: examine the sample under ultraviolet light (many fluoresce), or allow the sample to stand overnight, and examine for interface and/or volatiles in the headspace the following day. Refer to the following sections on purging and sample collection for setup and general operation.

Collecting dense non-aqueous phase liquids (DNAPLs) will be accomplished using a transparent bailer with a double check valve. The bailer must be lowered very slowly to the bottom of the well and raised slowly out of the well in a controlled fashion. Sample for analysis as above. The same field check described above may be employed for DNAPL. Refer to the following sections on purging and sample collection for set up and general operation.

If NAPLs are present in the well, **and** a low-flow pump is to be used for purging and sampling, the well will be allowed to re-equilibrate prior to purging and sampling. This will be accomplished by allowing the well to stand undisturbed for at least 8 hours prior to purging and sample collection.

3.5 WELL PURGING GENERAL RULES

Water within the casing of a well will stagnate, de-gas, lose volatiles, possibly precipitate metals due to changes in redox potential, and may react with the screen and/or casing material. It is, therefore, necessary to purge a sufficient volume of this stagnant water from the well and/or casing to ensure that a representative sample of formation water can be obtained. Traditionally, the volume of water to be purged was arbitrarily set at 3-5 equivalent volumes. Recent advances in sampling technologies have caused a re-thinking of such arbitrary purge volumes. It is, for this reason, that monitoring of select chemical and physical properties of the sample medium will be used instead of strict volumes to determine when a representative sample may be taken from a well.

Acceptable purge/sampling devices include: bailers, high-discharge submersible pumps (purge only), and variable speed, low-flow pumps that include both submersible pumps (purge and sample) and dedicated bladder pumps (purge and sampling). It is recommended to purge and sample at similar rates with one type device per well. An acceptable exception to this general rule is to use a high-discharge submersible pump to purge a deep, fast-recharging well, and a bailer to sample the same well.

Peristaltic, gas-lift, and centrifugal pumps can cause volatilization, produce high pressure differentials, and result in variability in the analysis of some analytes of interest. For this reason, these pumps should be used with caution and flow rate slowed to minimize volatilization.

To prevent groundwater from cascading down the sides of the screen into an open hole, thereby aerating the sample, purge rates will closely match recharge rates. If the static water level is within the casing, the initial purge rates may be set high enough to lower the water level to the top of the screen, then reduced to maintain that level and identify the well’s recharge rate.

Purging will be accomplished with either a submersible pump, a low-flow (submersible or bladder) pump, or bailer. The choice of bailer or pump will be based on depth to water table, volume to be purged, and permeability of the aquifer. If the well recharges rapidly and/or has greater than 20 gal (estimated EV) to be purged, water may be removed with a submersible pump or a low-flow pump. If the well recharges slowly and/or has less than 20 gal to be purged, water will be removed with a bailer or a low-flow pump.

Purging will be accomplished with as minimal disturbance to the surrounding formation as possible.

Purge water will be containerized onsite until analysis of samples is completed. Based on sample results, accumulated purge water will be properly disposed of.

If the water level is within the screened interval and the well recharge rate is less than 0.1 L/minute, purge the well using a low-flow pump as follows:

1. Draw the water down to within 1 ft of the top of the pump.

2. Allow the well to recover.

3. Check and record field parameters.

4. Repeat Steps 1 through 3 then collect samples for metals analysis only[4].

5. Note the event in the Field Logbook, and report the problem to the Project Manager. If this extremely low recharge problem consistently occurs in a given well, the well may be considered for re-development and/or replacement.

6. If adjacent wells have elevated VOC levels, additional soil gas surveys will be considered in the vicinity of the low recharge well to help determine the need for replacement.

3.6 PURGING AND SAMPLING WITH BAILERS

Bailers may be used for both purging and sampling wells if: (1) the well recharge rate is less than 4 L/minute, (2) depth to the water table is less than 50 ft, and (4) less than 20 gal are to be purged (5 EV < 20 gal)[5].

When purging with a bailer, either a polyvinyl chloride, PTFE, or stainless steel bailer may be used. The bailer will be attached to either a spool of PTFE-coated stainless steel cable or polypropylene rope. If using cable, attach it to the bailer using stainless steel cable clamps. Thoroughly decontaminate the cable after each use, prior to rewinding cable onto spool. Cable clamps and raw cable ends may serve to trap contamination. Exercise particular caution in decontaminating these areas. If using rope, attach the rope to the bailer using a bowline knot, dispense the needed length (a few feet more than the well depth), and cut the remainder away; then, at the end opposite the bailer, make a slip knot and place it around the well casing or protective posts to prevent losing the bailer and rope down the well. The polypropylene rope will be not reused; it will be properly disposed of. Either type of bailer will be repeatedly lowered gently into the well until it fills with water, is removed, and the water discharged into an appropriate container until purging is complete. Care must be taken not to unduly agitate the water, as this tends to aerate the sample, increase turbidity, makes stabilization of required parameters difficult to achieve, and generally prolongs purging.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

---

[4] Analyte losses due to volatilization in a drained well are too high for valid VOC sampling (McAlary and Barker 1987).

[5] These numbers are based on the following assumptions: (1) In purging, it is preferable to remove water at approximately the recharge rate; (2) 4 L/minute is estimated as the approximate maximum rate at which water can be removed with a bailer from depths of 20-50 ft; and (3) 20 gal is estimated to be at the limit of the sampler's endurance, at which point fatigue and sloppiness of technique begin.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly. Refill bailer as needed.

If the controlled flow bottom discharge attachment is used for VOC sampling, attach it to the bottom of the bailer. Using the stopcock valve on the bailer to control the flow, and fill sample vials as described above in Section 3.3.

Remove check valve top and pour unfiltered sample into inorganics sample bottles.

Collect filtered samples as described in Section 3.3. Decontaminate bailer and cable.

3.7 PURGING WITH PUMP, SAMPLING WITH BAILER

If the recharge rate of the well is greater than 30 L/minute, or the water level is deeper than 50 ft, or more than 20 gal of purge water will be generated (5 EV > 20 gal), then purging and sampling may be accomplished using a submersible pump/bailer combination.

When purging with a pump, gradually lower the intake until it is submerged within the screened interval. Lower an electronic water level probe to the top of the screen (as determined from completion records) to the monitor water level, start pump, and slowly lower the pump as the water level continues to fall. Care should be exercised to lower the water column to the top of the screened interval (water level probe will stop beeping) but not below the top of the screen if possible. This will ensure that the stagnant layer has been removed, but should minimize the detrimental effects of over pumping the well. Secure hose(s) and/or power cord to casing and place discharge hose into the proper container, downhill and as far away from the well as possible. Determine and record the discharge rate.

Discharge rate = volume of container/time to fill container

The discharge rate will be established at approximately equal to or just greater than the well's recharge rate (determined from well development). If well development records are incomplete, recharge rate can be determined by monitoring the rise/fall of the water level within the casing as one purges the well. If the water level is static at a given pumping rate, but fluctuates up or down as pumping rate is decreased or increased, the pumping rate at which the water level is static is the recharge rate.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with a double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles). Filtration of metals samples will be accomplished using either an in-line filter attached to the bottom of the bailer, or a funnel and appropriate filter (Section 3.3).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly, and fill sample containers as described in Section 3.6. Decontaminate bailer and cable in and decontaminate pump.

3.8 PURGING AND SAMPLING WITH LOW-FLOW PUMP

To obtain representative samples, subsurface disturbances should be kept to a minimum, thereby preventing sample alteration due to sampling actions. The reasoning behind the use of low-flow pumps to purge and sample monitoring wells is that these pumps minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. For these reasons, the low-flow pump is the preferred method for both purging and sampling in most cases. For the purposes of this SOP, “low-flow pumps” are defined as either dedicated bladder pumps or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 to 30 L/minute.

Low-flow pumps may be used for purging and sampling any well having recharge greater than 0.1 L/minute, which is the practical lower limit of pump performance. Below that pumping rate, pump inefficiencies and/or overheating may alter the physical and chemical properties of the sample. If the pump is continuously operated at sampling rates higher than the well recharge rate, the water level will be lowered in the well, possibly allowing aeration of the sample that is unacceptable sampling procedure. Low-flow pumps are suitable for sampling wells with recharge rates lower than 0.1 L/minute if precautions are taken to avoid aeration of the sample.

Low flow submersible pumps will be used as follows:

- Lower the pump into the well, slowly so as not to agitate the water, until the pump is at the mid-point of the screened interval or the mid-point of the water column if the static water table lies below the top of the screen.[6]

---

[6] This assumes a 10-ft screened interval. If the screened interval is greater than 10 ft, multiple samples should be taken as follows:
- If the screen is 10-12 ft, sample the canter of the water column, as outlined above.
- If the screen is longer than 12 ft, and the water column is 10 ft or less, sample the center of the water column.

- Attach the pump's umbilical cord (which will consist of power cord and sampling tubing) to the protective casing, or lock the cord spool so that the pump cannot move vertically in the well during sampling.

- Lower the water level probe into the well behind the pump until it just touches water. This will allow the sampler to monitor the water level while purging and sampling, and prevent the inadvertent drying of the well.

- Begin purging at the pump's lowest setting, then gradually increase rate[7] until the pumping rate matches the aquifer recharge rate. **If the water level is above the top of the screen**, the pumping rate may be allowed to slightly exceed recharge rate, lowering the water level to no less than 1 ft above the screen, then reduced until it matches recharge rate and purging continued. **If the water level is below the top of the screen**, always keep the purge rate lower than well's recharge rate.

- Monitor stabilization parameters listed in Section 3.6 beginning immediately, using an in-line monitoring system. Record parameters regularly, at a rate of one set of parameters per each 1-3 liters of water removed from the well. When these parameters stabilize to within 10 percent over three consecutive readings, reduce[8] flow rate to 0.1 L/minute (if needed) and begin collecting VOC samples directly from the discharge line.

- If the well recharges at a rate less than 0.1 L/minute, purge until the water level is even with the top of the screen, allow the well to recover, and sample immediately.

- Remove and decontaminate water level probe and pump.

4. MAINTENANCE

Refer to manufacturer's requirements for maintenance of pumps and generators.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for appropriate personal protective equipment.

- If the screen is longer than 12 ft, and the water column fills the screen, or extends above the screen, sample at 1/3 and 2/3 the height of the water column, or about every 6 ft.

[7] Some sources indicate that the pumping rate should not exceed 1 L/minute, with 0.5 L/minute being preferable. The optimal purge rate is highly aquifer dependent, and may range from less than 0.5 L/minute to greater than 10 L/minute. The purge rate for a given well will, therefore, be a field decision, based on well development, purge, and sampling records rather than SOP mandate.

[8] Sampling should occur at the same rate as purging as long as aeration of sample does not occur.

6. REFERENCES

McAlary, T.A. and J.F. Barker. 1987. Volatilization Losses of Organics During Groundwater Sampling From Low Permeability Materials, in Groundwater Monitoring Review. Fall.

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Standard Operating Procedure No. 016
for
Field Logbooks and Surface Water, Groundwater, and Soil/Sediment Field Checklists

Prepared by

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Revision: 01
July 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 016	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	June 2019	Combine SOP 059 with 016. Reviewed and updated content as appropriate.	Dan Hinckley Jesse Drummond	Matthew Bowman

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1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for completion of field logbooks and completion of field forms used to record surface water, groundwater, soil/sediment sampling information, instrument calibration data, and data from hydrologic testing. Acceptable field logbooks are bound, unprinted books such as a surveyor's field logbook, or a Federal Supply Service Number (No.) 7530-00-222-3525 record book (or equivalent); or they may be company-proprietary, pre-printed forms bound into a field logbook. Example forms are provided herein. Alternate, equivalent forms are acceptable.

2. MATERIALS

The following material may be required: field logbook, indelible ink pen, and field checklists documented in Sections 3.1 through 3.7.

3. PROCEDURE

All information pertinent to a field survey or sampling effort will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line-out deletions that are initialed and dated. The person making the correction will provide a brief explanation for the change. Entries are factual only. No personal opinions should be entered.

There should be no blank lines on a page. A single blank line or a partial blank line (i.e., at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it. The bottom of each page must be signed and dated by the field personnel entering the information.

At a minimum, entries in the field logbook will include but not be limited to the following:

- Date.
- Project number and project name.
- Name and address of field contact.
- Identification of sample crew members.
- Documentation should include model numbers of equipment used (e.g., data loggers, drilling rigs) and calibration (if applicable). Each day's entry should begin with time onsite, who is onsite (including observers other than the sampling crew), brief description of what work will be performed that day and how, and the weather.

- If samples are being taken in or near tidal waters, the time of high and low tide for the site should be determined from local gauges or tables and recorded.

- References such as maps of the sampling site.

- Times of key daily milestones should be entered (e.g., time borings began, times personnel arrived and left site, times subcontractors arrived and left site, etc.). Time should be recorded in the left-hand margin on the page in military time.

- Sample-specific information:

  - Unique, sequential field sample number
  - Purpose of sampling
  - Location, description, and log of photographs of each sampling point
  - Details of the sample site (e.g., elevation of the casing, casing diameter and depth, integrity of the casing, etc.)
  - Documentation of procedures for preparation of reagents or supplies that become an integral part of the sample (e.g., filters and absorbing reagents)
  - Type of media of sample (e.g., groundwater, surface water, soil, sediment, and product)
  - Suspected waste composition
  - Number and volume of sample taken
  - Sampling methodology, including distinction between grab and composite sample
  - Sample preservation
  - Date and time of collection
  - Collector’s sample identification number(s)
  - Sample shipment (e.g., name of the laboratory and cartage agent: Federal Express, United Parcel Service, etc.)
  - Field observations (e.g., oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, moisture content, layering, Unified Soil Classification System classification, etc.)

- — Any field measurements made (e.g., pH, conductivity, explosivity, water depth, organic vapor analyzer readings, etc.)
- — Signature and date by the personnel responsible for observations
- — Decontamination procedures.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a field logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the sampler's memory. Further, the project work plan or field sampling plan should be reviewed to identify additional specific information or requirements that should be included in the field logbook.

The Project Manager will keep a master list of all field logbooks assigned to the Sampling Team Leaders. One field logbook kept by the Project Manager will be a master site log of daily activities and will contain the list of field logbooks assigned to Sampling Team Leaders.

Project name and number should be clearly marked on the outside cover using indelible ink. If more than one field logbook exists for the project, then the number of the field logbook should also be clearly marked on the outside cover.

Field checklists associated with the collection of soil, sediment, surface water, and groundwater are shown in Figures SOP016-1 through SOP016-9 and described in Sections 3.1 through 3.7. The details described above for completion of the field logbook should be completed even though these field checklists have been completed, and the field checklists noted in the field logbook. While the importance of the use of field logbooks is emphasized in this SOP, it is acknowledged that alternate documentation approaches may be necessary (e.g., higher reliance on documentation forms, use of electronic tablets) for a variety of client and project-specific reasons. It is essential the team establish clear expectations for the use of field logbooks during project planning and document any differences from this SOP in the project-specific variance form.

3.1 SOIL/SEDIMENT FIELD CHECKLISTS (REQUIRES FIGURES SOP016-1 AND SOP016-3)

3.1.1 Field Parameter Form (Items on Figures SOP016-1 and SOP016-2)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No."

2. HIGH HAZARD?: Answer "Yes" or "No."

3. SITE: Record the complete name of the site.

4. AREA: Record the area designation of the sample site.

5. INST CODE: Record the 2-letter installation code appropriate for the installation or site. Correct abbreviations can be found on Pages 3-6 of the Installation Restoration Data Management System (IRDMS) User's Guide for chemical data entry.

6. FILE NAME: Record "CSO" for a soil sample or "CSE" for a sediment sample.

7. SITE TYPE: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry. This entry must match the Site Type on the map file form.

8. SITE ID: Record a code up to 10 characters or numbers that is unique to the site.

9. FIELD SAMPLE NUMBER: Record a code specific for the sample.

10. DATE: Enter the date the sample was taken.

11. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken.

12. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock).

13. SAMPLE PROG: Record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

14. DEPTH (TOP): Record the total depth sampled.

15. DEPTH INTERVAL: Record the intervals at which the plug will be sampled.

16. UNITS: Record the units of depth (feet, meters)

17. SAMPLE MEASUREMENTS: Check the appropriate sampling method.

18. CHK: Check off each container released to a laboratory.

19. ANALYSIS: Record the type of analysis to be performed on each sample container.

20. SAMPLE CONTAINER: Record the sample container type and size.

21. NO.: Record the number of containers.

22. REMARKS: Record any remarks about the sample

23. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers.

24. SITE DESCRIPTION: Describe the location where the sample was collected.

25. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System.

26. COLOR: Record the color of the sample as determined from standard Munsell Color Charts.

27. ODOR: Record the odor of the sample or "none." See SOP No. 001 Section 5.

28. PID (HNu): Record the measured photoionization detector (PID) (HNu) values.

29. UNUSUAL FEATURES: Record anything unusual about the site or sample.

30. WEATHER/TEMPERATURE: Record the weather and temperature.

31. SAMPLER: Record your name.

3.1.2 Map File Form (Figure SOP016-3)

1. The map file logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used).

2. SITE ID: Record the Site ID from the field parameter form.

3. POINTER: Record the field sample number for the sample being pointed to.

4. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks.

5. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks.

6. MAP REFERENCE: Record which U.S. Geological Survey Quad Map references the site.

7. COORDINATE DEFINITION: Write the compass directions the X- and Y-Coordinates of the map run.

8. COORDINATE SYSTEM: Write "UTM" (Universal Transverse Mercator).

9. SOURCE: Record the 1-digit code representing the Map Reference.

10. ACCURACY: Give units (e.g., write "1-M" for 1 meter).

11. X-COORDINATE: Record the X-Coordinate of the sample site location.

12. Y-COORDINATE: Record the Y-Coordinate of the sample site location.

13. UNITS: Record the unit's map sections are measured in.

14. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey.

15. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference.

16. ACCURACY: Record the accuracy of the map or survey providing the topographical information.

17. ELEVATION: Record the elevation of the sampling site.

18. UNITS: Write the units in which the elevation is recorded.

19. SAMPLER: Write your name.

3.2 SURFACE WATER FIELD CHECKLISTS (REQUIRES FIGURES SOP016-2 AND SOP016-3)

3.2.1 Field Parameter Form (Items Unique to Figure SOP016-3)

1. CAL REF: Record the calibration reference for the pH meter.

2. pH: Record the pH of the sample.

3. TEMP: Record the temperature of the sample in degrees Celsius.

4. COND: Record the conductivity of the water.

5. For all other sections, see Section 3.2.1.

3.3 GROUNDWATER SAMPLING FIELD CHECKLISTS (REQUIRES FIGURES SOP016-2, SOP016-3, AND SOP016-4)

3.3.1 Field Parameter Form (Items on Figure SOP016-4)

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry.

2. SAMPLE NO.: Record the reference number of the sample.

3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks.

4. X-COORD and Y-COORD: Record the survey coordinates for the sampling site.

5. ELEV: Record the elevation where the sample was taken.

6. UNITS: Record the units the elevation was recorded in.

7. DATE: Record the date in the form MM/DD/YY.

8. TIME: Record the time, including a designation of AM or PM.

9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

10. WELL DEPTH: Record the depth of the well in feet and inches.

11. CASING HT.: Record the height of the casing in feet and inches.

12. WATER DEPTH: Record the depth (underground) of the water in feet and inches.

13. WELL DIAMETER: Record the diameter of the well in inches.

14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches.

15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations, to determine one equivalent volume (EV):

    1 EV = Volume in casing + volume in saturated sand pack. Or to restate:

    $$1 \text{ EV} = (BR_w^2h_w + 0.30B(R_s^2 - R_w^2)h_s) * (0.0043)$$

    where

    R_s = Radius of sandpack in inches
    R_w = Radius of well casing in inches
    h_s = Height of sandpack in inches
    h_w = Water depth in inches

    $0.0043 = \text{gal/in.}^3$
    and filter pack porosity is assumed as 30 percent

— OR —

Volume in casing = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_c^2)(W_h)

where

R_c = Radius of casing in inches
W_h = Water column height in feet

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_b^2 - R_c^2)(W_h)(0.30)

(if W_h is less than the length of the sandpack),

— PLUS —

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_b^2 - R_c^2)(S_h)(0.30)

(if W_h is greater than the length of the sandpack).

where

R_b = Radius of the borehole
S_h = Length of the sandpack.

Show this calculation in the comments section.

17. VOLUME OF BAILER OR PUMP RATE: Record bailer volume or pump rate.

18. TOTAL NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

19. WELL WENT DRY? Write “YES” OR “NO.”

20. NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers or pump time which made the well go dry.

21. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry.

22. RECOVERY TIME: Record the time required for the well to refill.

23. PURGE AGAIN?: Answer “YES” or “NO.”

24. TOTAL VOL. REMOVED: Record the total volume of water (in gal) removed from the well.

25. CAL REF.: Record the calibration reference for the pH meter.

26. TIME: Record time started (INITIAL T[0]), 2 times DURING the sampling and the time sampling ended (FINAL).

27. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

28. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

29. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

30. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

31. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

32. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL).

33. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

34. NAPL: Record the presence and thickness of any non-aqueous phase liquids (light or dense)

35. COMMENTS: Record any pertinent information not already covered in the form.

36. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (MAINTAINED AS A SEPARATE LOGBOOK, OR INCORPORATED INTO SAMPLING LOGBOOKS)

3.4.1 Items on Figure SOP016-5

1. Record time and date of calibration. Note whether 12- or 24-hour clock was used.

2. Record calibration standard reference number.

3. Record meter I.D. number

4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

5. Record value of reference standard (as required).

6. COMMENTS: Record any pertinent information not already covered on form.

7. SIGNATURE: Sign form.

3.5 GROUNDWATER HYDROLOGY TESTS CHECKLISTS (MUST INCLUDE FIGURES SOP016-6 AND SOP016-7 AND/OR SOP016-8 OR SOP016-9)

3.5.1 Field Permeability Test Data Sheet (Items on Figures SOP016-6)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

4. PROJECT NO.: Record the contractor assigned project number or the contract number.

5. LOCATION: Specific location

6. CLIENT: Agency or company with the contract under which the work is being performed.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

9. TEST TYPE: Short description of the type of test to be performed.

10. RISING/FALLING HEAD WITH SLUG: Check if the test involved the insertion/removal of and inert object.

11. RISING/FALLING HEAD WITHOUT SLUG: Check if the test involved the addition/removal of a quantity of water.

12. START DATE: Date on which the test was begun.

13. CLOCK TIME: Time each datum (depth to groundwater level) is collected. Note whether 12- or 24-hour clock was used.

14. ELAPSED TIME: Time since the last datum was collected.

15. DEPTH TO GWL (ft): Depth to the top of the groundwater table (Groundwater Level) as measured by manual methods.

16. REC. (ft): Water level as reported by transducer/datalogger (this is the depth of water above the transducer.

17. TIME: Time the discharge rate check was begun (addition or removal of water method). Note whether 12- or 24-hour clock was used.

18. FLOW METER (Addition or removal of water method): The amount of water added or removed as registered by the flowmeter, in gal of liters.

19. DISCHARGE RATE: Flowmeter reading divided by time interval (gal/min or liters/min).

20. SIGNATURE: The person completing this form must sign the form at the end of the test.

21. DATE: Date the form was signed.

3.5.2 Groundwater Levels – Single Well (Items on Figure SOP016-7)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: Remedial investigation wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATE: Date of each water level reading

16. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

17. ELAPSED TIME: Time since test was begun.

18. DEPTH TO WATER: Measured depth to the groundwater table.

19. WATER ELEVATION: Elevation of the top of the groundwater table (use datum listed above).

20. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

21. TAPE NO.: The unique identification number of the traceable standard tape used to calibrate the measuring device.

22. WELL STATUS: Condition of the well at the time of measuring (see abbreviation key at the bottom of the data sheet).

23. REMARKS: Any additional pertinent comments not specifically required above.

24. INITIALS: Initials of person completing this data entry.

25. ABBREVIATION KEYS: Self-explanatory.

26. SIGNATURE: The person completing this form must sign the form at the end of the test.

27. DATE: Date the form was signed.

3.5.3 Groundwater Levels – Single Well (Items on Figure SOP016-8)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATALOGGER: This section is record of pertinent datalogger information.

16. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

17. MODEL: Enter the model number of the datalogger.

18. S/N: Enter the serial number of this datalogger.

19. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

20. TRANSDUCER: This section is a listing of pertinent information about the transducer used.

21. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

22. MODEL: Enter the model number of the transducer.

23. S/N: Enter the serial number of this transducer.

24. INPUT/UNITS: What are the units this transducer uses?

25. RANGE: Record the pressure or depth range over which this transducer is certified.

Calibration

26. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer. (Usually in psi, or kpa).

27. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

28. VOLUME WATER ADDED/REMOVED: (Applicable if inert object insertion/removal method was not employed.) Record the volume of water added to or removed from the well.

29. DISCHARGE RATE: If z (above) is filled, enter the rate at which this water was added or removed.

30. INITIAL WATER LEVEL (ft): Enter the water level in the well at the beginning of the test.

31. PRESSURE TRANSDUCER SUBMERGENCE: Record the depth to which the transducer is submerged at the beginning of the test and the depth to the transducer at the end if the test. All depths will be recorded to the nearest 0.01 ft.

32. TIME: Record the time the test is begun and ended. Note whether 12- or 24-hour clock was used.

33. OBSERVED CHANGES IN ADJACENT WELLS: Note any changes in water levels in nearby wells.

34. RESULTS RECORDED ON DISKETTE #: Tracking number of the diskette on which these data are archived.

35. DISKETTE FILE NAME: Name of the file(s).

36. SIGNATURE: The person completing this form must sign the form at the end of the test

37. DATE: Date the form was signed.

3.6 GROUNDWATER LEVELS – MULTIPLE WELLS (ITEMS ON FIGURE SOP016-9)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

5. LOCATION: Specific location.

6. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

7. CLIENT: Agency with the contract under which the work is being performed.

8. REMARKS: Any pertinent observations not specifically required above.

9. WELL: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

10. DATE: Date this measurement was made.

11. TIME: Time this measurement was made. Note whether 12- or 24-hour clock was used.

12. DEPTH TO WATER: Depth from MP to top of groundwater table.

13. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

14. MP ELEV.: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

15. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

16. REMARKS/MP: Describe the location and nature of the measuring point.

17. INITIALS: Initials of the person completing this form.

18. ABBREVIATION KEYS: Self-explanatory.

19. SIGNATURE: The person completing this form must sign the form at the end of the test.

20. DATE: Date the form was signed.

3.7 GROUNDWATER LEVELS – DATALOGGERS

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's fieldwork.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019, Section 3.4).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

Datalogger (This section is a record of pertinent datalogger information)

15. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

16. MODEL: Enter the model number of the datalogger.

17. S/N: Enter the serial number of this datalogger.

18. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

Transducer (This section is a listing of pertinent information about the transducer used)

19. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

20. MODEL: Enter the model number of the transducer.

21. S/N: Enter the serial number of this transducer.

22. INPUT/UNITS: What are the units this transducer uses?

23. RANGE: Record the pressure or depth range over which this transducer is certified.

Calibration

24. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer (usually in psi, or kpa).

25. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

26. DATE: Date of each water level reading

27. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

28. LOGGING TIME INTERVAL: Time since test was begun.

29. WL FEET BELOW MP: Measured depth to the groundwater table from measuring point.

30. SUBMERGENCE: Depth of water above the transducer.

31. MEAS.METHOD: What device/method was used to measure the water level.

32. TAPE NO.: Record the tape identification number.

33. TRANSDUCER MOVED?: Was the transducer moved since the last water level reading?

34. REMARKS: Any pertinent remarks not otherwise specified.

35. INITIALS:

Data Transfer to Diskette

36. DATE: Date data were archived onto diskette.

37. TIME: Time stamp the computer assigns the data file.

38. FILE NAME: Name assigned the data file.

39. SOFTWARE USED FOR TRANSFER: Any special software, or computer operating system used to write the files to diskette. NOTE: If a "shareware" archiver which compresses files was used, and the archived file is not self-extracting, a copy of the unarchive program should be copied onto the diskette also.

40. OUTPUT FORMAT: What is the format of the output file? (DOS, UNIX, Binary, Compressed?)

41. INITIALS: Initials of the person who copied the data to diskette.

42. ABBREVIATION KEY: Self-explanatory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

None.

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Figures

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FIGURE SOP016-1
FIELD PARAMETER LOGBOOK
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

INSTALLATION/SITE ______________________________ AREA __________________

INST CODE FILE NAME ____

SITE TYPE SITE ID
FIELD SAMPLE NUMBER

DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.

DEPTH (TOP) DEPTH INTERVAL UNIT ____________

SAMPLING METHOD:

SPLIT SPOON AUGER SHELBY TUBE SCOOP OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION:____
SAMPLE FORM _____________________ COLOR ____________ ODOR ____________
PID (HNu) ______________________ UNUSUAL FEATURES ______________________
____
WEATHER/TEMPERATURE
SAMPLER

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

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FIGURE SOP016-2
FIELD PARAMETER LOGBOOK
GROUNDWATER AND SURFACE WATER SAMPLES

INSTALLATION/SITE AREA
INST CODE FILE NAME SITE TYPE
SITE ID FIELD SAMPLE NUMBER
DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.
DEPTH (TOP) DEPTH INTERVAL UNITS

SAMPLING MEASUREMENTS
CAL REF. pH TEMPERATURE C CONDUCTIVITY OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS
SITE DESCRIPTION
SAMPLING METHOD
SAMPLE FORM COLOR ODOR
PID (HNu)
UNUSUAL FEATURES
WEATHER/TEMPERATURE ____________________________ SAMPLER ___________________

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FIGURE SOP016-3
MAP FILE LOGBOOK

SITE ID POINTER ____________________
DESCRIPTION/MEASUREMENTS
SKETCH/DIMENSIONS:

MAP REFERENCE
COORDINATE DEFINITION (X is Y is)
COORDINATE SYSTEM SOURCE ACCURACY
X-COORDINATE Y-COORDINATE UNITS
ELEVATION REFERENCE
ELEVATION SOURCE ACCURACY ELEVATION
UNITS

SAMPLER

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FIGURE SOP016-4
MAP FILE AND PURGING LOGBOOK
GROUNDWATER SAMPLES

WELL COORD. OR ID SAMPLE NO.______________
WELL/SITE
DESCRIPTION____

____

X-COORD. Y-COORD. _______________ ELEV. UNITS
DATE ____/____/____ TIME AIR TEMP.

WELL DEPTH _________ ft _________ in. CASING HT. _________ ft _______ in.
WATER DEPTH __________ ft _________ in. WELL DIAMETER __________ in.
WATER COLUMN HEIGHT _________ ft _________ in. SANDPACK DIAM. _______ in.
EQUIVALENT VOLUME OF STANDING WATER ____________ (gal) (L)
VOLUME OF BAILER ___________ (gal) (L) or PUMP RATE ___________ (gpm) (lpm)
TOTAL NO. OF BAILERS (5 EV)___________ or PUMP TIME ___________ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME_______MIN
VOL. REMOVED __________ (gal) (L) RECOVERY TIME __________ MIN
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (gal) (L)

Date and Time	Quantity Removed	Time Required	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/ clarity/odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS:____
____
____
____

SIGNATURE

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FIGURE SOP016-5
FIELD CALIBRATION: pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, OXIDATION-REDUCTION POTENTIAL, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ______________________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID _________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID ________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER			

FIGURE SOP016-5 *(continued)*

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ____________________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS:____

____

____

____

____

SIGNATURE

FIGURE SOP016-6
FIELD PERMEABILITY TEST DATA SHEET

Contractor: **Seq. #** /

Project Name:	Project #:	
Location:	Client:	
Party Chief:	Contractor:	
Observation Well:		
Test Type: Rising/Falling Head w/Slug	Rising/Falling Head w/out Slug	
Start Date:		Discharge Rate

Clock Time	Elapsed Time (min)	Depth to GWL (ft)	Rec (ft)	Clock Time	Elapsed Time	Depth to GWL (ft)	Rec (ft)	Time	Flow Meter	Discharge Rate

Signature: ____ **Date:** ______________________

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FIGURE SOP016-7
GROUNDWATER LEVELS – SINGLE WELL

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:

Well No.: Site: Area:

up (+)/down (-) from: Datum = MSL or:

Measuring Point Description:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:
Input/Units: Range:

Calibration:
Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v) / (mv)

Volume Water Added/Removed:
Discharge Rate:
Initial Water Level (ft):

Pressure Transducer Submergence
Initial (ft): Final(ft): Time:Start: End:
Observed Changes in Adjacent Wells:

Results Recorded on Diskette #:
Diskette File Name:

Signature: ____ **Date:** ______________________

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FIGURE SOP016-8
GROUNDWATER LEVELS – MULTIPLE WELLS

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:
Measuring Point Description:
Remarks:
Well No.:
Site: Area: up (+)/down (-) from:
Datum = MSL or:

Date	Time	Elapsed Time	Depth to Water	Water Elevation	Meas. Meth.	Tape No.	Well Status	Remarks	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

Signature: ______________________________ **Date:** ____________________

FIGURE SOP016-8 *(continued)*

Contractor: **Seq. #** /

Project No.:
Project Name: Location:
Field Party Chief: Client:

Well	Date	Time	Depth to Water	Stickup	MP Elev.	Meas. Meth.	Tape No.	Remarks/MP	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

FIGURE SOP016-9
GROUNDWATER LEVELS DATALOGGERS

Contractor

Project No.: **Well No.:**
Project Name: **Site:**
Field Party Chief: **Area:**

WELL DATA: Stickup: **(ft)** **up (+)/down (-) from:**
MP Elevation: **Datum = MSL or:**

Measuring Point Description:
Remarks:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:
Transducer: Manufacturer: Model: S/N:
Input/Units: Range:
Calibration: Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v)

Logging	Date	Time	Logging Time Interval	WL, ft Below MP	Submergence (logger reading)	Meas. Method	Tape No.	Well Status	Transducer Moved	Remarks	Initials
Start											
Stop											
Start											
Stop											

Data Transfer to Disk

Date	Time	File Name	Software Used for Transfer	Output Format	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently
NP = Nearby well pumping
NRP = Nearby well recently pumped
X = Obstructed

Signature **Date**

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Standard Operating Procedure No. 019
for
Monitoring Well Installation

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 01
October 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 019	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
01	October /2019	Updated various items associated with current practice and deeper (>100 feet) monitoring wells	Kevin Sharpe Ryan Guth	Matthew Bowman

1. SCOPE AND APPLICATION

The installation approach and details for monitoring wells are driven by the existing conditions at the project site and state and local regulatory requirements. The project team should carefully address these considerations as they may require some deviations for procedures described in this standard operating procedure (SOP). State and local regulatory requirements supersede the guidance prescribed herein. The purpose of this SOP is to delineate the quality control measures required to ensure the accurate installation of monitoring wells. The applicable site-specific Work Plan should be consulted for specific installation instructions. The term "monitoring wells," as used herein, is defined to denote any environmental sampling well. An example Well Construction Log Form is provided in Attachment A. Alternate, equivalent forms are acceptable.

2. MATERIALS

2.1 DRILLING EQUIPMENT

The following drilling equipment may be required:

- Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
- Source of approved water
- Water level indicator
- Weighted steel tape measure
- Photoionization detector: RAE® Systems MiniRAE 3000 (or equivalent)
- Lower explosive limit – oxygen monitor
- Steel drums for intrusion-derived wastes (drill cuttings, contaminated personal protective equipment, decontamination solutions, etc.)
- Heavy plastic sheeting
- High temperature, high pressure sprayer and water obtained from approved source for decontaminating drilling equipment
- Sorbent pads and/or log.

2.2 WELL INSTALLATION MATERIALS[1]

The following well installation materials may be required:

- Well screen:[2]
  - Polyvinyl chloride (PVC): Johnson (or equivalent); PVC 0.010 slot; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with ASTM International (ASTM) D2665, D1784, and F480; free of ink markings; and cleaned and prepackaged by manufacturer.
  - Stainless steel: Johnson (or equivalent); stainless steel 0.010 slot; 304 stainless steel[3]; ASTM F480 flush threads; cleaned, wrapped, and heat sealed by manufacturer.
- Riser pipe:
  - PVC: Johnson (or equivalent); STD; PVC; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with ASTM, D1784, and F480; free of ink markings; and cleaned and prepackaged by manufacturer.
  - Stainless steel: Johnson (or equivalent); Schedule 5; 304 stainless steel; ASTM Type A312 material; 4-inch (in.) diameter; cleaned, wrapped, and heat sealed by manufacturer.
- Plugs/caps: Johnson (or equivalent); standard PVC or stainless steel.
- Filter pack: Morie, 100 well gravel (or equivalent). NOTE: Final gradation may vary as a function of the gradation of the formation.[2]
- Fine Silica or Ottawa sand (or equivalent).
- Bentonite seal: BAROID, bentonite pellets (3/8-in. diameter).
- Cement: Type II Portland cement (table below).

---

[1] Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack, bentonite powder, and bentonite pellets will be supplied to the Project Manager.

[2] Well screen slot size and filter pack gradation will be determined from sieve analysis of aquifer materials. Screen and casing material type will be determined based on field tests of groundwater chemistry and contaminants.

[3] Unless the sum of Cl-, F-, and Br- is >1,000 parts per million (ppm), in which case Type 316 should be used.

Cement Type	Special Characteristics	Recommended Usage
I	No special properties	General use as grout mix or cement plug (if sulfates <250 ppm), surface pad.
IA	Air-entraining Type I (Note that air entrainment properties can be achieved by chemical admixtures)	Air entrainment gives cement greater freeze-thaw resistance. Recommended for surface pads.
II	Moderate sulfate resistance, low heat of hydration	General use as grout mix or cement plug where groundwater sulfate >250 ppm and <1,500 ppm, surface pad.
IIA	Air-entraining Type II	See Type IA.
III	High early strength, high heat of hydration	Elevated temperature can damage well casing and fracture grout/cement plugs. NOT RECOMMENDED.
IIIA	Air-entraining Type III	NOT RECOMMENDED.
IV	Low heat of hydration	General use as grout mix or cement plug preferred type for well abandonment to ensure intact grout/cement plug.
V	High sulfate resistance	Use when groundwater sulfate levels >1,500 ppm.

NOTE: ppm = Part(s) per million.

- Bentonite powder: Baroid, Aquagel Gold Seal.
- Steel protective casing: Brainard-Kilman (or equivalent) zinc-plated steel, lockable, painted.[4]
- Geotextile: Milrafi (or equivalent); GTF 130; non-woven; 4 ounces.
- Coarse (blanket) gravel: Crushed stone aggregate.
- Containers for purged water, as required.
- Submersible pump or bailer of appropriate capacity, and surge block sized to fit well.
- Hach DREL 2000 portable laboratory (or equivalent).
- Conductivity, pH, oxidation-reduction potential (ORP), turbidity, dissolved oxygen, and temperature meters.
- Water level meter or interface probe
- Protective steel covers.

---

4. All painted components (protector casing, steel bollards/pickets) will be painted high-visibility orange and allowed to dry completely prior to being brought onsite.

- Portland Type IA cement (see previous table) alone, or as part of concrete mix for surface pad.

- Steel posts (bollards/pickets), painted (see footnote).

2.3 DOCUMENTATION

The following documents may be required by field staff supervising the installation of monitoring wells:

- Copy of appropriate Work Plan
- Copy of approved Health and Safety Plan
- Copies of well and excavation permits
- Boring log forms
- Well completion diagram form
- Well development form.

2.4 GEOLOGIST'S PERSONAL EQUIPMENT

The following equipment may be required for the geologist:

- 10 times magnifying hand lens
- Unified Soil Classification System chart
- Munsell soil color chart
- Sieve set (Keck model SS-81 or equivalent)
- Personal protective equipment as required by the Health and Safety Plan.

3. PROCEDURE

3.1 MATERIALS APPROVAL

Water sources for drilling, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the drilling equipment. Information required for the water source includes: water source, manufacturer/ owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analyses over the past 2 years, and name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the Project Manager prior to the arrival of the drilling equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product description, and intended use for the product.

Granular filter pack material must be approved by the Project Manager prior to drilling. A 1-pint representative sample must be supplied to the Project Manager. Information required includes: lithology, grain size distribution, brand name, source, processing method, and slot size of intended screen.

Screen and casing materials must be approved by the Project Manager prior to drilling. Materials for deep wells must have adequate strength to prevent collapse or damage. A collapsed well is an expensive and time-consuming mistake.

Portland Type II cement will be used for grout (see previous table).

3.2 DRILLING

The objective of the selected drilling technique is to ensure that the drilling method provides representative data while minimizing: (1) subsurface contamination, (2) cross-contamination of aquifers, and (3) drilling costs. The preferred drilling method for shallow (<100 feet [ft]) well installation is hollow-stem auger, although direct-push and sonic methods can also be considered, and other methods can be approved as conditions warrant. The method used at a specific site will be proposed in the work plan and evaluated by the Project Manager.

If the design depth of the well is >100 ft, other rotary drilling methods (mud rotary, air rotary, air rotary with downhole hammer, dual-tube reverse rotary, etc.) may be used to install wells. The following drilling fluids and methods are approved in the order listed: (1) rotary drilling with water from an approved source as drilling fluid (clays from the formations will tend to thicken the fluid and coat the walls of the borehole and this is acceptable); (2) rotary drilling with water as a fluid, advancing a temporary casing with the bit to maintain an open hole; and (3) mud rotary using water with additives as drill fluid. Due to the potential for aquifer contamination and plugging, mud rotary drilling is not recommended for monitoring wells. If, however, "running sands" are encountered and the aquifer is expected to have a relatively high flow rate, then mud rotary is considered an approved method. Pure sodium bentonite is the only approved additive. Mud rotary drilling must be halted at the last aquitard above the target aquifer. Casing must be set, all bentonite-bearing fluids flushed from the hole and drill rig, and drilling may be resumed using water only as the drill fluid until the target depth is reached. Rotary drilling with air is useful and efficient in bedrock drilling and is typically done with no additions to the air stream; however, additives (e.g., foam) can be considered if conditions warrant.

A site geologist will be present during all well drilling and installation activities and will fully characterize all tasks performed in support of these activities into the monitoring well logbook. The site geologist will be responsible at only one operating rig for: (1) logging of samples, (2) monitoring of drilling operations, (3) recording of water losses/gains and groundwater data, (4) preparing the boring logs and well diagrams, and (5) recording the well installation procedures of the rig. The site geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties as outlined in the contractual documents. Items in the possession of each site geologist will include: (1) the approved Health and Safety Plan; (2) this SOP; (3) a hand lens (10 times); (4) a standard color chart; (5) grain-size chart;

(6) a weighted (with steel or iron) steel tape long enough to measure the deepest well, heavy enough to reach that depth, and small enough to fit readily within the annulus between the well and drill casing; and (7) a water level measuring device, preferably electrical.

Only anti-seizing compounds that are environmentally safe (i.e., commercial products for environmental drilling projects or solid vegetable shortening [e.g., Crisco®]) may be used on downhole drilling equipment. Compounds containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, and field equipment/vehicles.

Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction. Steps in the form of grading or sandbagging can be taken to ensure that runoff is directed away from the borehole.

Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in areas in contact with drilling fluid. The ground surface at the well site will be protected from possible coolant, fuel, and hydraulic fluid spills and/or leakage by placement of plastic sheeting with raised edges; and draining into a lined catch basin large enough to contain spills and/or leakage from motors, radiators, or vehicle tanks. Sorbent pillows will be placed to catch obvious leaks from the drill rig. Sorbent logs may be used instead of, or in conjunction with, a lined catch basin to contain spills.

An accurate measurement of the water level will be made upon encountering water in the borehole and later upon stabilization (levels will have less usefulness during mud rotary drilling). Levels will be periodically checked throughout the course of drilling. Any unusual change in the water level in the hole (i.e., a sudden rise of a few inches may indicate artesian pressure in a confined aquifer) will be the basis for cessation of drilling. The geologist will immediately contact the Project Manager[5]. Particular attention for such water level changes will be given after penetrating any clay or silt bed, regardless of thickness, which has the potential to act as a confining layer.

Anticipated depths of wells are given in well-specific work plans. In case the previously defined criteria have not been met before the depth range for a given hole is reached, the geologist will stop the drilling and confer with the Project Manager. The current boring conditions (depth, nature of the stratigraphic unit, and water table depth) will be compared to those of other wells nearby to decide to continue drilling or terminate and complete the well.

If the well is to be installed in the surficial aquifer, drilling will be terminated before penetrating the basal aquitard. The basal aquitard is defined as the first 2 ft-thick clay below the water table, or below 5 ft in the case of a shallow aquifer.

If the well is to be installed in a lower, confined aquifer:

---

5. The contract technical oversight will also be contacted for guidance.

- Penetrations of aquifers located lower than the water table aquifer will be limited to avoid cross-contamination.

- Placement of new upper confined aquifer wells will be initially limited to those areas where contamination has been confirmed.

- The location of upper confined aquifer wells will be based upon the findings of the water table aquifer investigation. Areas of known contamination will be targeted for installing upper confined aquifer wells for the purposes of delineating vertical contamination.

- Where possible, upper-confined aquifer wells will be located such that they afford triangulation with other wells within the same aquifer to allow for a determination of groundwater flow direction.

- Some upper-confined aquifer wells will be installed approximately 10-15 ft from water table wells to enable the accurate assessment of vertical hydraulic gradients. If the direction of groundwater flow is known, wells within a group will be located sidegradient of each other.

- The boring will be advanced until the base of the surficial aquifer is reached (Section 3.2).

- An outer surface casing will be set 2-5 ft into the confining layer to minimize the potential for cross-contamination from the unconfined aquifer during drilling activities.

- The surface casing will be driven into the confining bed and grouted into place. Grout will be tremied into the annulus around the outside of the casing to within 5 ft of the ground surface. A grout plug at least 2 ft thick will be tremied into the bottom of the surface casing. The grout will be permitted to cure for 24 hours. All drilling fluids within the surface casing will then be removed, and the casing will be flushed with clean potable water.

- The drilling equipment will be decontaminated, a smaller bit or auger selected, and the hole will be continued through the grout plug into the confined aquifer.

- If deeper aquifers are to be screened, repeat preceding steps until total depth is reached.

If dense non-aqueous phase liquid (DNAPL) contamination is detected during drilling, the well will be terminated and completed at the base of the aquifer as described in Section 3.4. Drilling will not continue through the confining unit.

3.3 LOGGING

All borings for monitoring wells will be logged by a geologist. Logs will be recorded in a field logbook and/or a boring log. If the information is recorded in a logbook, it will be transferred to boring log forms on a daily basis. Field notes are to include, at a minimum:

- Boring number
- Material description (as discussed below)
- Weather conditions
- Evidence of contamination
- Water conditions (including measured water levels)
- Daily drilling footage and quantities (for billing purposes)
- Notations on man-placed materials
- Drilling method and borehole diameter
- Any deviations from established field plans
- Blow counts for standard penetration tests
- Core and split-spoon recoveries.

Material description for soil samples must include:

- Classification
- Unified Soil Classification System symbol
- Secondary components and estimated percentages
- Color
- Plasticity
- Consistency
- Density
- Moisture content
- Texture/fabric/bedding and orientation
- Grain angularity
- Depositional environment and formation
- Incidental odors
- Photoionization detector reading(s)
- Staining.

A typical boring log entry will include: (1) Munsell color, (2) moisture content, (3) primary components, (4) secondary components, (5) Unified Soil Classification System symbol, and (6) other attributes (density, consistency, and others from the list above). The relative proportions of secondary components will be described with descriptive terms: trace (less than 5 percent), few (6-15 percent), little (16-30 percent), some (31-49 percent), and (36-50 percent).

Material description for rock samples must include:

- Classification
- Lithologic characteristics

- Bedding/banding characteristics
- Color
- Hardness
- Degree of cementation
- Texture
- Structure and orientation
- Degree of weathering
- Solution or void conditions
- Primary and secondary permeability
- Sample recovery
- Incidental odors
- Photoionization detector reading(s)
- Staining.

3.4 WELL CONSTRUCTION AND INSTALLATION

3.4.1 General

After the borehole is drilled and logged, the hole will be backfilled as required for proper screen placement. The integrity of the aquitard will be restored by placing a bentonite plug of an appropriate thickness, either to the top of the aquitard (normal well installation) or to within 0.3 ft of the top of the aquitard (DNAPL well). Aquifer fill will be clean filter pack.

The installation of monitoring wells in uncased or partially cased holes will begin within 12 hours of completion of drilling or, if the hole is to be logged, within 12 hours of well logging, and within 48 hours for holes fully cased with temporary drill casings. Once installation has begun, work will continue until the well has been grouted and the drill casing has been removed.

The construction of each well will be depicted as built in a well construction diagram. The diagram will be attached to the boring log and will graphically denote:

- Borehole depth
- Screen location and length
- Joint location
- Granular filter pack
- Seal
- Grout
- Cave-in
- Centralizers
- Height of riser
- Protective casing detail.
- Water level on the construction date

3.4.2 Well Casing and Screen Installation

Assemble appropriate decontaminated lengths of pipe and screen. Make sure these are clean and free of grease, soil, and residue. Lower each section of pipe and screen into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethelyne tape, or glue may be used in joining the pipe and screen sections. If a well extends below 50 ft, centralizers will be installed at 50 ft and every 50 ft thereafter except within screened interval and bentonite seal. Centralizer material will be PVC, polytetrafluoroethelyne, or stainless steel. Determination of centralizer material will be based on the same criteria as screen and casing selection.

Normal screen placement for the water table (surficial) aquifer will extend from 2 ft above the static water level to no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable. The bottom of the screen will rest no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable.

NOTE: The end cap in DNAPL wells will rest on the bottom of the hole, or bentonite backfill if applicable (Section 3.2).

Screen placement for a confined aquifer well will normally be at the top of the confined aquifer.

Screen lengths will not normally exceed 10 ft. If it appears advantageous in a given situation (e.g., to screen an entire aquifer that is thicker than 10 ft), approval must be sought on a case-by-case basis from the appropriate regulatory agency. Otherwise, wells will be screened as follows:

Thickness of Aquifer	Action
<10 ft	Screen entire aquifer
>10 ft <30 ft	Screen top 10 ft; consider vertically nested well cluster
>30 ft	Install vertically nested well cluster

Plastic well screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or ASTM equivalent for potable water usage. These materials will bear the appropriate rating logo. If the logos are not present, a written statement from the manufacturer/supplier stating that the materials contain the appropriate rating must be obtained. Material used will be new and essentially chemically inert to the site environment.

Well screen and casing should be inert with respect to the groundwater; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants. The screen will be capped without sediment trap or DNAPL sampling cup, and lowered into the hole. The well casing will be pre-cut to extend 2-2.5 ft above ground surface. Prior to placement of the last piece of well casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

Screen slot size will be appropriately sized to retain 90-100 percent of the filter pack material, the size of which will be determined by sieve analysis of formational material.

Stainless steel screens will be used in DNAPL wells. The formation grain size will be multiplied by the higher factor (6) to determine filter pack grain size. This will ensure that the filter pack is sufficiently coarse to permit DNAPL to pass freely from the formation into the coarser filter pack, then into the open well (Cohen and Mercer 1993).

DNAPL sampling cups are prohibited. The well screen will be capped and set 0.3 ft (0.5 ft maximum) into the top of the confining bed and rest on the bottom of the hole or bentonite backfill (if used). No sand will be placed below the screen.

3.4.3 Filter Sand Installation

Place the appropriate filter pack. Monitor the rise within the annulus with a weighted tape to assure that bridging is not occurring. After the filter pack is in place, wait 3-5 minutes for the material to settle, tamp and level with a capped PVC pipe, and check its depth with a weighted steel tape.

Filter pack material will be placed, lightly tamped, and leveled. Filter pack will extend from the bottom of the hole to a height of 1-2 ft above the top of the screen. The filter pack will be capped with a minimum of 1 ft of fine (e.g., Ottawa-type) sand to prevent the bentonite seal (placed as pellets) from infiltrating the filter pack. If the bentonite seal is placed as a slurry, a minimum of 2 ft of fine sand will be required.

If the hole is less than 20 ft deep, the filter pack may be poured into the annulus directly. If the hole is deeper than 20 ft, the filter pack must be tremied into place.

Granular filter packs will be chemically and texturally clean, inert, and siliceous.

Filter pack grain size will be based on formation grain size analysis. The D30 (70 percent retained) sieve size multiplied by a factor of not less than 3 nor greater than 6 will be used to determine the appropriate grain size.

Calculations regarding filter pack volumes will be entered into the field logbook along with any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the field logbook.

3.4.4 Bentonite Installation

Install the bentonite seal (2- to 5-ft thick) by placing bentonite pellets into the hole gradually. If the well is deeper than 20 ft, a tremie pipe will be used to place either bentonite pellets or slurry. Tamp and level pellets. If the well is within 20 ft deep, tamp with a capped PVC pipe; if >20 ft, tamping may be accomplished with the weighted end of the tape. In either case, check the depth to the top of the seal with a weighted tape as above.

If the bentonite pellets are of poor quality, they may have a tendency to hydrate and swell inside the tremie pipe and bridge. This situation may be solved by the following procedure:

1. Use a different brand of pellets. Different brands may have longer hydration times.

2. Freeze the pellets[6]. Note that this will require a longer wait time to allow proper hydration after the pellets thaw.

3. Place the bentonite seal as a slurry using a side-discharge tremie pipe as though installing grout. Note (Section 3.4) this will require that a minimum of 2 ft of fine sand be placed as a cap on top of the filter pack material.

Wait for the pellets to hydrate and swell. Hydration times will be determined by field test or by manufacturer's instructions. Normally this will be 30-60 minutes. Document the hydration time in the field notebook. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

The final depth to the top of the bentonite seal will be measured and recorded.

3.4.5 Grout Installation

Mix an appropriate cement-bentonite grout (described below). Be sure the mixture is thoroughly mixed and as thick as is practicable.

Lower a side discharge tremie pipe into the annulus to the level of the pellet seal.

Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing. Stop the grout fill at 5 ft below the ground surface. Allow to cure for not less than 12 hours. If grout settles more than 6 in., add grout to bring level back up to within 5 ft of ground surface. Place approximately 2 ft of bentonite pellets (minimum 0.5 ft) in annulus. Seat the protective casing in the bentonite seal, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Fill inner annulus (between well casing and protective casing) with bentonite pellets to the level of the ground surface. Cover bentonite pellets with 1 ft of clean granular material (coarse sand or pea gravel filter pack). Fill the outer annulus (between the protective casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing. Lock the cap.

---

[6] Bentonite pellets may be "flash-frozen" by brief immersion in liquid nitrogen (LN2). This can be accomplished by pouring LN2 over a small quantity (0.25-0.5 bucket) of pellets, allowing the LN2 to boil off, then pouring the pellets into the tremie pipe. NOTE: Use of LN2 is an additional jobsite hazard and must be addressed in the contractor's Health and Safety Plan. This contingency must be covered before drilling starts in order to avoid delays in well installation.

– OR –

Continue the grout fill to the ground surface. Seat the protective casing in the grout, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Lock the cap.

– AND –

Allow the grout slurry to set overnight.

Fill the outer annulus (between the casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing.

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, Type II) (see previous table)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- 8 gallons (maximum) of approved water per 94-pound bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement. Grout placement will be performed using a commercially available grout pump and a rigid, side discharge tremie pipe.

The following will be noted in the field logbook: (1) calculations of predicted grout volumes; (2) exact amounts of cement, bentonite, and water used in mixing grout; (3) actual volume of grout placed in the hole; and (4) any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the field logbook.

Well protective casings will be installed around all monitoring wells on the following day as the initial grout placement around the well. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

3.4.6 Surface Completion

Cut the riser with a pipe cutter approximately 2-2.5 ft above grade. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the well casing is less than or equal to 0.02 ft. Notch, file, or otherwise permanently scribe a permanent reference point on the top of the casing.

Torches and saws may not be used to cut the riser. Care must be taken that all filings or trimmings cut from the reference point fall outside the riser rather than into the well. **Under no circumstances will a permanent marker or paint pencil be used to mark the reference point**.

The tops of all well casings will be capped with covers composed of materials compatible with the products used in the well installation. Caps may either be vented, or a telescopic fit, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case, it should be secure enough to preclude the introduction of foreign material into the well yet allow pressure equalization between the well and the atmosphere (e.g., avoid the use of unvented well plugs).

In some locations, safety requirements may mandate that a well be flush-mounted with no stickup. If a flush-mounted well is required at a given location, an internal pressure cap must be used instead of a vented cap to ensure that rainwater cannot pool around the wellhead and enter the well through the cap.

Slope the ground surface away from the casing for a distance of 2 ft, at a rate of no less than 1 in. in 2 ft. Surface this sloping pad with a geotextile mat covered by 6 in. of coarse gravel.

– OR –

Frame and pour a 4-ft square × 6-in. thick (4 ft × 4 ft × 6 in.) concrete pad centered around the protective casing.

– AND –

Set pre-painted protective steel pickets (3 or 4) evenly around and 4 ft out from the well. These pickets will be set into 2 ft deep holes, the holes will then be filled with concrete; and, if the pickets are not capped, they will also be filled with concrete.

3.5 WELL DEVELOPMENT

Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well have been removed while restoring the aquifer hydraulic conductivity. Development corrects any damage to or clogging of the aquifer caused by drilling, increases the permeability of the aquifer in the vicinity of the well, and stabilizes the formation and filter pack sands around the well screen.

Well development will be initiated after 48 consecutive hours but no longer than 7 calendar days following grouting and/or placement of surface protection.

Two well development techniques, over pumping and surging, will be employed in tandem. Over pumping is simply pumping the well at a rate higher than recharge. Surging is the operation of a plunger-like device (e.g. surge block) up and down within the well casing similar to a piston in a cylinder.

3.5.1 Materials Required

The following materials will be required for well development:

- Well Development Form
- Boring Log and Well Completion Diagram for the well
- Submersible pump or bailer of appropriate capacity, and surge block
- Conductivity, pH, ORP, turbidity, dissolved oxygen, and temperature meters
- Water-level meter or interface probe, as appropriate
- Containers for purged water, if required.

3.5.2 Summary of Procedures and Data Requirements

Pump or bail the well to ensure that water flows into it, and to remove some of the fine materials from the well. Removal of a minimum of one equivalent volume is recommended at this point. The rate of removal should be high enough to stress the well by lowering the water level to approximately half its original level. If well recharge exceeds 15 gallons per minute, the requirement to lower the head will be waived.

Slowly lower a close-fitting surge block into the well until it rests below the static water level, but above the screened interval. (NOTE: This latter is not required in the case of a light non-aqueous phase liquid well.)

Begin a gentle surging motion that will allow any material blocking the screen to break up, go into suspension, and move into the well. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one equivalent volume.

Repeat previous step at successively lower levels within the well screen until the bottom of the well is reached. Note that development should always begin above, or at the top of, the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.

Development is expected to take at least 2 hours in a small well installed in a clean sand, and may last several days in large wells, or in wells set in silts with low permeabilities.

Development will continue until little or no sediment can be pulled into the well, and target values for parameters listed below are met.

At a minimum, development will remove 3-5 well volumes of water. One development volume is defined as (1) equivalent volume, plus (2) the amount of fluid lost during drilling, plus (3) the volume of water used in filter pack placement.

1. Monitor water quality parameters (turbidity, pH, conductivity, ORP, dissolved oxygen, and temperature) before beginning development procedures, and after removing 2, 2.5, and 3 well volumes of water.

2. If these parameters have stabilized over the three readings, the well will be considered developed.

3. If the parameters have not stabilized after these three readings, continue pumping the well to develop, but stop surging. Monitor the stabilization parameters every half development volume.

4. When the parameters have stabilized over three consecutive readings at half development volume intervals, the well will be considered developed.

All water removed must be disposed of as directed by the Work Plan.

Record all data as required on a Field Record of Well Development Form (Attachment B), which is made a part of the complete well record. These data include:

- Depths and dimensions of the well, casing, and screen obtained from the well diagram.

- Water losses and uses during drilling, obtained from the boring log for the well.

- Depth-to-water measurements.

- Measurements of the following indicator parameters: turbidity, pH, conductivity, ORP, dissolved oxygen, and temperature.

- Target values for the indicator parameters listed above are as follows: pH – stabilize, conductivity – stabilize, ORP – stabilize, dissolved oxygen –- stabilize, temperature – stabilize, and turbidity – 5 nephelometric turbidity units or stabilize. A value is considered to have stabilized when three consecutive readings taken at half development volume intervals are within 10 percent of each other.

- Notes on characteristics of the development water.

- Data on the equipment and technique used for development.

- Estimated recharge rate and rate/quantity of water removal during development.

3.6 TEMPORARY WELLS

Temporary wells typically differ from permanent installations in the following ways: (1) the wells are typically shallow and have small diameters; (2) installation methods tend to be driving, direct-push, but could be any of the rotary methods or sonic; and (3) the wells tend to have limited surface completions with no protective casing, concrete pad, or bollard posts. Keep in mind that temporary wells may still require well permits and perhaps reporting on abandonment. The installation should follow steps to allow for expedited abandonment after a limited timeframe, meaning: (1) the casing should be amenable to pulling or ripping, (2) the borehole should be limited in diameter to expedite filling, and (3) surface disturbance should be minimized to allow for quick site restoration and possible reseeding.

3.7 WELL SURVEY

Newly installed monitoring wells will typically be surveyed by a state-registered surveyor to determine the geographical coordinates and elevations. Typical standards for the survey are surveying the well to vertical accuracy of 0.010 U.S. survey ft using the 1988 North American Vertical Datum and a horizontal accuracy to within 0.10 ft tied to site datum (World Geodetic System 1984 Universal Transverse Mercator Zone 11 North). The elevations for the natural ground surface (not the top of the grout collar) and the highest point on the riser casing rim of the uncapped well casing, and the protective casing for each well will be surveyed. A survey mark will be indicated by a small groove or other permanent marking in the well riser casing.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of physical and chemical hazards and preventive measures to be used during well installation and development activities.

6. REFERENCES

Cohen, R.M. and J.W. Mercer. 1993. DNAPL Site Evaluation, CRC Press, Inc.

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Attachment A

Well Construction Log Form

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WELL CONSTRUCTION LOG

EA Engineering, Science, and Technology, Inc., PBC

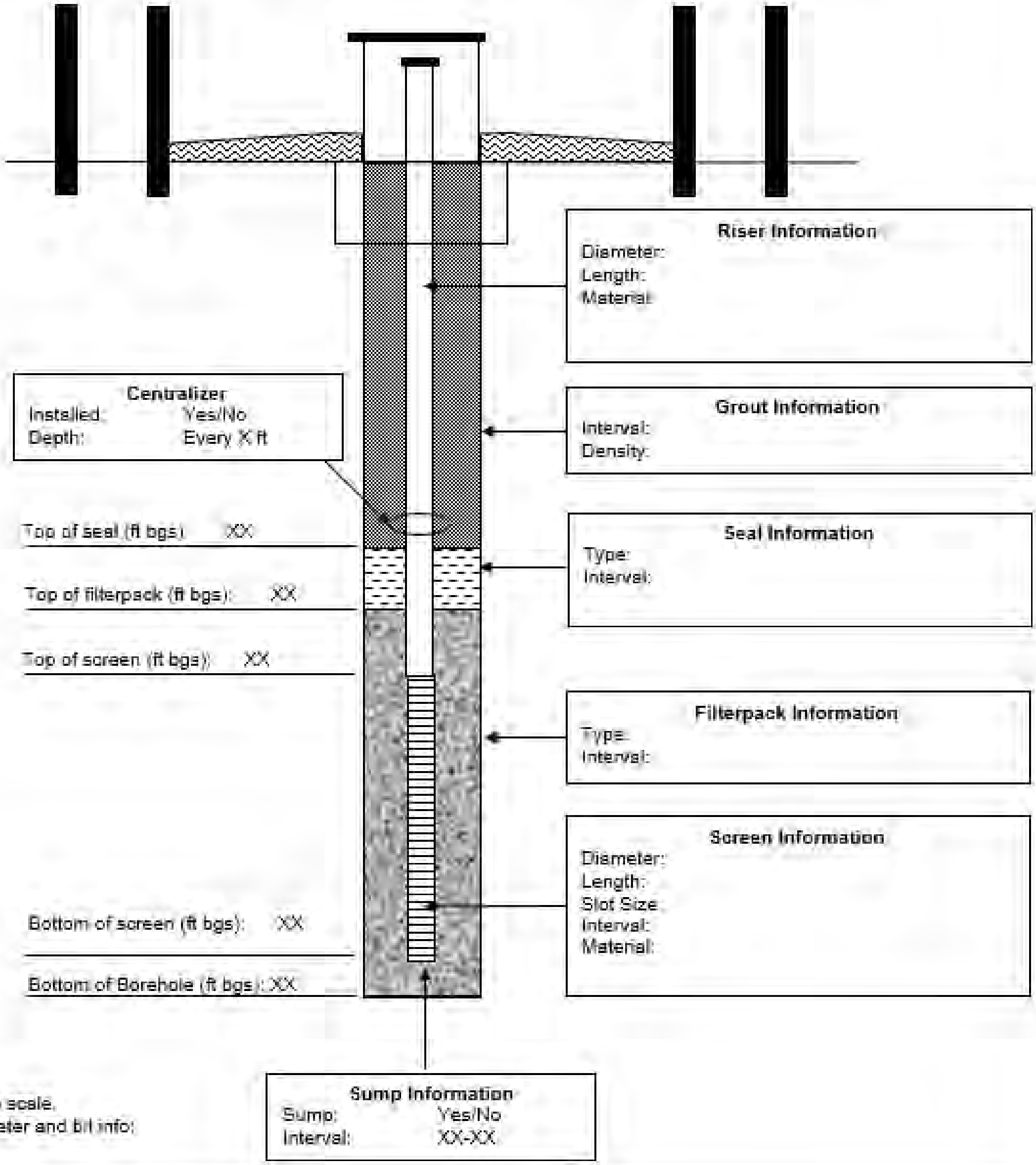
Project Name/ Project No.:

Location:

Monitoring Well ID No.:

[Coordinates]
Not Yet Surveyed
[Aquifer Type]

All footages indicated are below ground surface (bgs).



Riser Information
Diameter:
Length:
Material:

Centralizer
Installed: Yes/No
Depth: Every X ft

Grout Information
Interval:
Density:

Top of seal (ft bgs): XX

Seal Information
Type:
Interval:

Top of filterpack (ft bgs): XX

Top of screen (ft bgs): XX

Filterpack Information
Type:
Interval:

Screen Information
Diameter:
Length:
Slot Size:
Interval:
Material:

Bottom of screen (ft bgs): XX

Bottom of Borehole (ft bgs): XX

Sump Information
Sump: Yes/No
Interval: XX-XX

Notes:
Features not to scale.
Borehole diameter and bit info:

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Attachment B

Field Record of Well Development Form

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FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth To Water (ft):	D. Well Volume/ft:
B. Total Well Depth (ft):	E. Total Well Volume (gal)[C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						
Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						
Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Standard Operating Procedure No. 021
for
Sediment Sampling

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
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Hunt Valley, Maryland 21031

Revision: 02
March 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 021	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
02	March 2019	Systematic review and update	Caryn Kiehl-Simpson Peggy Derrick	Matthew Bowman

1. SCOPE AND APPLICATION

This standard operating procedure (SOP) delineates protocols for sampling sediments from streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols, which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. PROCEDURES

The water content of sediment varies. Sediments range from soft to dense and fine to rocky. A variety of equipment may be necessary to obtain representative samples, even at a single site. Factors to consider in selecting the appropriate sampling equipment include sample location (edge or middle of the waterbody), depth of water and sediment, grain size, water velocity, and analytes of interest.

3. GENERAL PROCEDURES

1. All samples must be handled in a manner that satisfies the project Quality Assurance Project Plan, SOPs, and data quality objectives. Prior to a field effort, verify general sample requirements such as sample numbers, volume requirements, holding times, sample preservation requirements, and duplicate and other quality assurance/quality control sample requirements. Verify general sampling logistics such as site access, access to temporary and secure field storage, designated sample transport procedures, laboratory shipping address(es), and points of contact.

2. Comply with the Health and Safety Plan specifications for proper personal protective equipment (steel-toed boots, safety glasses, hard hats, splash shields, and Tyvek as appropriate and designated in the site-specific Health and Safety Plan). Wear chemically-protective gloves when collecting samples appropriate for the potential constituents to be sampled. Complete review of emergency plans and equipment. If sampling from a boat or near waterbodies with depths of 4 feet or more, the sampling team will wear life jackets. Review and comply with SOP Number (No.) 035 Small Boat Operations, if applicable.

3. Verify local One Call service has been contacted prior to sampling activities and proper utility clearance has been obtained. Verify site access, dockage, other required communications (e.g., U.S. Coast Guard, local authorities, etc.) have been secured.

4. Review specific responsibilities of each field team member and conduct daily safety briefings as specified by the site-specific Safety and Health Plan.

5. Confirm sampling equipment and supplies are adequate for the field effort. In addition to the sampling equipment and vessel requirements, verify that support equipment including, but not limited to, spatulas, scoops, spoons, pans, buckets, bowls, gloves, measuring implements, plastic sheeting, data forms, and logbooks are available. Appropriate sample storage and transport equipment may include a refrigeration unit, ice chests, dry ice or ice, insulation or other stabilization material to protect sample containers, custody seals, sampling containers, and shipping paperwork. Confirm decontamination supplies and equipment are sufficient for the duration of the field effort.

6. Collect samples first from areas suspected of being the least contaminated to minimize the risk of cross-contamination.

7. If surface water and sediment samples are to be collected at the same location or co-located (if both are required in the project-specific Sampling and Analysis Plan), collect the surface water sample first (refer to SOP No. 007 for surface water sampling). Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

8. Water quality measurements may be required at the same locations as the surface water and/or sediment sample locations. Collect the water quality measurements before the collection of surface water or sediment samples (refer to SOP No. 043 for water quality measurement collection).

9. Minimize the potential for sediment disturbance prior to sampling. Care should be taken when wading into a waterbody and/or during vessel operations prior to sampling. These activities can disturb the sediment. Move slowly and cautiously, approach the sample location from downstream. If flow is not strong enough to move entrained particles away from the sample location, wait for the sediment to resettle before sampling.

10. Collecting samples directly into sample containers is not recommended. Sediment samples should be placed in Teflon®, stainless steel, or glass trays, pans, or bowls for sample preparation and processing.

11. Use the proper equipment and material construction for the analytes of interest. For example, for volatile organic compound analysis, the sampling material in direct contact with the sediment or surface water must consist of Teflon, polyethylene, or stainless steel.

12. Refer to EA SOP No. 005 (Field Decontamination) for proper decontamination methods before and after sampling and between samples.

13. Collect samples for volatile organic compound analysis and acid volatile sulfide analysis first. Do not mix such samples before placing them in the sample containers. For composite volatile organic compound and acid volatile sulfide samples, place equal aliquots of each subsample in the sample container with no headspace. To maintain sample integrity, exposure to oxygen/air should be limited to the extent possible.

14. Sediment that will be analyzed for other constituents should be prepared as follows:

    - Place the sediment in a mixing container.
    - Divide the sediment into equal quarters by volume.
    - Mix each quarter separately and thoroughly.
    - Combine the quarters and mix thoroughly.
    - For composite samples, mix each subsample as described above. Place equal aliquots of each subsample in a mixing container and follow the procedure described above.
    - Sediment preparation activities should be performed where the potential of contamination from external sources (e.g., running engines) can be minimized or eliminated.

15. Mark the sampling location on a site map. Record sampling location coordinates with a Global Positioning System unit, photograph (optional, recommended), describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location (if appropriate). The photographs and description must be adequate to allow the sampling station to be relocated at a future date.

16. Dispose of investigation-derived wastes according to applicable rules and regulations.

4. CORERS

A corer provides a vertical profile of the sediment that may be useful in tracing historical contaminant trends, geological characterization and dating, and characterizing the depth of impacts at a site. Because displacement is minimal, a corer is particularly useful for maintaining the integrity of the vertical sediment profile. Core samplers are also useful when it is important to maintain an oxygen-free environment as they limit oxygen exchange with the air more effectively than grab samplers. Corers can be constructed out of a variety of materials.

4.1 EQUIPMENT

The following list of equipment may be needed during the collection of sediment core samples. Depending upon the actual collection method used and the analyses that will be conducted in the samples, not all equipment on the list may be used.

- Probing equipment for pre-sampling testing for utilities
- Sampling vessel, floating platform (properly equipped and sized barge or boat), and waders and plan for collecting samples by hand (may significantly limit sample depth)
- Winch
- Crane, boom arm or A-frame
- Sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.)
- Core liners, core catchers, liner caps, etc.
- Saw, knife, and cutters to open or split core liners
- Sampling vessel
- Propulsion method for sampling vessel or floating platform
- Containers, buckets, and tubs
- Small trays
- Calibration bucket
- Wash box
- Glassware
- Logbook
- Labels
- Coolers
- Spoons
- Water filters
- Gloves for sampling
- Gloves for other sampling activities such as cutting, equipment handling, etc.

- Measuring device
- Decontamination chemicals and de-ionized water.

4.2 PROCEDURE

4.2.1 Manual Sampling

When sampling manually, a polyvinyl chloride pipe (commonly 2-inch in diameter) with a Teflon or polyethylene liner (as an example) can be lowered into the sediment; a well cap can be used to form an airtight seal and negative pressure as the pipe is withdrawn.

1. Ensure that the corer and (optional) liner and other sampling equipment are properly cleaned.
2. Position downstream of the sample location.
3. Force the corer into the sediment with a smooth continuous motion. Rotate (not rock) the corer if necessary to penetrate the sediment.
4. Twist the corer to detach the sample; then withdraw the corer in a single smooth motion. If the corer does not have a nosepiece, place a cap on the bottom to keep the sediment in place.
5. Remove the top of the corer and decant the water in a slow controlled manner (into appropriate sample containers for surface water analysis, if required).
6. Remove the nosepiece or cap and begin sample description, logging, and processing per the work planning documents.
7. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.
8. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may need to be obtained if the core recovery is insufficient to achieve the required volume. Verify recovery limits are in accordance with work planning documents and data quality objectives.
9. Process the core samples as described in work planning documents.

4.2.2 Sampling from a Vessel

1. Select a sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.) suitable for the bottom conditions, water depth expected, water velocity, the volume of material needed, and the planned/targeted depth of sampling.

2. Select sediment coring tools of sufficient diameter and length to obtain the needed sample volume and depth of penetration. Depending on the volume of sediment needed, multiple sediment cores may be required. To the extent possible, predetermine the number of cores required to avoid having to return to a location for additional cores/sample volume.

3. Set up the sediment coring tool and install the core liner tube, drive head, drive shoe, and/or core catcher, piston, and piston line, as appropriate for the specific sampler chosen and the proposed depth of sample/penetration.

4. Securely attach the core sampler to a winch with cable or line of sufficient length and strength to accommodate the weight of the sampler and sample (Vibracore) or other sampler (piston tube or Wildco tube sampler) to sufficient pipe to reach the maximum proposed sample depth.

5. A measurement system should be in place capable of documenting the depth to the sediment surface, depth of penetration, and depth of recovery. Location coordinates should be collected at each sample location (if a vessel navigation system will be used to collect the location coordinates, an offset may be required between the antenna and the sampler deployment location).

6. Slowly lower the sampler through the moon pool or over the side until the sampler reaches the water/sediment interface. The sampler may be lowered using a crane or on a winch cable and A-frame or other mechanical mechanism capable of carry/control the weight of the sampler. The crane, A-frame, or boom arm must have enough clearance to accommodate the length of the sample and sampling apparatus and enough strength to safely accommodate the weight of the sample and sampling apparatus. Note the depth to the top of sediment.

7. Advance the sediment core sampler into the sediment to the proposed depth or refusal, whichever comes first. Vibracore samplers will be advanced by the vibrating head. Vibracore samplers will continue to be attached to the winch line and the rate of descent will be controlled during penetration into the sediment. Piston tube or Wildco tube samplers will be advanced manually. If necessary, a piston tube or Wildco tube sampler may be advanced by tapping the top of the pipe with a rubber mallet. These samplers are intended for soft sediment and will not tolerate heavy abuse from pounding in an attempt to penetrate through debris, shell beds, or consolidated material.

8. Slowly retrieve the sediment coring tool. As soon as possible, cap the bottom of the sample tube to prevent loss of sample. Secure the sampling apparatus.

9. Remove the sediment core liner from the sampling apparatus.

10. Allow the core to drain or siphon water, taking care not to disturb the surface of the sediment. At the first sign of sediment in the drained water sample, cease draining and tie or cap the sample liner to ensure that the surficial layer remains intact in the sample.

11. Cut off any empty core liner to eliminate headspace. Measure core recovery. Acceptable core recoveries may be specified in the work planning documents. Typically, recoveries of 70 or 80 percent are favorable for results interpretation and data evaluations. Lesser recoveries may not sufficiently represent the sediment column. The data quality objectives of a specific project will dictate the selected recoveries. If the sampler meets refusal above the proposed depth, offset the initial location and make up to the required number of attempts. Work planning documents should specify the maximum number of attempts to be made to obtain a core with sufficient recovery. If sufficient recovery cannot be obtained, other drilling and sampling methods and/or location abandonment may be appropriate.

12. If sufficient recovery was obtained in the interval penetrated, process the core and obtain samples from that interval.

13. Write the location identification and orientation (up arrow) on the outside of the core tube with a permanent marker. Write the location identification, date, and time of collection on the core tube cap.

14. The location (Global Positioning System coordinates), collection date and time, penetration depth, recovery depth, and identification for each core should be recorded in the field logbook.

15. Transport sediment cores to the onshore processing area throughout the day, if possible. Data quality objectives and work planning documents may require that core tubes be maintained in a vertical orientation. When possible, transport sediment cores to shore after each location or at an interval that will maintain the integrity of the samples. Cores should be stored under refrigeration or iced on the sampling vessel to maintain sample integrity.

16. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.

17. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may be needed if the core recovery is insufficient to achieve the required volume. Debris and obstructions are possible that may prevent the full penetration and recovery of all of the advanced cores. Observation of debris, obstructions, or hard bottom conditions that preclude advancement of the sampler should be documented in the field logbook.

18. Water quality measurements may be required at each coring location or locations specified in the project work plan. The measurements should be conducted on the same day as the core collection, and prior to the core collection, if possible.

19. Verify that all field measurements and documentation are complete prior to moving off location.

20. Process the core samples as described in work planning documents.

5. SCOOPS AND SPOONS

When sampling at the margins of a waterbody or in shallow water, scoops and spoons may be the most appropriate sampling equipment. For sample collection several feet from shore or in deeper water, the scoop or spoon may be attached to a pole or conduit. Equipment will be a subset of that described above in Section 4.1.

- Stand downstream of the sample location.
- Collect the sample slowly and gradually to minimize disturbing the fine particles.
- Decant the water slowly to minimize the loss of fine particles.
- Transfer the sediment to sample containers or mixing trays, as appropriate.
- Process the samples as indicated by the project work plan.
- Verify that all field measurements and documentation are complete prior to moving off location.

6. DREDGES

Three types of dredges are most frequently used: Peterson, Ponar, and Eckman. Many other dredge types are available; their applicability will depend upon site-specific factors. Equipment will be a subset of that described above in Section 4.1.

6.1 PETERSON, VAN VEEN, AND PONAR DREDGES

These dredges are suitable for hard, rocky substrates, deep waterbodies, and streams with fast currents. Ponars have top screens and side plates to prevent sample loss during retrieval.

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

6.2 ECKMAN DREDGE

The Eckman dredge works best in soft substrates in waterbodies with slow or no flow.

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.

- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.

- Holding the line taut, send down the message to close the jaws.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

7. REFERENCES

Not applicable.

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Standard Operating Procedure No. 025
for
Soil Sampling

Prepared by

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Revision 0
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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-*specific* variances to this standard operating procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 025	
SOP Section	**Variance**

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Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**

1. SCOPE AND APPLICATION

The purpose of this standard operating procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2. MATERIALS

The following materials may be required:

- Bucket auger or push tube sampler
- Drill rig and associated equipment
- Personal protective equipment as required by the Health and Safety Plan
- Split-spoon, Shelby tube, or core barrel sampler
- Stainless steel bowl
- Stainless steel spoon, trowel, knife, spatula (as needed)

3. PROCEDURE

3.1 SUBSURFACE SAMPLES

Don personal protective equipment. Collect split-spoon, core barrel, or Shelby Tube samples during drilling. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a photoionization detector or flame ionization detector. If sampling for volatile organic compounds, determining the area of highest concentration, use a stainless steel knife, trowel, or laboratory spatula to peel and sample this area. Log the sample in the Field Logbook while it is still in the sampler. Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel. Place the sample into the required number of sample jars. Preserve samples as required. Discard any remaining sample into the drums being used for collection of cuttings. Decon sampling implements. All borings will be abandoned.

NOTE: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The Field Logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (Shelby tube) sampler.

3.2 SURFICIAL SOIL SAMPLES

Don personal protective equipment. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

- As each sample is collected, place a standard volume in a stainless steel bowl.
- After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon or spatula.

If no compositing is to occur, place sample directly into the sample jars. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas. Samples for volatile organic compounds will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container. Preserve samples as required. Decon sampling implements.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the Health and Safety Plan.

Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

6. REFERENCES

ASTM International. Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

———. Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers. 1972. Engineer Manual 1110-2-1907 Soil Sampling. 31 March.

Standard Operating Procedure No. 028
for
Well and Boring Abandonment

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Revision 1
January 2021

PROJECT-SPECIFIC VARIANCE FORM

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DOCUMENT REVISION HISTORY

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Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	January 2021	Systematic review and update	Luis Vega Michael Kelly	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocols by which all wells and borings will be safely abandoned. The primary objective of well abandonment is to ensure that the abandoned well or boring does not provide a conduit for the vertical migration of contamination between aquifers. This Standard Operating Procedure applies to boreholes and monitoring wells.

2. MATERIALS

The following materials may be required:

Drill rig	Bentonite pellets (seal)
Filter pack material	Cement (Portland Type II or V)
Pure sodium bentonite with no additives (bentonite) powder (grout)	Approved water

3. PROCEDURE

The procedures used in boring abandonment will ideally accomplish two objectives: (1) protect aquifers from cross-contamination by sealing the borehole, and (2) restore the strata in the borehole to nearly original conditions by selective placement of fill material.

State and local regulations often apply to well and boring abandonment requiring notifications, permits, and licensing. A thorough review of state and local regulations and requirements should be performed while planning well and boring abandonment activities. Be aware that multiple regulatory jurisdictions may apply depending on the location and type of well abandonment activity.

3.1 GROUT

Grout used in construction will be composed, by weight, of the following:

- Twenty parts cement (Portland cement, Type II or V)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- Eight gallons (maximum) of approved water per 94-pound bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

Grout placement will be performed using a commercially available grout pump and a rigid tremie pipe removal; and grouting will be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This will be accomplished by placing a grout pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the top-most section, until grout comes to 3 feet (ft) of the ground surface, then monitored for settlement and finished with mounded cement. Efforts will be made to grout incrementally as the casing is removed.

After 24 hours, the abandoned drilling site will be checked for grout settlement. On that day, any settlement depression will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface.

3.2 BORINGS

The term “Borings” as used in this Standard Operating Procedure applies to any drilled hole made during the course of a remedial investigation that is not completed as a well. This includes soil test borings, soil sampling borings, and deep stratigraphic borings. Whether completed to the planned depth or aborted for any reason prior to reaching that depth, borings will be grouted and normally closed within 4 hours, or within 4 hours of completion of logging.

3.2.1 Shallow Borings Not Penetrating Water Table

Shallow borings made for the collection of subsurface soil samples will be abandoned by backfilling the hole with cuttings from the hole, **if and only if the boring does not penetrate the water table.** Clean sand will be used to make up any volume not filled by the cuttings.

3.2.2 Borings Penetrating the Water Table

Shallow borings made for the collection of subsurface soil samples **that penetrate the water table** will be abandoned by grouting the hole from the bottom to the top.

3.2.3 Deep Stratigraphic Borings

Deep stratigraphic borings will normally be located in areas that, by virtue of the historical record, are presumed relatively uncontaminated. Therefore, these borings are usually over 100 ft from any sampling well locations. Any boring located within 10 ft of a proposed well location, or located directly upgradient or downgradient (on anticipated flow line) of a proposed well location, will be abandoned by placing clean sand in the aquifer intervals and bentonite or grout in aquitard intervals as described below. If the boring is over 10 ft from and/or not upgradient of a proposed well location, the boring will be completely filled with grout.

3.3 WELLS

The following procedure applies to wells aborted prior to completion and existing wells determined to be no longer required for its original purpose, ineffective, or otherwise in need of closure.

If the well is within 10 ft of another monitoring well in the same aquifer, or a replacement well is to be installed within 10 ft of the well, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, the hole will then be backfilled with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 ft or thicker) clay and silt strata. Where sand as backfill approaches the ground surface, 2 ft of bentonite will be placed above the sand and below the concrete plug near the surface. Backfill materials will be placed from the bottom of the hole to within 3 ft of the ground surface. These materials will be allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

If the well is not within 10 ft of another monitoring well, and is not to be replaced by another well within 10 ft of the original location, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole to within 3 ft of the ground surface, and allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

4. REPLACEMENT WELLS

Replacement wells (if any) will normally be offset at least 10 ft from any abandoned well in a presumed upgradient or crossgradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

5. PRECAUTIONS

None.

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Standard Operating Procedure No. 34
for
Drum Sampling

Prepared by

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Revision 1
July 2020

PROJECT-SPECIFIC VARIANCE FORM

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Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	July 2020	Systematic review and update	Mike Phillips, Caron Mierczak	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to provide technical guidance on implementing safe and cost-effective response actions at hazardous waste sites containing drums with unknown contents. Container contents are sampled and characterized for disposal, bulking, recycling, segregation, and classification purposes.

These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required, dependent on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Prior to sampling, drums must be excavated (if necessary), inspected, staged, and opened. Drum excavation must be performed by qualified personnel. Inspection involves the observation and recording of visual qualities of each drum and any characteristics pertinent to classification of the drum's contents. Staging involves the physical grouping of drums according to classifications established during the physical inspection. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination. The contents of a drum can be further characterized by performing various field tests.

If buried drums are suspected, geophysical investigation techniques (i.e., magnetometry or ground penetrating radar) may be employed in an attempt to determine the location and depth of drums. During excavation, the soil must be removed with great caution to minimize the potential for drum rupture.

Until the contents are characterized, sampling personnel should assume that unlabeled drums contain hazardous materials. Labeled drums are frequently mislabeled, especially drums that are reused. Because a drum's label may not accurately describe its contents, extreme caution must be exercised when working with or around drums.

If a drum that contains a liquid cannot be moved without rupture, its contents may be immediately transferred to a sound drum using an appropriate method of transfer based on the type of waste. In any case, preparations should be made to contain the spill (i.e., spill pads, dike, etc.) should one occur.

If a drum is leaking, open, or deteriorated, it must be placed immediately in overpack containers.

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized or if shock-sensitive materials are suspected. A laser thermometer may be effective in order to determine the level of the drum contents via surface temperature differences.

Drums that have been over-pressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums including, but not limited to, hydraulic and remotely operated drum puncturing tools. Drum venting methods must be selected after careful consideration of potential hazards and in coordination with EA's safety coordinator. Venting should be performed from behind a wall or barricade. Once the pressure has been relieved, the bung can be removed and the drum sampled.

Because there is potential for accidents to occur during handling, particularly initial handling, drums should only be handled if necessary. All personnel should be warned of the hazards prior to handling drums. Overpack drums and an adequate volume of absorbent material should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

2. MATERIALS

The following materials may be required:

Absorbent material for spills	Glass thieving tubes or composite liquid waste sampler
Bung wrench	Hydraulic drum opener
Chain-of-custody records	Other appropriate sample jars
Coring device	Personal protective equipment
Decontamination materials	Pneumatic devices
Drum deheader (if necessary)	Stainless steel spatula or spoons
Drum opening devices	Uniquely numbered sample identification labels with corresponding data sheets
Drum overpacks	Appropriate sample containers for laboratory analysis of contents
Drum/Tank Sampling Data Sheets and Field Test Data Sheets for Drum/Tank Sampling or similar	

3. PROCEDURE

3.1 PREPARATION

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain the necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan (HASP).

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

3.2 DRUM EXCAVATION

If it is presumed that buried drums are onsite and prior to beginning excavation activities, geophysical investigation techniques should be utilized to approximate the location and depth of the drums. In addition, it is important to ensure that all locations where excavation will occur are clear of utility lines, pipes, and poles (subsurface as well as above surface).

Excavating, removing, and handling drums are generally accomplished with conventional heavy construction equipment. These activities should be performed by an equipment operator who has experience in drum excavation. During excavation activities, drums must be approached in a manner that will avoid digging directly into them.

The soil around the drum should be excavated with non-sparking hand tools or other appropriate means and, as the drums are exposed, a visual inspection should be made to determine the condition of the drums. Ambient air monitoring should be performed to determine the presence of unsafe levels of volatile organics or other anticipated hazards. Based on this preliminary visual inspection, the appropriate mode of drum excavation and handling may be determined.

Drum identification and inventory should begin before excavation. Information such as location, date of removal, drum identification number, overpack status, and any other identification marks should be recorded on the Drum/Tank Sampling Data Sheet (Attachment A-1) or similar project-specific form.

3.3 DRUM INSPECTION

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The drums should be inspected for the following:

- Drum condition, corrosion, rust, punctures, bungs, and leaking contents

- Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable), or further identifying the drums

- Signs that the drum is under pressure

- Shock sensitivity.

Monitoring should be conducted around the drums using instruments such as radiation meters, organic vapor analyzers, and combustible gas indicators as specified in the site-specific HASP.

Survey results can be used to classify the drums into categories, including the following:

- Radioactive
- Leaking/deteriorating
- Bulging
- Laboratory packs
- Explosive/shock sensitive
- Empty.

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized. Once a drum has been visually inspected and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels, or bands should be used to identify the drum's category based on visual inspection. A description of each drum, its condition, any unusual markings, the locations where it was buried or stored, and field monitoring information should be recorded on a Drum/Tank Sampling Data Sheet or similar project-specific form. These data sheets become the principal recordkeeping tools for tracking the drum onsite.

3.4 DRUM STAGING

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into groups based on their contents, condition, or other criteria specified in the site-specific Work Plan. This separation is performed because the strategy for sampling and handling drums/containers in each of these categories will be different. This may be achieved by visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

Where there is good reason to suspect that drums contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and adverse effects of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums should be moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor. Drums may be restaged as necessary after opening and sampling.

3.5 DRUM OPENING

There are three basic techniques available for opening drums at hazardous waste sites:

1. Manual opening with non-sparking bung wrenches
2. Drum deheading
3. Remote drum puncturing or bung removal.

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under Occupational Safety and Health Administration 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be non-shock sensitive, non-reactive, non-explosive, and non-flammable.

3.5.1 Manual Drum Opening with a Bung Wrench

Manual drum opening with bung wrenches should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-shock sensitive, non-reactive, non-explosive, or non-flammable. If opening the drum with bung wrenches is deemed safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear.

- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up.

- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a “cheater bar” can be attached to the handle to improve leverage.

3.5.2 Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader (Attachment B, Figure B-1) by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented, it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader. Self-propelled drum openers that are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

The drum deheader should be decontaminated, as necessary, after each drum is opened to avoid cross contamination and/or adverse chemical reactions from incompatible materials.

3.5.3 Remote Drum Opening with Hydraulic Devices

A piercing device with a non-sparking metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

3.5.4 Remote Drum Opening with Pneumatic Devices

Pneumatically operated devices utilizing compressed air have been designed to remove drum bungs remotely. Prior to opening the drum, a bung fitting must be selected to fit the bung to be removed. The adjustable bracketing system is then attached to the drum and the pneumatic drill is aligned over the bung. This must be done before the drill can be operated. The operator then moves away from the drum to operate the equipment. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container and, therefore, appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

3.6 DRUM SAMPLING

After the drum has been opened, preliminary monitoring of headspace gases should be performed first with an explosimeter/oxygen meter. Afterwards, an organic vapor analyzer or other instrument(s) should be used. If possible, these instruments should be intrinsically safe. In most cases, it is impossible to observe the contents of these sealed or partially sealed drums. Since some layering or stratification is likely in any solution left undisturbed, a sample that represents the entire depth of the drum must be taken.

When sampling a previously sealed drum, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom and then comparing it to the known interior depth.

3.6.1 Glass Thief Sampler

The most widely used implement for sampling drum liquids is a glass tube commonly referred to as a glass thief (Attachment B, Figure B-2). This tool is cost effective, quick, and disposable. Glass thieves are typically from 6- to 16-millimeter inner diameter and 48 inches long.

Procedures for use:

1. Remove the lids from the sample containers.
2. Insert the glass tubing almost to the bottom of the drum or until a solid layer is encountered. Approximately 1 foot of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with the stopper.
5. Carefully remove the capped tube from the drum and insert the uncapped end into the appropriate sample container.
6. Release stopper and allow glass thief to drain until the container is approximately two-thirds full.
7. Remove tube from the sample container, break it into pieces, and place the pieces in the drum.
8. Cap the sample container lightly and label it. Place the sample container into a carrier.
9. Replace the bung or place plastic over the drum.
10. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets or similar.
11. Perform hazard categorization analyses if included in the project scope.
12. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete chain-of-custody records.

In many instances, a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube into this layer, then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel laboratory spoon.

It should be noted that, in some instances, disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other glass thief disposal techniques should be evaluated.

3.6.2 Composite Liquid Waste Sampler

The Composite Liquid Waste Sampler (COLIWASA) and modifications thereof are equipment that collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA (Attachment B, Figure B-3) is a frequently cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152- × 4-centimeter inner diameter section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. One model of the COLIWASA is shown in Attachment B; however, the design can be modified and/or adapted somewhat to meet the needs of the sampler.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for use:

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handles sits against the sampler’s locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into the appropriate sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and label it. Place the sample container in a carrier.

7. Replace the bung or place plastic over the drum.

8. Log all samples in the site logbook and on Drum/Tank Sampling Data Sheets or similar.

9. Perform hazardous categorization analyses if included in the project scope.

10. Transport the sample to the decontamination zone and package for transport to the analytical laboratory, as necessary. Complete the chain-of-custody records.

3.6.3 Coring Device

A coring device may be used to sample drum solids. Samples should be taken from different areas within the drum. This sampler consists of a series of extensions, a T-handle, and the coring device.

Procedures for use:

1. Assemble the sampling equipment.

2. Remove the lids from the sample containers.

3. Insert the sampling device to the bottom of the drum. The extensions and the “T” handle should extend above the drum.

4. Rotate the sampling device to cut a core of material.

5. Slowly withdraw the sampling device so that as much sample material as possible is retained within it.

6. Transfer the sample to the appropriate sample container, and label it. A stainless steel spoon or scoop may be used, as necessary.

7. Cap the sample containers tightly and place them in a cooler.

8. Replace the bung or place plastic over the drum.

9. Log all samples in the site log book and on Drum/Tank Sampling Data Sheets or similar project-specific form.

10. Perform hazard categorization analyses if included in the project scope.

11. Transport the sample to the decontamination zone and package it for transport to the analytical laboratory, as necessary. Complete the chain-of-custody records.

3.7 HAZARD CATEGORIZATION

The goal of characterizing or categorizing the contents of drums is to obtain a quick, preliminary assessment of the types and levels of pollutants contained in the drums. These activities generally involve rapid, non-rigorous methods of analysis. The data obtained from these methods can be used to make decisions regarding drum staging or restaging, bulking, or compositing of the drum contents.

As a first step in obtaining these data, standard tests should be used to classify the drum contents into general categories such as auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analyses should be conducted to more precisely identify the drum contents.

Examples of tests used to categorize drums include:

- HazCat^R chemical identification systems
- Chlor-N-Oil Test Kit
- Spill-fyter Chemical Classifier Strips
- Setaflash (for ignitability).

These methods must be performed according to the manufacturers’ instructions and the results must be documented on the Field Test Data Sheet for Drum/Tank Sampling (Attachment A-2) or similar project-specific form.

Other tests that may be performed include:

- Water Reactivity
- Specific Gravity Test (compared to water)
- Water Solubility Test
- pH of Aqueous Solution.

The tests must be performed in accordance with the instructions on the Field Test Data Sheet for Drum/Tank Sampling or similar project-specific form, and results of the tests must be documented on these data sheets.

The specific methods that will be used for hazard categorization must be documented in the Quality Assurance Work Plan.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

When working with potentially hazardous materials, follow U.S. Environmental Protection Agency, Occupational Safety and Health Administration, and Corporate Safety and health procedures. All drum sampling activities must be conducted in accordance with the site-specific HASP. Any activities or conditions not directly addressed by the HASP must be approved by EA's safety coordinator.

More specifically, the opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended. It is important to understand and acknowledge that the use of non-sparking tools does not completely eliminate spark risk when working with drums and may require additional measures to protect field staff.

6. REFERENCES

Not applicable.

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Attachment A

Field Test Data Sheets

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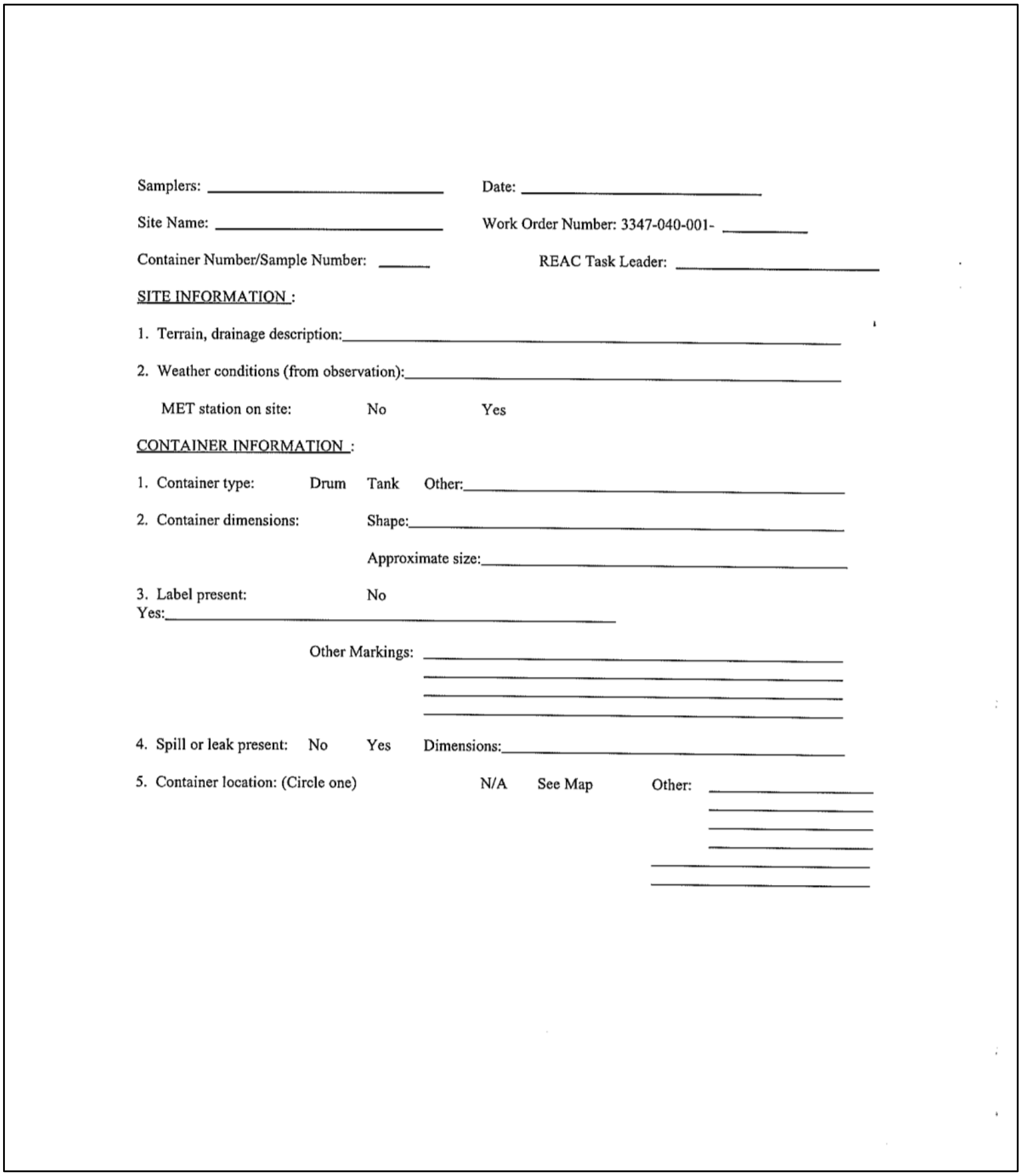
Attachment A-1
Drum/Tank Sampling Data Sheet



Samplers: ______________________ Date: ______________________

Site Name: ______________________ Work Order Number: 3347-040-001- ________

Container Number/Sample Number: _____ REAC Task Leader: ____________________

SITE INFORMATION :

1. Terrain, drainage description:____

2. Weather conditions (from observation):_____________________________________

MET station on site: No Yes

CONTAINER INFORMATION :

1. Container type: Drum Tank Other:______________________________________

2. Container dimensions: Shape:______________________________________

Approximate size:________________________________

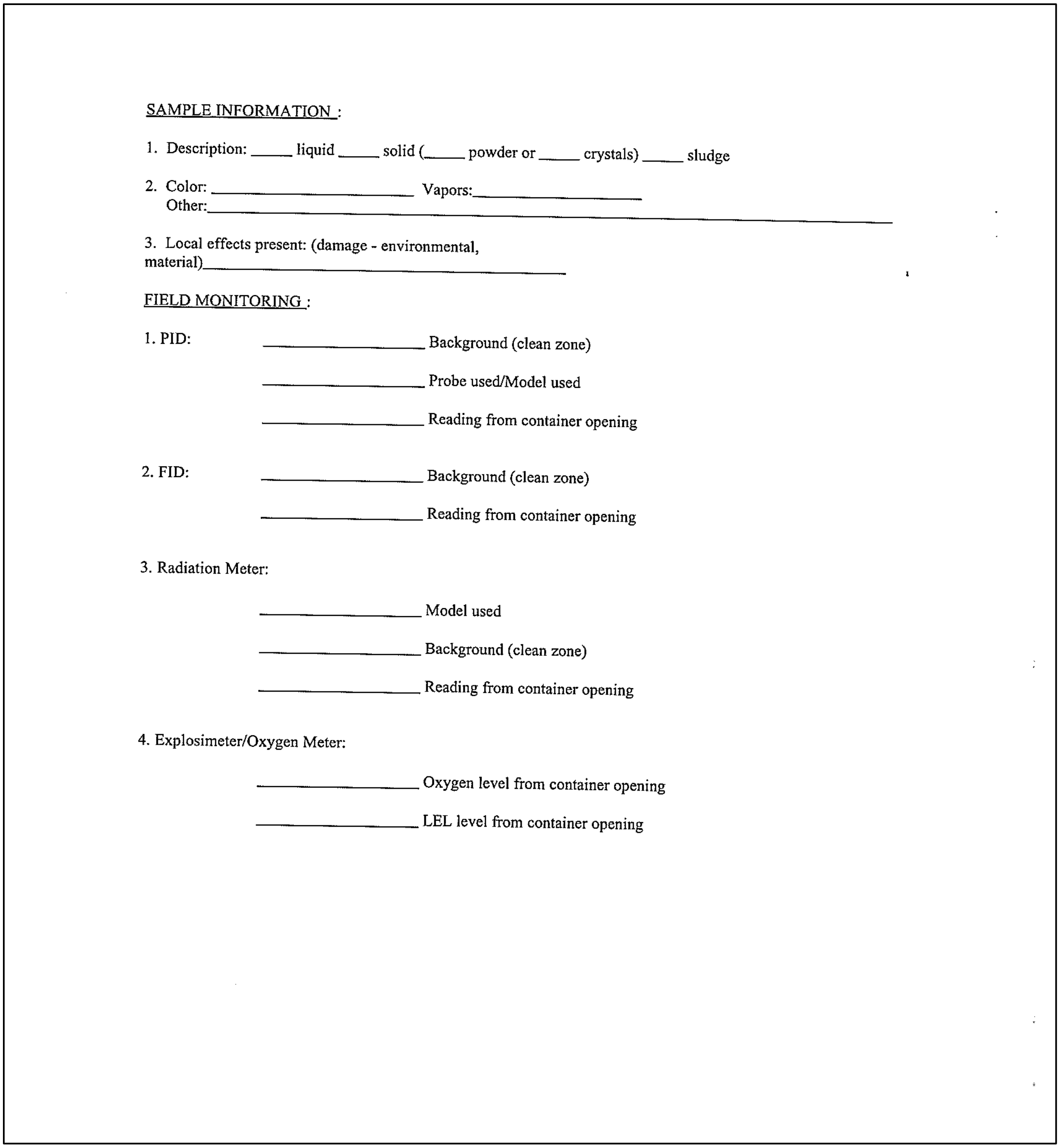
3. Label present: No
Yes:____

Other Markings: ______________________________________
____
____
____

4. Spill or leak present: No Yes Dimensions:______________________________

5. Container location: (Circle one) N/A See Map Other: ______________
____
____
____
____
____

Attachment A-1
Drum/Tank Sampling Data Sheet (continued)



SAMPLE INFORMATION :

1. Description: _____ liquid _____ solid (_____ powder or _____ crystals) _____ sludge

2. Color: ______________________ Vapors: __________________
Other: ____

3. Local effects present: (damage - environmental, material) ____

FIELD MONITORING :

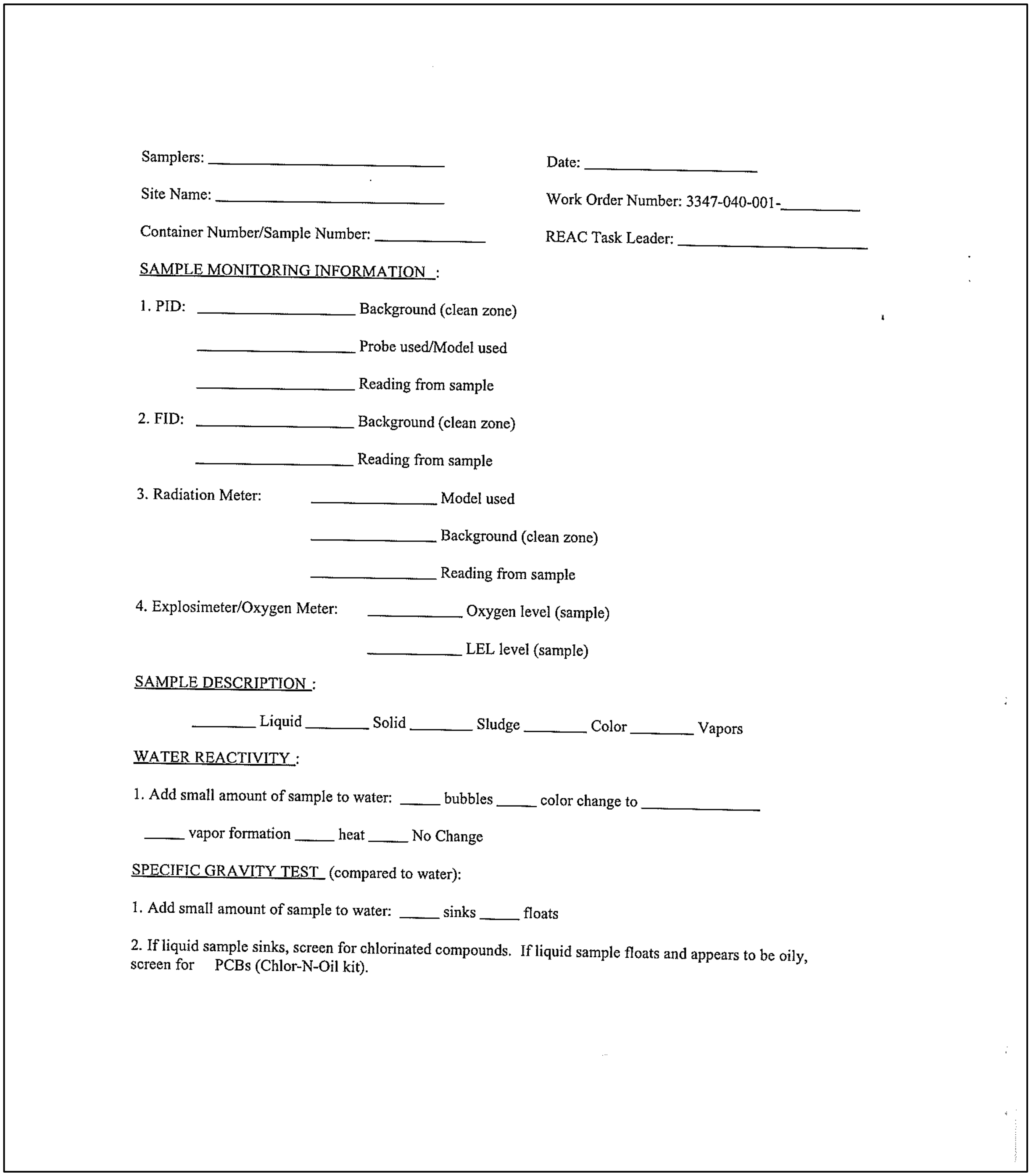
1. PID:
__________________ Background (clean zone)
__________________ Probe used/Model used
__________________ Reading from container opening

2. FID:
__________________ Background (clean zone)
__________________ Reading from container opening

3. Radiation Meter:
__________________ Model used
__________________ Background (clean zone)
__________________ Reading from container opening

4. Explosimeter/Oxygen Meter:
__________________ Oxygen level from container opening
__________________ LEL level from container opening

Attachment A-1
Drum/Tank Sampling Data Sheet (continued)



Samplers: ______________________ Date: ________________

Site Name: _____________________ Work Order Number: 3347-040-001-________

Container Number/Sample Number: __________ REAC Task Leader: ________________

SAMPLE MONITORING INFORMATION :

1. PID: ______________ Background (clean zone)

______________ Probe used/Model used

______________ Reading from sample

2. FID: ______________ Background (clean zone)

______________ Reading from sample

3. Radiation Meter: ___________ Model used

___________ Background (clean zone)

___________ Reading from sample

4. Explosimeter/Oxygen Meter: ________ Oxygen level (sample)

________ LEL level (sample)

SAMPLE DESCRIPTION :

______ Liquid ______ Solid ______ Sludge ______ Color ______ Vapors

WATER REACTIVITY :

1. Add small amount of sample to water: ____ bubbles ____ color change to ___________

____ vapor formation ____ heat ____ No Change

SPECIFIC GRAVITY TEST (compared to water):

1. Add small amount of sample to water: ____ sinks ____ floats

2. If liquid sample sinks, screen for chlorinated compounds. If liquid sample floats and appears to be oily, screen for PCBs (Chlor-N-Oil kit).

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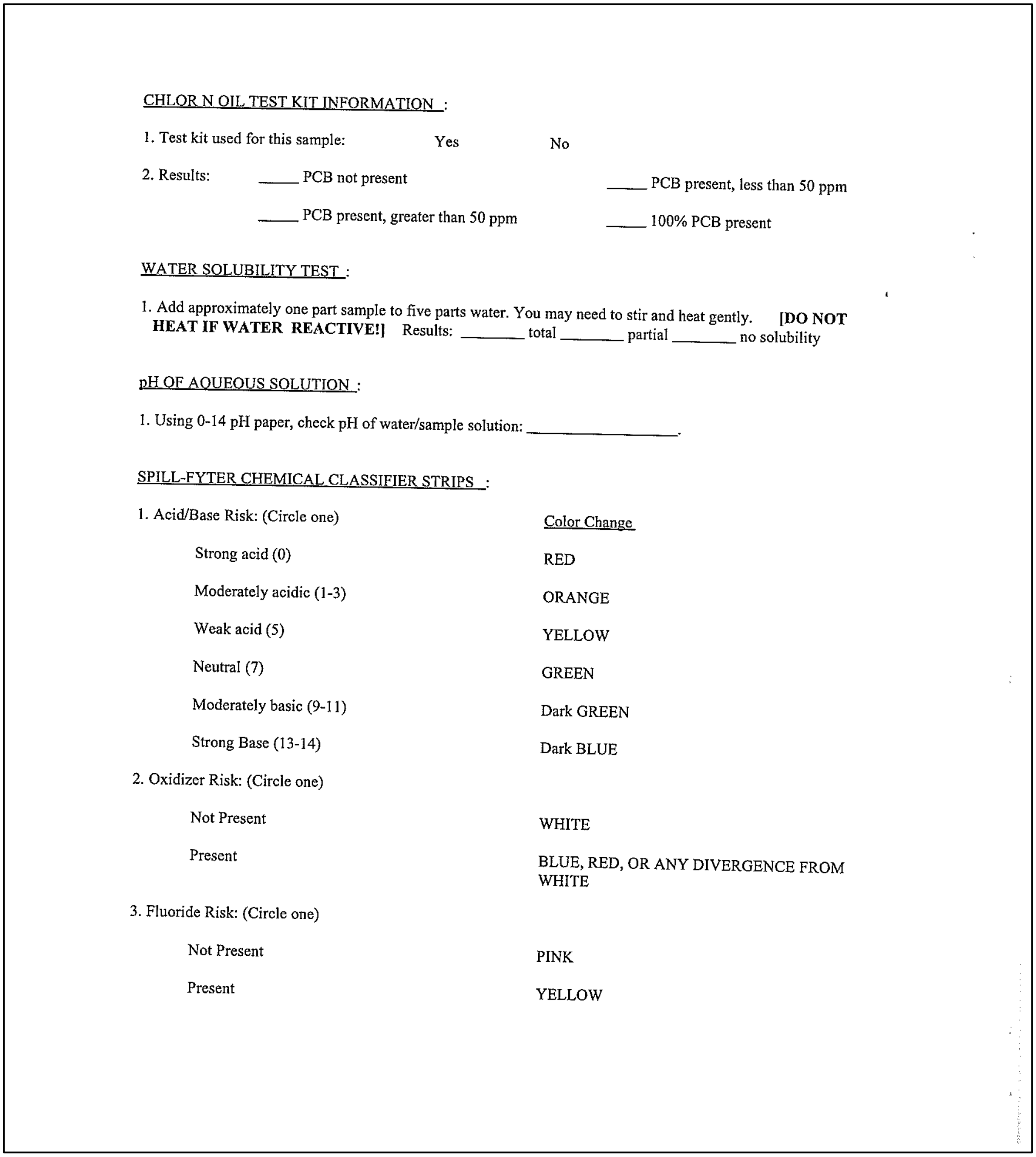
Attachment A-2
Field Test Data Sheet for Drum/Tank Sampling



CHLOR N OIL TEST KIT INFORMATION :

1. Test kit used for this sample: Yes No

2. Results: _____ PCB not present _____ PCB present, less than 50 ppm
_____ PCB present, greater than 50 ppm _____ 100% PCB present

WATER SOLUBILITY TEST :

1. Add approximately one part sample to five parts water. You may need to stir and heat gently. **[DO NOT HEAT IF WATER REACTIVE!]** Results: _______ total _______ partial _______ no solubility

pH OF AQUEOUS SOLUTION :

1. Using 0-14 pH paper, check pH of water/sample solution: ________________.

SPILL-FYTER CHEMICAL CLASSIFIER STRIPS :

1. Acid/Base Risk: (Circle one)	Color Change
Strong acid (0)	RED
Moderately acidic (1-3)	ORANGE
Weak acid (5)	YELLOW
Neutral (7)	GREEN
Moderately basic (9-11)	Dark GREEN
Strong Base (13-14)	Dark BLUE

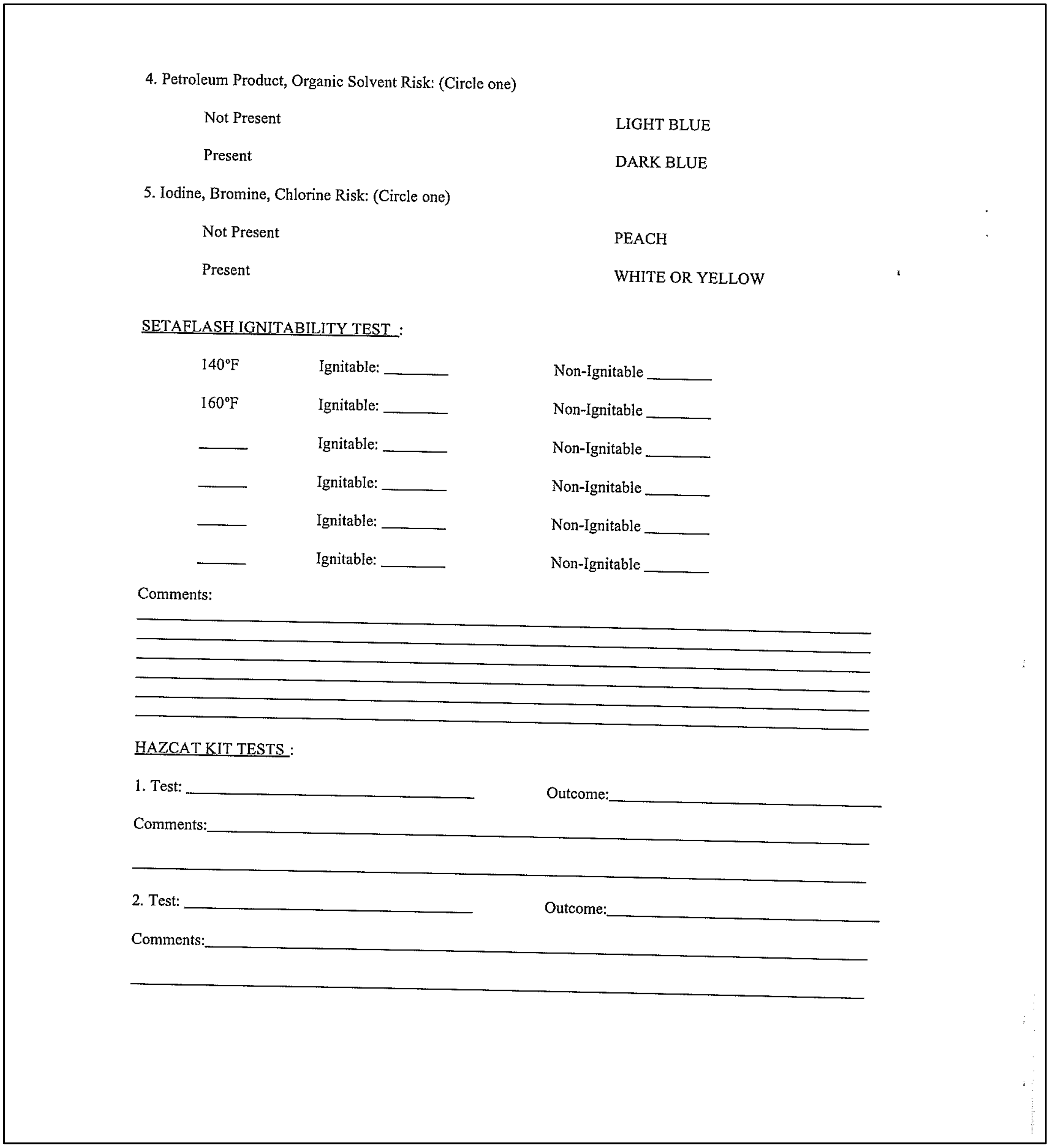
2. Oxidizer Risk: (Circle one)

Not Present	WHITE
Present	BLUE, RED, OR ANY DIVERGENCE FROM WHITE

3. Fluoride Risk: (Circle one)

Not Present	PINK
Present	YELLOW

Attachment A-2
Field Test Data Sheet for Drum/Tank Sampling (continued)



4. Petroleum Product, Organic Solvent Risk: (Circle one)

Not Present	LIGHT BLUE
Present	DARK BLUE

5. Iodine, Bromine, Chlorine Risk: (Circle one)

Not Present	PEACH
Present	WHITE OR YELLOW

SETAFLASH IGNITABILITY TEST :

140°F	Ignitable: ______	Non-Ignitable ______
160°F	Ignitable: ______	Non-Ignitable ______
______	Ignitable: ______	Non-Ignitable ______
______	Ignitable: ______	Non-Ignitable ______
______	Ignitable: ______	Non-Ignitable ______
______	Ignitable: ______	Non-Ignitable ______

Comments:

HAZCAT KIT TESTS :

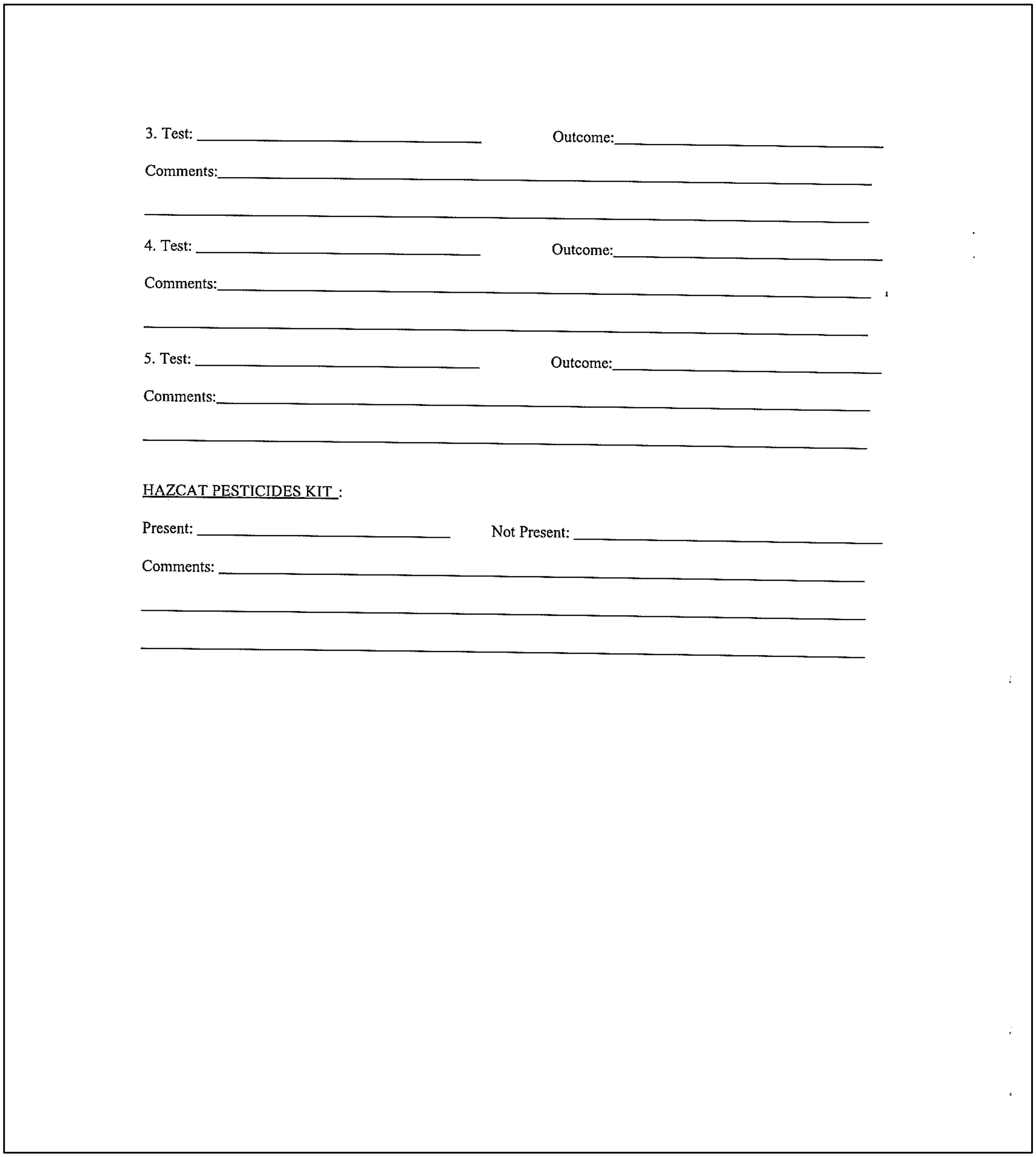
1. Test: ____________________ Outcome: ____________________

Comments: ____________________

2. Test: ____________________ Outcome: ____________________

Comments: ____________________

Attachment A-2
Field Test Data Sheet for Drum/Tank Sampling (continued)



3. Test: ____________________ Outcome: ____________________

Comments: ____

____

4. Test: ____________________ Outcome: ____________________

Comments: ____

____

5. Test: ____________________ Outcome: ____________________

Comments: ____

____

HAZCAT PESTICIDES KIT :

Present: ____________________ Not Present: ____________________

Comments: ____

____

____

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Attachment B

Equipment Diagrams

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Figure B-1. Drum Deheader

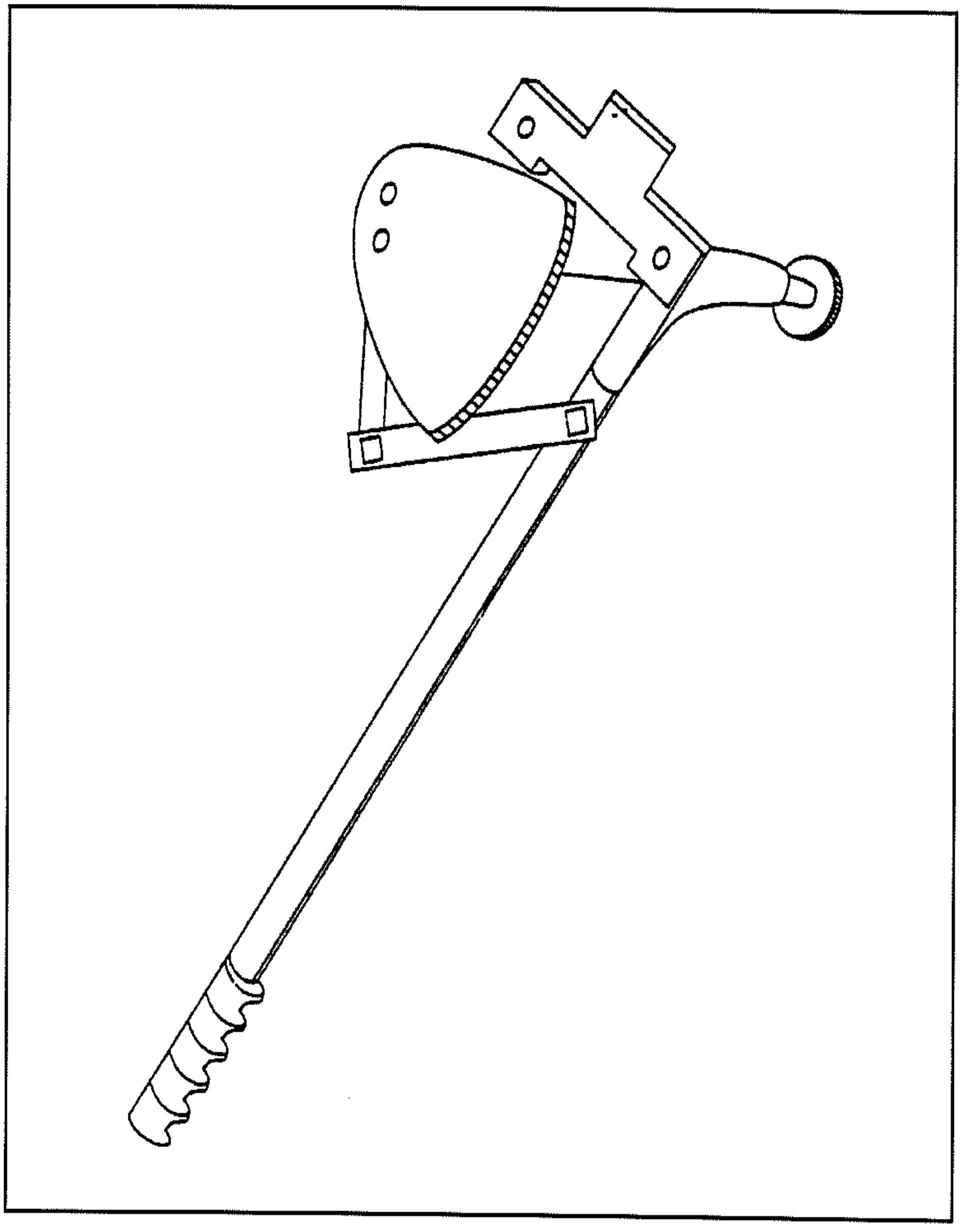

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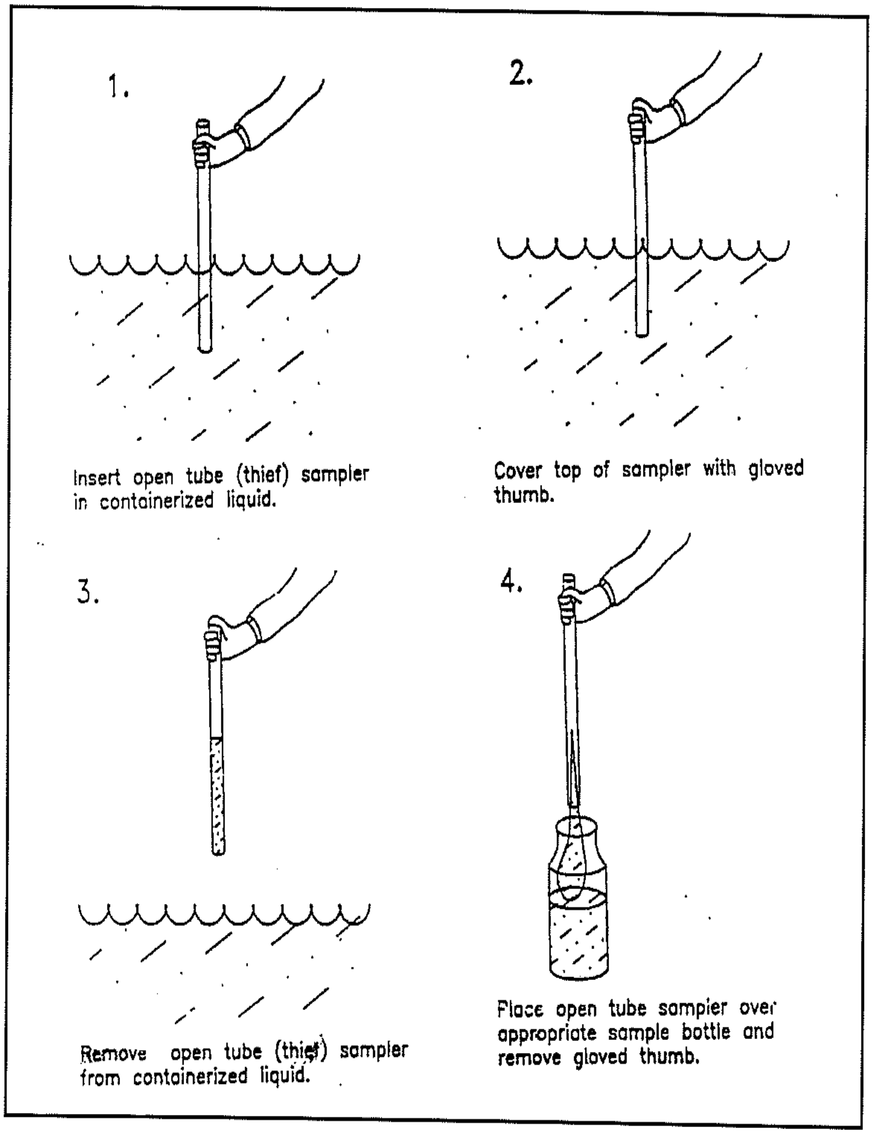
Figure B-2. Glass Thief



Insert open tube (thief) sampler in containerized liquid.

Cover top of sampler with gloved thumb.

Remove open tube (thief) sampler from containerized liquid.

Place open tube sampler over appropriate sample bottle and remove gloved thumb.

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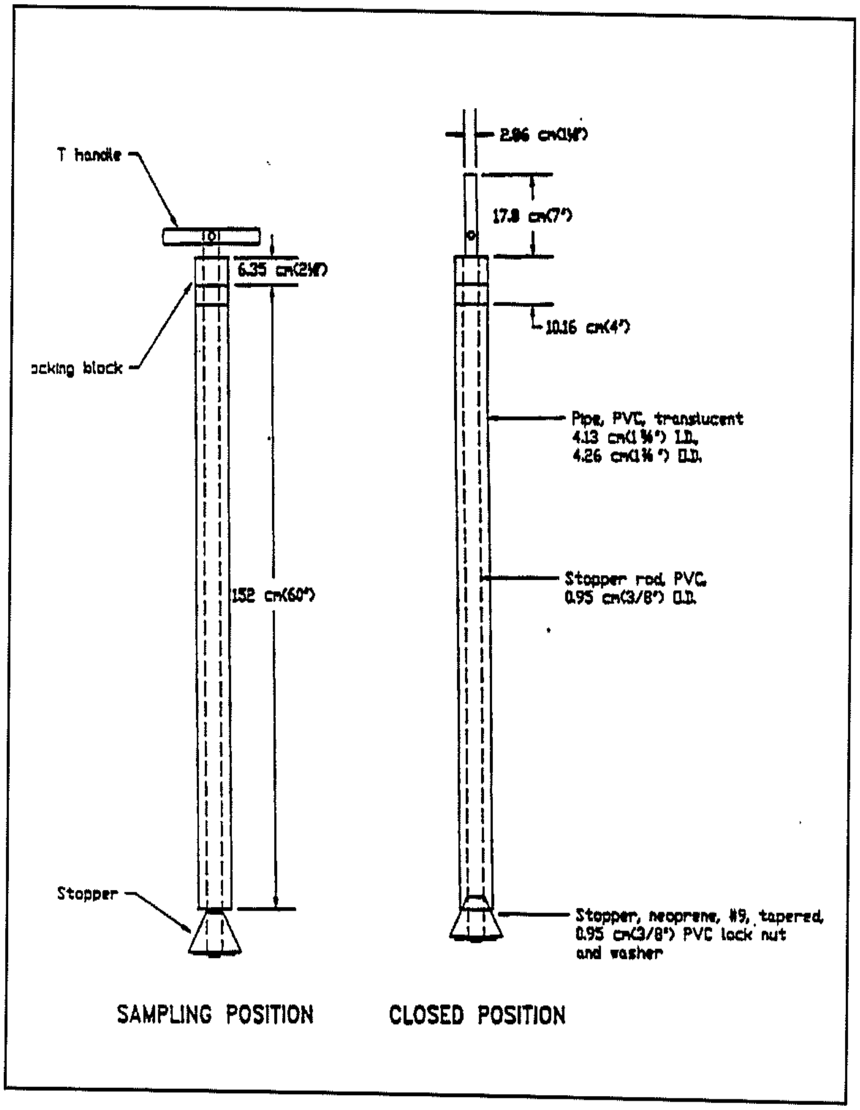
Figure B-3. COLIWASA



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Standard Operating Procedure No. 039
for
Sample Preservation and Container Requirements

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 2
September 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 039	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	25 September 2018	Add notes about incremental sampling and minor changes	Daniel Hinckley, Sanita Corum	Matthew Bowman

1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to define the preservatives and techniques to be employed in preserving environmental samples between collection and analysis.

2. MATERIALS

The following materials may be required:

- Containers (Section 3 provides a description)
- Nitric acid
- Sulfuric acid
- Sodium hydroxide
- Ice chests
- Ice.

3. DEFINITION OF CONTAINER TYPES

Listed below are the definitions of various container types.

Type	Container	Closure	Septum
A	80-ounce amber glass, ring handle bottle/jug, 38-millimeter (mm) neck finish	White polypropylene or black phenolic, baked polyethylene cap, 38-430 size, 0.015-mm polytetrafluoroethelyne (PTFE) liner	
B	40-milliliter glass vial, 24-mm neck finish	White polypropylene or black phenolic, open top, screw cap, 15-mm opening, 24-400 size	24-mm disc of 0.005-inch) PTFE bonded to 0.120-inch silicon for total thickness of 0.125 inches
C	1-liter high density polyethylene, cylinder-round bottle, 28-mm neck finish	White polyethylene cap, white ribbed, 28-410 size; F217 polyethylene liner	
D	120-milliliter wide mouth glass vial, 48-mm neck finish	White polyethylene cap, 40-480 size; 0.015-mm PTFE liner	
E	250-milliliter Boston round glass bottle	White polypropylene or black phenolic, open top, screw cap	Disc of 0.005-inch PTFE bonded to 0.120-inch silicon for total thickness of 0.125 inches
F	8-ounce short, wide mouth, straight-sided, flint glass jar, 70-mm neck finish	White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.030-mm PTFE liner	
G	4-ounce tall, wide mouth, straight-sided, flint glass jar, 48-mm neck finish	White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.015-mm PTFE liner	

Type	Container	Closure	Septum
H	1-liter amber, Boston round, glass bottle, 33-mm pour-out neck finish	White polypropylene or black phenolic, baked polyethylene cap, 33-430 size; 0.015-mm PTFE liner	
K	4-liter amber glass ring handle bottle/jug, 38-mm neck finish.	White polypropylene or black phenolic, baked polyethylene cap, 38-430 size; 0.015-mm PTFE liner	
L	500-milliliter high-density polyethylene, cylinder bottle, 28-mm neck finish	White polypropylene, white ribbed, 28-410 size; F217 polyethylene liner	

4. PROCEDURE

All containers described in Section 3 must be certified clean (SOP Number [No.] 031), with copies of laboratory certification furnished upon request. There may be circumstances when alternative containers will be used (e.g., aluminum foil around tissue samples placed in plastic bags, plastic buckets or bags for large soil/sediment samples, etc.) for which laboratory certification may not be available. Such containering should be appropriately decontaminated or verified appropriately clean prior to using.

Water samples will be collected into pre-preserved containers appropriate to the intended analyte as documented in the Quality Assurance Project Plan. Samples taken for volatile organic compounds will be collected in accordance with SOP No. 003, Section 3.3.8. Samples taken for metals analysis will be verified in the field to a pH <2. The container should be tightly capped, then swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure that this operation may have generated. Samples taken for total phosphorous content will be verified in the field to a pH <2. The container should be tightly capped and swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure that this operation may have generated. Samples taken for cyanide will be verified for a pH >12. Most other samples do not require added preservation; however, there are analytes that may require special preservation, (i.e., sulfide that requires a zinc acetate preservation). Preservation must be performed as documented in the project-specific Quality Assurance Project Plan. These samples will be immediately placed on ice and cooled to 4±2 degrees Celsius (°C).

Soil and sediment samples will be collected into containers appropriate to the intended analyte as documented in the Quality Assurance Project Plan. Samples taken for volatile organic compound analysis will collected in accordance with the site-specific SOP. Samples taken for metals analysis will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Samples taken for total phosphorous content will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Large (1-2 kilograms) soil/sediment samples taken for incremental samples (SOP No. 057) can be placed in pre-cleaned (SOP No. 005) gallon plastic bags or plastic buckets. Under most circumstances, no preservatives will be added to soil or sediment samples; follow project-specific requirements as documented in the Quality Assurance Project Plan. These samples will be immediately placed on ice and cooled to 4±2°C.

5. MAINTENANCE

Not applicable.

6. PRECAUTIONS

Note that acidifying a sample containing cyanide may liberate hydrogen cyanide gas.

- Avoid breathing any fumes emanating from acidified samples.
- Acidify samples only in the open, rather than in closed spaces (i.e., a vehicle).
- Hold suspected hydrogen cyanide-generating sample away from body and downwind while manipulating it.
- See the Health and Safety Plan for other safety measures.

7. REFERENCES

U.S. Environmental Protection Agency (EPA). 1986. Test Methods for Evaluating Solid Waste, SW-846.

———. 1987. A Compendium of Superfund Field Operations Methods, EPA 540-P87-001.

———. 1991. A Compendium of ERT Soil Sampling and Surface Geophysics Procedures.

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Standard Operating Procedure No. 042
for
Disposal of
Investigation-Derived Material

Prepared by

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Hunt Valley, Maryland 21031

Revision 1
December 2014

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this standard operating procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☒ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 042	
SOP Section	**Variance**
3.2 and 3.2	Onsite disposal of IDW is not anticipated during this project.

Frank DeSantis (Deputy)

Project Manager (Name)

17 August 2023

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**

1. SCOPE AND APPLICATION

The purpose of this standard operating procedure is to define the required steps for disposing of investigation-derived material (IDM) generated during field activities.

IDM, as used herein, includes soil cuttings, drilling muds, extraneous sediment, purged groundwater, decontamination fluids, and disposable personal protective equipment. For the sake of clarity and ease in use, this Standard Operating Procedure is subdivided into procedures for disposal of liquid IDM and solid IDM as follows:

- Liquid IDM (Section 3.2) includes the following materials:
    - Water from initial development of new wells and the redevelopment of existing wells
    - Purge water from groundwater sampling
    - Decontamination fluids (Section 3.4)
- Solid IDM (Section 3.3) consists of the following materials:
    - Soil drill cuttings from monitoring well installation
    - Sediment remaining after collection of the required sample volume
    - Grout, a mixture of cement and bentonite, generated during installation of monitoring wells
    - Disposable personal protective equipment (Section 3.4).

2. MATERIALS

The following materials may be required:

- Any additional equipment that may be dictated by project or site-specific plans
- Bar codes
- Chain-of-custody forms
- Department of Transportation 17C specification metal containers
- Hazardous waste labels
- Permanent marker
- Field logbook (bound)
- Waste identification labels

3. PROCEDURE

3.1 GENERAL

No container will be labeled as a "Hazardous Waste" unless the contents are in fact known to be hazardous as defined by 40 Code of Federal Regulation 261.

IDM may be disposed onsite if it is: (1) initially screened, or evaluated to determine whether it is contaminated; (2) not abandoned in an environmentally unsound manner; and (3) not inherently waste-like.

IDM is to be considered contaminated if: (1) it is visually or grossly contaminated; (2) it has activated any field monitoring device that indicates that the level exceeds standard Level 1; (3) it has previously been found to exhibit levels of contamination above environmental quality standards; and (4) the responsible party and/or appropriate regulator deem(s) that records of historical uses indicate that additional testing of the IDM is needed, or additional caution is warranted handling IDM from a given site.

3.2 PROCEDURES FOR LIQUID INVESTIGATION-DERIVED MATERIAL DISPOSAL

Listed below are the procedures for the disposal of liquid IDM:

1. All water from the initial development of new wells, and purge water generated during the first round of groundwater sampling, will be containerized in Department of Transportation approved 55-gallon drums. Decontamination fluids may be bulk-containerized until completion of the field task.

2. Label all containers as to type of media, date the container was sealed, point-of-generation, and points-of-contact. The well number and container number will be identified on the container.

3. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include the following: date of generation, contents of containers, number of containers with the same contents (if applicable), location of containers, well number the media is associated with, personnel sampling the media, sampling dates, and sampling results.

4. Containers of well development water and purge water may be stored at the well site pending the first round analytical results.

---

1. This value is defined as two times background, where "background" values are to be determined as follows: (1) regional background values will be used where they are available; and (2) if regional values are not available, background may be empirically determined at uncontaminated sampling sites using onsite sensors such as organic vapor analyzers (photoionization detector or flame ionization detector), scintillometers, etc.

5. Laboratory turnaround time must be no greater than 30 days. Upon receipt of the analytical results, a copy will be furnished to the client within 3 working days. Both the client and contractor will evaluate the data to determine disposal requirements, per state and local regulations. A disposal decision is required within 10 days of receipt of sampling results. Appropriate disposal must be performed no later than 50 days from the decision date unless prevented by inclement weather (e.g., rain and muddy conditions may preclude site access, freezing weather may freeze media).

   Dispose of media in accordance with Steps 6 and 7 of this procedure, as appropriate.

6. If the first round analytical data of the liquid media are below the Maximum Contaminant Levels established by the Federal Safe Drinking Water Act, the water may be gradually infiltrated into the ground at least 50 feet downgradient of the well.

   If the well location has no downgradient area, the water will be infiltrated into the ground in an area deemed appropriate by the client and the contractor/support personnel.

   Disposal locations must allow percolation of the water and prohibit "ponding."

   Upon completion of water discharge to ground, enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook and provide this information to the client.

   Empty containers are to be properly decontaminated, stored, and reused by the appropriate personnel.

   If the liquid media sampling results do not meet the required Maximum Contaminant Levels and cannot be discharged to the ground, then determine if the waste meets the sanitary sewer discharge criteria (National Pollutant Discharge Elimination System standards).

7. If, at any time, visual contamination of purge/development water is observed, or if organic vapor monitor readings (HNu, photoionization detector) register more than 5 parts per million above background and/or radiological meters register more than twice the background mrems, then the liquid will be drummed and a composite sample will be taken that day. A disposal decision will be based on the analytical results of this sample rather than the first round of analytical results.

3.3 PROCEDURES FOR SOLID INVESTIGATION-DERIVED MATERIAL DISPOSAL

Listed below are the procedures for the disposal of solid IDM:

1. If the conditions outlined in Section 3.1 are met, proceed to Section 3.3, Step 2; otherwise, proceed to Section 3.3, Step 7.

2. During soil drilling operations or sediment sampling, the resulting cuttings, mud, and/or extraneous sediment will be discharged onto the ground (or waterbody for sediment) near the well (or sample location for sediment) if the following conditions are met: (1) no visual contamination is observed, (2) organic vapors are less than 5 parts per million above background, (3) radiological meter readings (if applicable) are under two times background, and (4) the medium has been screened and found to be less than two times background if the potential for contamination exists.

   Proper sediment and erosion control measures will be implemented as follows:

   - Soil drill cuttings will be uniformly spread and contoured to blend with the surroundings of the site.

   - If amount of solid IDM exceeds 5,000 square feet or 100 cubic yards of material, a sediment and erosion control plan is required.

   - If the amount of solid IDM is under 5,000 square feet or 100 cubic yards, the site will be stabilized as soon as possible. Stabilization includes mulch, seed, and tack.

   - Critical areas require stabilization within 7 days from the date of well completion. Critical areas include swales, water sources, drainage ditches, etc.

   - All other disturbed areas require stabilization within 14 days from the date of well completion.

3. If the well location is in or near a wetland, the soil drill cuttings will be drummed and transported away from the site for spreading.

4. Label all IDM containers that will not be spread on the day of generation. Each container should be labeled with the type of media, date the container was sealed, point-of-generation, and name of the contact person. The well number or sample location and container number should be identified on the container.

5. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include: date of generation, contents in containers, number of containers with the same contents, location of containers, and well number or sample location the media is associated with.

6. Containers will be staged at the well site until contractor/support personnel spread the cuttings in the appropriate locations, using proper sediment and erosion control measures per Section 3.3.

7. If soil drilling mud, cuttings, or sediment show visible contamination, or organic vapor readings are more than 5 parts per million above background levels, or radiological meter

readings (if applicable) show greater than two times background levels, or if the potential for contamination exists (levels greater than two times background), media will immediately be containerized, labeled appropriately (Section 3.2), and sampled on the same day.

8. The solid IDM should be sampled and appropriate Toxicity Characteristic Leaching Procedure analyses conducted prior to determining disposition. Laboratory turn-around time must be no greater than 30 days. Upon receipt of analytical results, a copy will be furnished to the client within 3 working days. The contractor will evaluate the data to determine disposal requirements within 10 days. Appropriate disposal must be performed no later than 50 days after the decision date if weather permits (Section 3.2).

    - If the solid IDM is determined to be non-hazardous and uncontaminated, proceed to Section 3.3.

    - If the solid IDM is determined to be non-hazardous but contaminated, proceed to Section 3.3.

    - If the solid IDM is found to be hazardous wastes, proceed to Section 3.3.

9. If the solid IDM is not a hazardous waste **and** analytical data show contaminant concentrations below the U.S. Environmental Protection Agency Region 3 (or applicable Region where work is being performed) Risk-Based Concentrations, contact the appropriate federal, state, or local agency for approval to discharge onto the ground or back to the waterbody near the site of generation.

    - Follow steps detailed in Section 3.3, Step 2 (above) pertaining to sediment and erosion control.

    - Upon completion of the solid IDM discharge to the ground or waterbody (for sediment), enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook. This information must be provided to the client.

    - Empty containers are to be properly decontaminated, stored, and reused by appropriate personnel.

10. If the intrusive media is not a hazardous waste but analytical data show concentrations above the screening criteria, dispose of the IDM according to state and local regulations.

    - Ensure that the waste containers are properly labeled as applicable in accordance with Section 3.3, Step 4.

    - Inform the client of the type and amount of waste, and location of the waste.

- When the waste is removed, enter the type of waste, amount of waste, date of pickup, and destination of the waste in a bound Field Logbook. This information must be provided to the client.

3.4 PROCEDURES FOR DECONTAMINATION SOLUTION AND PERSONAL PROTECTIVE EQUIPMENT DISPOSAL

Decontamination solutions include catch water from steam-cleaning operations performed on large sampling equipment, drill rigs, and drums, as well as smaller quantities of soapy water and rinse solutions used in decontaminating field sampling equipment. At the completion of the field event, a composite sample of the decontamination solution will be taken. The decontamination solution will be treated as liquid IDM pending results (Section 3.2).

Personal protective equipment will be containerized onsite, appropriately labeled, and disposed in a designated trash receptacle.

4. MAINTENANCE

The waste manifest document and bill of lading should be uploaded to the project file as soon as possible in either hard copy or electronic format. Refer to EA's Records Retention Policy for archiving information.

5. REFERENCES

Environment Article Section 7-201(t).

U.S. Environmental Protection Agency. 1991. Management of Investigation-Derived Wastes during Site Inspections PB91-921331, OERR Directive 9345.3-02. Office of Emergency and Remedial Response U.S. Environmental Protection Agency, Washington, D.C. May.

Standard Operating Procedure No. 043 for Multi-Probe Water Quality Monitoring Instruments

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision No. 2
June 2020

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 043	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	June 2020	Systematic review and update. Combined with previously separate SOPs for pH, temperature, specific conductivity, turbidity, dissolved oxygen, and redox potential.	Eddie Meadows Catherine Maxwell	Matthew Bowman

1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for field operation of multi-probe water quality instruments. The instrument can monitor a variety of basic parameters including dissolved oxygen, percent saturation, temperature, pH, conductivity, specific conductivity, resistivity, salinity, total dissolved solids, turbidity, oxidation reduction potential (ORP), level, and depth.

The use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the vendor must provide applicable and comparable SOPs for the maintenance and calibration from the specific manufacturer of the instrument being used.

2. MATERIALS

The following materials may be required:

- Multi-probe instrument
- Probe/sonde with appropriate cables
- Appropriate standards/calibration fluids
- Accessories (batteries, charger, case, etc.)
- Decontamination materials or laboratory wipes
- Deionized water and distilled water (as needed for calibration and decontamination)
- Instrument logbook
- Manufacturer’s Operations Manual.

3. CALIBRATION PROCEDURE

Calibration must be performed or verified daily at a minimum before using the instrument. Calibration may be performed in the laboratory or in the field. Detailed step-by-step calibration procedures for the equipment described below are provided in the most recent version of the manufacturer’s Operations Manual. Documentation includes at a minimum: time, date, analyst, standard, primary standard/calibration fluid lot number, secondary standard/calibration fluid lot number, and expiration dates of standards/calibration fluids. An example calibration log is provided in Attachment A.

Fill the calibration cup with the appropriate standard as follows:

- Temperature: None required
- Specific Conductance: Conductivity standards
- pH: pH 7 buffer plus pH 4 and/or pH 10 buffer
- Dissolved Oxygen: Saturated air or saturated water
- ORP: Quinhydrone (Zobell’s Solution) or other standard

• Turbidity:	Nephelometric turbidity unit (NTU) standards
• Salinity:	Calibration for specific conductance
• Depth/Level:	Set zero in air.

3.1 CONDUCTIVITY CALIBRATION

Conductivity meters are calibrated at least once per day to at least one standard. The standard should be selected in accordance with the range expected to be measured (e.g., 1.0 microSiemans per centimeter [µS/cm]) standard should not be used to calibrate meters being used in saltwater). See manufacturer's recommendations in the Operations Manual for additional information on calibration standard selection. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.2 PH CALIBRATION

The pH meters are calibrated at least once per day to a minimum of two standard buffers (pH 4 and 7, or pH 7 and 10) in accordance with the range expected to be measured. The calibration is verified using a fresh solution of pH 7 buffer post-calibration. The probe should be rinsed in distilled water between standards. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.3 DISSOLVED OXYGEN CALIBRATION

Dissolved oxygen meters are saturated-air or saturated-water calibrated at least once per day. Each method requires the true barometric pressure to be input or collected from the instrument prior to calibration.

- ***Saturated Air Method***—Dip the calibration chamber (i.e., probe storage cup) into distilled or tap water at ambient temperature, pour out excess water, and then insert dissolved oxygen probe into the wet chamber. This ensures that the air inside the chamber is saturated with water vapor. CAUTION: Be sure that the membrane/probe has no droplets of water adhering to it since this would reduce the rate of oxygen diffusion through the membrane and would produce erroneous results. Do not fully thread the probe storage cup on the probe during equilibration.

- ***Saturated Water Method***—To make a 100 percent (%) air-saturated calibration standard, fill a container (e.g., a 1-liter or 1-gallon container with a closed top) three-quarters full with distilled water or clean (conductivity of less than 500 µS/cm) tap water. Let the water temperature reach equilibrium with the calibration environment. Then shake the container vigorously for approximately 30 seconds. This makes 100% air-saturated water. Place the air-saturated water into the probe storage cup and allow to equilibrate. Do not fully thread the probe storage cup on the probe during equilibration.

Calibration information is recorded in conjunction with the data collected for that sampling event.

3.4 OXIDATION REDUCTION POTENTIAL CALIBRATION

ORP meters are calibrated at least once per day to at least one standard. It is recommended that Zobell's Solution is used; however, another solution can be used as long as it meets the manufacturer's specifications for calibration. Note that the standard value for Zobell's Solution is dependent on temperature. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.5 TURBIDITY CALIBRATION

The turbidity meters are calibrated at least once per day to a minimum of two standards (0 NTU and 100 or 200 NTUs recommended) in accordance with the range expected to be measured. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.6 DEPTH/LEVEL CALIBRATION

The depth and level calibration is performed with the depth sensor module in the air and not immersed in any solution. The appropriate correction for height above the water surface is inputted into the meter. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.7 ADDITIONAL CALIBRATIONS

Additional measurements may be taken with the multi-probe water quality instruments. For any of these measurements, the calibration procedures will be conducted in accordance with the manufacturer's specifications. Calibration information is recorded in conjunction with the data collected for that sampling event.

4. FIELD OPERATION

4.1 SETUP OF MULTI-PROBE WATER QUALITY INSTRUMENT

Post-calibration and prior to sampling, the multi-probe water quality instrument should be inspected, cleaned, and set up for data collection. If the cables have been unattached, they will be reconnected to the transmitter (if applicable) and the display. Once all cables are attached, the meter will be turned on and allowed to warm up for a few seconds in order to allow the display screen to load. The unit should be allowed to come to ambient air temperature if it has been stored in a hotter or colder environment prior to use.

4.2 SURFACE WATER

Prior to sampling, check the condition of the probes before each deployment. When sampling in surface water, the sensor must be in an amount of water sufficient for all probes to be submerged. Data values displayed on the display screen are recorded in a field logbook, a dedicated project field form (i.e., an EA Purging and Sampling Record, or on an EA-provided iPad on an approved GoFormz), and accepted into the instrument's data logger (if used). Post-data collection, the sensor will be retrieved and rinsed for use at the next sample location. If travel time between sample locations is significant, the display is to be turned off. When all sampling is completed, disconnect all equipment, clean probes and the instrument in accordance with the manufacturer's instructions, attach a solid protective cap, and return it to its proper storage location.

4.3 GROUNDWATER

Prior to sampling, check the condition of the probes before each deployment. When sampling groundwater, mount sampler on a flow-through cell. Start sampler pump and allow pump/hose system to be purged of air bubbles. Required parameters should be recorded every 3-5 minutes (unless otherwise specified in the sampling plan). Record the monitored values in the appropriate field logbook, on a dedicated project field form (i.e., an EA Purging and Sampling Record, or on an EA provided iPad on an approved GoFormz) to ensure against inadvertent data loss. If travel time between sample locations is significant, the display is to be turned off. When all sampling is completed, disconnect all equipment, clean probes and the instrument in accordance with the manufacturer's instruction, remove flow-through cell and attach solid protective cap, and return it to its proper storage location. If a flow-through cell cannot be used (e.g., groundwater sampling using a bailer), bailed water should be poured into a clean container for collecting readings over standard intervals of volume purged or time.

5. MAINTENANCE

All maintenance should be performed in accordance with the manufacturer's Operations Manual.

6. PRECAUTIONS

Check the condition of the probes frequently between sampling. Do not force pins into connections; note keying sequence. If field readings are outside the expected range, check for bubbles on, or damage to, the probes. If there are no bubbles or damage, recalibrate the sensor.

7. REFERENCES

Not applicable.

Attachment A

Equipment Calibration Log

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ATTACHMENT A

EQUIPMENT CALIBRATION LOG

Site Name:		**Client:**		
Job Number:		**Calibration Performed by:**		Page ______ of ______

Date and Time	Instrument Name	Instrument Make and Model	Instrument Serial Number	Standard Value	Calibrated Value	Percent Deviation	Bump Check (if applicable)	Standard/ Calibration Fluid Lot Number and Expiration Date	Comments or Adjustments Made

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Standard Operating Procedure No. 047
Direct-Push Technology Sampling

Prepared by

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Revision: 0
December 2014

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PROJECT-SPECIFIC VARIANCE FORM

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☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 047	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	Revision Date	Revision Summary	Revised By	Reviewed By

1. SCOPE AND APPLICATION

This standard operating procedure (SOP) establishes the protocol for using direct-push technology (DPT) in media sampling and performing subsurface characterization. This SOP includes the following DPT methods: Geoprobe®, Hydropunch®, Cone Penetrometer Testing (CPT), and Site Characterization and Analysis Penetrometer System (SCAPS).

2. MATERIALS

The following materials may be required:

- Appropriately sized, all-terrain vehicle-skid-or track-mounted; DPT equipment; and supplies (i.e., hydraulic derrick and hammer assembly)
- Bentonite grout and clean sand for DPT hole abandonment
- DPT stainless steel rods
- Heavy plastic sheeting
- Logbook
- Long-handled bristle brushes
- Mini-bailer or tubing and peristaltic pump (groundwater sampling only)
- Personal protective equipment
- Phosphate-free, laboratory-grade detergent (e.g., Liquinox, Alconox, etc.)
- Source of approved water
- Steam cleaner/sprayer and water obtained from approved source for decontaminating DPT equipment
- Steel drums for intrusion derived wastes (e.g., contaminated personal protective equipment, decontamination solutions, etc.)
- Wash and rinse tubs

3. GEOPROBE® AND HYDROPUNCH®

3.1 MATERIALS

Water sources for Geoprobe® and Hydropunch® activities, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the Geoprobe® and Hydropunch® equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the Geoprobe® and Hydropunch® equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (SOP No. 019).

3.2 GROUNDWATER – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site to facilitate aquifer characterization and analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all sampling and installation procedures, and will fully document all procedures and soil characteristics in the Field Logbook (SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® and Hydropunch® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means.

- Drive the sampler to the desired groundwater sampling interval. At the desired depth, insert extension rods down the inside diameter of the probe rods until the extension reaches the bottom of the screen. Remove the probe rods and sampler sheath while holding the screen in place.

- Collect the groundwater sample in the screen interval with a mini-bailer, peristaltic or vacuum pump, or other acceptable small diameter sampling device.

- The head of the rod may be equipped with a sensing device for characterization of soil properties or the contaminant content.

The subcontractor will use the equipment-specific guidelines for installation of the Hydropunch® equipment. Rods will be forced into the ground by hydraulic means.

- The Hydropunch® tool is a double cylinder, designed to be sealed until the desired sampling depth is reached. Upon reaching the desired sampling depth, the outer cylinder is pulled back, exposing a perforated, stainless steel sampling barrel covered with filter material.

- The water sample enters the barrel and the sample is retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly. Groundwater is the only media that is sampled by Hydropunch® equipment.

- The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

- The sample volume collected with this technique is approximately 500-1,000 ml. Larger sample volumes can be collected by inserting tubing attached to a peristaltic pump into the rods to obtain water samples.

If desired, a small diameter monitoring well may be installed at this point. Refer to SOP No. 019 (Monitoring Well Installation).

If a well will not be installed, the rods will be removed as the borehole is simultaneously filled with a bentonite/grout mixture. A polyvinyl chloride (PVC) tube fed into the rod casing will allow the addition of grout.

3.3 SUBSURFACE SOIL – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site for characterization of the stratigraphy and for analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all DPT sampling and soil characterization. All procedures and soil characteristics will be fully documented in the Field Logbook (SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means. Additional rods will be added in 3- to 4-ft increments until the leading edge of the sampler reaches the top of the desired sampling interval.

Once the desired sampling depth has been reached, insert extension rods down the inside diameter of the probe rods until it reaches the top of the sampler assembly. Attach the extension rod handle to the top extension rod. Turn the handle clockwise until the stop-pin detaches from the drive head. Remove the extension rods and the stop-pin. Attach a drive cap to the probe and drive the sampler approximately 2 ft using hydraulic derrick.

The DPT sampler can be retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly.

The liner will be capped with Teflon® tape and vinyl end caps. The liners can be split open to remove samples for composition analysis or for transfer to other containers for shipment to the laboratory for analysis.

The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

3.4 DECONTAMINATION

All Geoprobe® and Hydropunch® DPT equipment must be thoroughly cleaned before and after each use to allow retrieval of representative groundwater samples. Geoprobe® soil sample liners are disposed of after each use. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

After decontamination, a new clean liner will be installed and all parts will be inspected for wear or damage.

Refer to SOP No. 005 (Field Decontamination).

3.5 ABANDONMENT

Pure bentonite or a bentonite/grout mixture (20:1) will be used to fill the resulting borehole if the water table is penetrated. Boreholes that do not penetrate the water table will be backfilled with cuttings from the hole and topped with a bentonite seal. Clean sand will be used to fill any remaining volume in the borehole.

Abandonment of Geoprobe® and Hydropunch® generated DPT boreholes will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

4. CONE PENETROMETER TESTING

4.1 MATERIALS

A CPT rig typically consists of an enclosed 20- to 40-ton truck equipped with vertical hydraulic rams that are used to force a sensor probe into the ground. The weight of the CPT rig is dependent upon the thrust required at the site. The majority of CPT rigs are mounted in heavy-duty trucks that are ballasted to a total dead weight of approximately 15 tons. Screw anchors are utilized to develop the extra reaction to reach the maximum thrust of 20 tons. The rig is separated into two separate workspaces: data acquisition and hydraulic push areas.

Water sources for CPT activities and decontamination must be approved by the Project Manager prior to arrival of the CPT equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the DPT equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (SOP No. 019).

4.2 SUBSURFACE CHARACTERIZATION

The objective of this technology is to collect stratigraphic information using CPT equipment to determine subsurface stratigraphy and geotechnical properties at a particular site. CPT activities will be in accordance with American Society for Testing and Materials D 3441-86 and American Society for Testing and Materials D 5778-95. The stratigraphic information gathered can be used to facilitate the selection of DPT sampling screen intervals. At the same time, it is possible to install a 0.25-in. diameter pre-packed PVC monitoring well.

CPT rods are used to hydraulically push the CPT probe into the subsurface. Probes cannot be pushed into hard rock, and significant gravel or cobble content in the formation may impede or preclude penetration of the probe. The depth of penetration achievable depends on the type of formation, type of sampling probe, and size of the hydraulic equipment used.

The CPT probe includes the following components:

- A conical tip to measure vertical resistance beneath the tip.
- A friction sleeve to measure frictional resistance on the side of the probe, as a function of depth.
- Two internal strain gauge-type load cells, which independently measure the vertical resistance and side friction.
- A cone pressure gauge to measure the water pressure as the probe is pushed into the ground.
- Inclinometer to determine potential drifting of the probe (optional).
- Seismic transducers to perform downhole seismic surveys (optional). Therefore, stratigraphic data collected with the CPT include: tip resistance, local friction, friction ratio, pore pressure, and resistivity.

Data will be transferred from the probe to the data acquisition system or logger through an electrical cable. The hole will be advanced continuously at a rate of 0.6-1.0 in. per second. The data will be logged at every 0.4-0.8 in. of penetration. Monitor the probe’s stratigraphic position will be monitored as it advances downward. Perform pore water pressure dissipation tests in representative hydrostratigraphic intervals. Record dissipated pore water pressures to represent hydraulic head values.

Once the confining unit underlying the surficial aquifer or the required depth has been reached, the CPT is pulled from the ground. Target interval samples can be collected during CPT hole advancement using direct push sampling techniques, i.e., Geoprobe® or Hydropunch® (Section 3).

4.3 DECONTAMINATION

All CPT equipment must be thoroughly cleaned before arrival at the work site, between test holes, and prior to being moved out of a work area. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

Refer to SOP No. 005 (Decontamination).

4.4 ABANDONMENT

If the push hole was developed for the stratigraphic test only, once the testing is completed, grout the hole from bottom to top. If the hole has not collapsed after removing the CPT, PVC piping will be used to grout the hole. If the hole has collapsed after removing the CPT, then hollow CPT rods and a sacrificial tip will be used to grout the hole. The PVC pipe or CPT rods will be pushed to the bottom of the hole. Grout will then be pumped to the bottom of the hole as the PVC pipe or CPT rods are withdrawn.

Refer to SOP No. 028 (Well and Boring Abandonment).

5. SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM

5.1 MATERIALS

SCAPS cone penetrometer and laser induced fluorescence (LIF) technology requires the use of a specialized 20-ton truck. The truck has two separate enclosed compartments. Each compartment is temperature controlled and monitored for air quality. The two rooms are the data acquisition and processing room, and the hydraulic ram/rod handling room. Approximately 20 ft of overhead clearance is required to fully extend the hydraulic ram and allow for leveling jack movement.

All materials required to complete SCAPS analysis are provided by the subcontractor to include cone penetrometer equipment. All hydraulic equipment, SCAPS rods, nitrogen lasers, etc. are included within the vehicle. A decontamination water source and a source of water for mixing the grout are required.

Water sources for equipment decontamination must be approved by the Project Manager prior to arrival of the SCAPS equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the SCAPS equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (SOP No. 019).

5.2 HYDRAULIC PUSHING AND SAMPLING

The objective of the SCAPS technique is to allow grab samples and stratigraphic information to be collected at a selected site to facilitate subsurface characterization and for analysis of potential contaminants. The analytical results obtained can also be used to determine the placement of monitoring wells. At the same time, it is possible to install a small diameter well for sampling purposes. Refer to SOP No. 019 (Monitoring Well Installation). If a well will not be installed, the borehole can be grouted as the equipment is removed.

A site geologist will be present during all installation and sampling procedures and will fully document all procedures and soil characteristics in the Field Logbook (SOP No. 016).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole SCAPS equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after direct-push activities.

The subcontractor will use the equipment specific guidelines for installation of the SCAPS DPT equipment. Prior to SCAPS field activities, calibration soil samples will be collected and analyzed in order to determine the LIF sensor fluorescence threshold and detection limits for the site.

SCAPS LIF technology uses a pulsed nitrogen laser coupled with an optical detector to make fluorescence measurements via optical fibers. The LIF sensor is mounted on a cone penetrometer probe so that soil classification data and fluorescence data are collected simultaneously. The laser consumes nitrogen gas, which is supplied from cylinders stored on the accompanying trailer.

The SCAPS CPT sensors are used to gather stratigraphic information. See Section 4 for CPT operating procedures.

Target interval samples can be collected during SCAPS hole advancement using direct push sampling techniques such as Geoprobe® or Hydropunch® (Section 3).

5.3 DECONTAMINATION

Decontamination of SCAPS equipment is automated after initialization by a field team member. A pressurized hot water system is used to decontaminate the push rods as they are retracted from the ground. The SCAPS vehicle is equipped with a decontamination collar mounted to the bottom that cleans the rods. The decontamination water is removed by vacuum and transferred to a storage drum prior to disposal or treatment. A trailer attached to the back of the vehicle contains the water pump, heater for decontamination, and decontamination water containment drum.

Worker exposure is reduced by minimizing contact with contaminated media.

Refer to SOP No. 005 (Decontamination).

5.4 ABANDONMENT

SCAPS automatically grouts the penetrometer cavity as the rods are removed. The grout is pumped at high pressure through a 0.25-in. diameter tube in the center of the penetrometer rods. The tip is sacrificed at the bottom of the cavity to allow release of the grout.

A trailer attached to the back of the vehicle contains the 300-gal grout mixing bin and pump.

If the automatic grout feed does not work, the cavity will be manually filled with grout.

Abandonment of SCAPS generated borehole will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

6. MAINTENANCE

Not applicable.

7. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during intrusive activities.

8. REFERENCES

ASTM International (ASTM). 1986. ASTM Designation D3441-86. ASTM, Standard Test Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Test of Soil. December.

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Standard Operating Procedure No. 048
for
Low-Flow Sampling

Prepared by

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Hunt Valley, Maryland 21031

Revision 0
December 2014

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this standard operating procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☒ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 048	
SOP Section	**Variance**
1.2 and 2.2	**high-density polyethylene (HDPE) and/or silicone tubing (known to be PFAS free)**
	for PFAS Sampling

Frank DeSantis (Deputy)

Project Manager (Name)

17 August 2023

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**

1. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING DEDICATED PUMPS

1.1 SCOPE OF APPLICATION

The purpose of this standard operating procedure (SOP) is to establish the protocol for collecting groundwater samples using dedicated pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity.

1.2 EQUIPMENT/MATERIALS

- Work Plan.
- Well construction data, location map, and field data from last sampling event.
- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).
- Electric water level measuring device, 0.01 ft accuracy for monitoring water level during pumping operations.
- Pumps: adjustable rate, submersible pumps constructed of stainless steel and Teflon®.
- Tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene tubing will be used.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator, etc.).
- Water quality indicator parameter monitoring instruments—pH, turbidity, specific conductance, and temperature. Optional indicators—Eh and dissolved oxygen.
- Flow-through cell (preferred) or clean container for water quality probes.
- Decontamination supplies (for monitoring instrumentation).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.
- Drum for purge water containment.

1.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Lay out sheet of polyethylene for monitoring and sampling equipment.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (flame or photo) instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Dedicated sampling pumps should be positioned with the pump intake mid-point in the screened interval. If non-dedicated equipment is used, care will be taken to position pump or sampling hose intake at the screen mid-point.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Prepare the pump by checking electrical connections, discharge tubing, and motor (Grundfos Redi-Flo2). Locate the generator (if applicable) downwind of the well; connect the power converter to the generator and to the pump.

1.4 WELL PURGING AND SAMPLING PROCEDURE

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Connect the flow-through cell or clean container containing the instrumentation header to the pump discharge and begin purging the well at 0.2-0.5 L/min, unless a different purge rate has been previously established for that well. Fill the flow cell completely. Care should be taken not to cause entrapment of air in the system. Record the purge start time and purge rate.

- Establish that the water level has not dropped significantly such that the pump is dry (bubbles in discharge) or water is heard cascading down the inside of the well. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

- During purging of the well, monitor the water quality indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Record purge rate, volume purged, depth to water, water quality indicator parameters values, and clock time at 3- to 5-minute intervals in field logbook and sampling record. Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 nephelometric turbidity units (NTU) are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing. Record pertinent observations in field logbook and sampling records.

- Begin filling sample containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation are discussed in Section 1.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated pumping assembly to the well by hanging the tube, electric line, and support cable inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

1.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

- — Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.

- — Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.

- — Invert the bottle, tap lightly, and check for air bubbles.

- — If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

- — Place samples on ice until shipment.

- **Inorganics**—Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

1.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (SDG) (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.

- Equipment Rinsate Blank—Required once prior to installation of dedicated pump systems.

- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

1.7 DECONTAMINATION

Non-dedicated sampling equipment and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternative procedures must be approved by the Project Manager prior to sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

2. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING PERISTALTIC PUMPS

2.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting groundwater samples using peristaltic pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity, and is intended to be used in conjunction with the analyses for the most common types of groundwater contaminants (VOCs and inorganic compounds).

2.2 EQUIPMENT/MATERIALS

- Work Plan.

- Well construction data, location map, field data from last sampling event.

- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).

- Water level measuring device, 0.01 ft accuracy (electronic preferred) for monitoring water level drawdown during pumping operations.

- Peristaltic pump.

- In-well tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene, PVC, Tygon, or polyethylene tubing may be used.

- Pump head tubing: Silicon tubing must be used to in the pump head assembly.

- Flow measurement supplies (e.g., graduated cylinder and stop watch).

- Power source (battery, etc.).

- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.

- Flow-through cell (preferred) or clean container for water quality probe.

- Decontamination supplies (for monitoring instrumentation).

- Sample bottles and sample preservation supplies (as required by the analytical methods).

- Sample tags or labels.

- Cooler with bagged ice for sample bottles.

- Drum for purge water containment.

2.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (photo or flame) instrument at the rim of the well and in the breathing zone and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad, or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will not be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Position the intake of the sampling hose at the mid-point of the screened interval.

- Prepare the pump by checking electrical connections and discharge tubing. Locate the battery downwind of the well; connect the peristaltic pump to the battery.

2.4 WELL PURGING AND SAMPLING PROCEDURES

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Measure the water level with the pump in well before starting the pump. Begin purging the well at 0.3-0.5 L/min, unless a different purge rate has been previously established for that well.

- If well diameter permits, establish that the water level has not dropped significantly such that the pump is dry (air in discharge) or tubing suction is broken. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken, or entrainment of air in the pump system. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.3 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collected the appropriate volume of samples with the pump.

- During purging of the well, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 NTU are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the sample discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing.

- Collect groundwater samples directly from the silicon tubing into preserved (when appropriate) sample containers. Begin filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Detail on sample preservation are discussed in Section 2.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated tubing assembly to the well by hanging the tube inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including: sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

- The silicon tubing used in the peristaltic pump will be changed after use at each well.

2.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:
  - Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.
  - Fill a sample bottle, preserve with HCL, and check the pH. Adjust the volume of HCL to assure pH<2.
  - Add the amount of HCL determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.
  - Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down, and screw cap on.
  - Invert the bottle, tap lightly, and check for air bubbles.
  - If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.
  - Place samples on ice until shipment.
- **Inorganics**—Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative that can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

2.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent

- Equipment (Rinsate) Blank—Required once prior to installation of dedicated sample tubing

- Source Water Blank—Required at a frequency of one per source per sampling event

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

- Temperature Blank—Required at a frequency of once per sample shipment container.

2.7 DECONTAMINATION

Non-dedicated sampling and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternate procedures must be approved by the Project Manager prior to the sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

3. SURFACE WATER AND LEACHATE SEEP SAMPLING PROCEDURE

3.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting surface water and leachate seep samples. The procedure is designed to permit the collection of representative surface water and leachate seep samples, and has been adapted from the procedure outlined in the Work Plan. This SOP is suitable for collecting surface water and seep samples requiring analyses for the most common types of surface water contaminants (VOCs and inorganic compounds).

3.2 EQUIPMENT/MATERIALS

- Work Plan.
- Location map, field data from last sampling event.
- Field logbook and Field Record of Surface Water and Sediment Sampling forms (Figure SOP048-2).
- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.
- Decontamination supplies (for monitoring instrumentation).
- Dedicated, pre-cleaned 1-L wide-mouth or volatile organic analyte sample container (for sample collection).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.

3.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing surface water or leachate seep sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, sample station identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Visually inspect sample station for evidence of changes in physical condition; record pertinent observations in field logbook and sampling form.

- Measure VOCs with a flame ionization detector instrument in the breathing zone and record the reading in the field logbook and sampling form.

3.4 SAMPLING PROCEDURE

The technique for surface water and leachate seep sampling must be selected after addressing such items as:

- Depth of waterbody
- Depth of sample
- Stratification
- Seasonal variations
- Analytical parameters of interest.

The following general procedure should be used to obtain representative surface water and leachate seep samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to sampling: date and time, sample method, and sample depth.

- Collect the sample from the surface water, within several tenths of a foot of the streambed, by immersing a new, dedicated 1-L glass or volatile organic analyte sample container into the waterbody. If a stream is being sampled, collect the sample upstream of the sampler with the opening of the sampling device oriented upstream but avoiding floating debris.

- Directly fill the appropriate sample containers from the 1-L or volatile organic analyte sampling device.

- Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- Water sample containers are generally filled directly from the source or sampler without special considerations. The exception is the collection of aqueous VOC samples requiring pH adjustment. VOC samples will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation methods are discussed in Section 3.6.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- Measure water quality indicator parameters, if possible, by direct immersion of instrument probes into the waterbody immediately following sample collection. If direct measurement is not possible, measure these parameters from water remaining in the sampling device or another sample bottle. Record this information in the field logbook and sample data record.

- Complete remaining portions of the Field Record of Surface Water and Sediment Sampling form (Figure SOP048-2) after each station is sampled, including: time of sample collection, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

3.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs**—Aqueous VOC samples must be collected as specified below. Each sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

  — Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the 1-L container, minimizing air entrainment, until the vial slightly overflows.

  — Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.

  — Invert the bottle, tap lightly, and check for air bubbles.

  — If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

  — Place samples on ice until shipment.

- **Inorganics**—Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

3.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the surface water and leachate seep samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.

- Equipment (Rinsate) Blank—Required at a frequency of once per day per media sampled.

- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

3.7 DECONTAMINATION

Field monitoring equipment will be decontaminated prior to use and following sampling of each station by the procedure listed below. Laboratory pre-cleaned, dedicated 1-L glass sample collection containers are used once and discarded and, therefore, do not undergo any decontamination. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

4. REFERENCES

U.S. Environmental Protection Agency. 1996. Groundwater Issue-Low Flow Sampling (Minimal Drawdown) Groundwater Sampling Procedures. April.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: ____________________
Project Number: ____________________
Well ID: ____________________
Well Lock Status: ____________________
Well Condition: ____________________
Weather: ____________________

Gauge Date: ____________________
Gauge Time: ____________________
Sounding Method: ____________________
Measurement Ref: ____________________
Stick Up/Down (ft):
Well Diameter (in.):

Purge Date: ____________________
Purge Time: ____________________
Purge Method: ____________________
Field Personnel: ____________________
Ambient Air VOCs (ppm): ____________________
Well Mouth VOCs (ppm): ____________________

WELL VOLUME

A. Well Depth (ft): ____________________
D. Well Volume/ft (L): ____________________
B. Depth to Water (ft): ____________________
E. Well Volume (L) (C*D): ____________________
C. Liquid Depth (ft) (A-B) ____________________
F. Three Well Volumes (L) (E*3): ____________________
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Total Quantity of Water Removed (L): __________
Samplers: __________ Sampling Time (Start/End): __________
Sampling Date: __________ Decontamination Fluids Used: __________
Sample Type: __________ Sample Preservatives: __________
Sample Bottle IDs: __________
Sample Parameters: __________

Site Name: __________ Project Number: __________ Date: __________
Well ID: Field Personnel:

Parameter	6	7	8	9	10	11
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Comments and Observations:

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FIELD RECORD OF SURFACE WATER AND SEDIMENT SAMPLING

Site Name:			Project Number:
Sample Location ID:			Date:
Time:	Start:	End:	Sample Team Members:

SURFACE WATER INFORMATION

Type of Surface Water:
( ) Stream ( ) River
( ) Pond/Lake ( ) Seep

Water Depth and Sample Location _________ (ft)

Depth of Sample from Top of Water ________ (ft)

Equipment Used for Collection:
( ) None, Grab into Bottle
( ) Bomb Sampler
( ) Pump _____________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Water Quality Parameters
( ) Temperature ____
( ) Conductivity ___ µmhos/cm
( ) pH ____ units
( ) Dissolved oxygen ____ mg/L
( ) Turbidity ____ NTU
( ) Eh ____ mv

Velocity Measurements Obtained? ( ) No ( ) Yes, See Flow Measurement Data Record
____

Field QC Data: ( ) Field Duplicate Collected Sample Location Sketch: Method Used:
Duplicate ID ____________ ( ) Yes ( ) Winkler
( ) MS/MSD ( ) No ( ) Probe

SEDIMENT INFORMATION

Type of Sample Collected:
( ) Discrete
( ) Composite

Sediment Type:
( ) Clay
( ) Sand
( ) Organic
( ) Gravel

Equipment Used for Collection:
( ) Gravity Corer
( ) Stainless Steel Split Spoon
( ) Dredge
( ) Hand Spoon/Trowel
( ) Aluminum Pans
( ) Stainless Steel Bucket
( ) _____________________________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Sample Observations:
( ) Odor ____
( ) Color

Field QC Data: ( ) Field Duplicate Collected ( ) MS/MSD
Duplicate ID ___________________________

FIELD RECORD OF SURFACE WATER AND SEDIMENT SAMPLING

SAMPLES COLLECTED

Check if Required at this Location	Matrix		Check if Preserved with Acid/Base	Volume Required	Check if Sample Collected	Sample Bottle IDs			
	Surface Water	Sediment							

NOTES/SKETCH

Standard Operating Procedure No. 061
for
Geographic Information System
Data Management and Deliverable Preparation

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 1
March 2021

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 061	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	March 2021	Update all sections to be current.	Mark Dhruv	Frank Barranco Jason Samus Beth Schrayshuen

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1. INTRODUCTION

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide EA personnel responsible for geographic information system (GIS) activities the guidance necessary to maintain company-wide uniformity of data management and storage, naming conventions, quality assurance (QA)/quality control (QC) procedures, and deliverables.

1.2 SCOPE

This SOP covers EA's basic requirements for creating and maintaining map projects, GIS data management including file convention and organizational data storage protocols, and preparing deliverables for a GIS project or GIS subtask. This SOP does not cover instructional information on using GIS software, nor does it include SOPs for Enterprise Geodatabase Management (formally ArcSDE), or ArcGIS Online (AGOL). For additional instructions regarding the use of GIS software, refer to available user documentation and Environmental Systems Research Institute (Esri) help topics.

This SOP is arranged to help new GIS users understand the elements required for a consistent and efficient data structure and project-specific format. Beginning with Section 3.2 – GEOGRAPHIC INFORMATION SYSTEM DATA MANAGEMENT, the overall GIS data structure is presented followed by project-specific file structure and naming conventions.

1.3 DEFINITIONS

- AGOL = ArcGIS Online
- APRX = ArcGIS Pro Project
- Esri = Environmental Systems Research Institute
- Feature Class = Vector data type that is stored in a geodatabase
- FGDC = Federal Geographic Data Commission (Federal Geographic Data Committee standards [http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/base-metadata/index_html])
- GDB = Geodatabase used to store Feature Classes, rasters, and xml files
- Metadata = Information about the geospatial data file
- MXD = Esri GIS project file extension
- Shapefile = Vector data type that is stored as standalone files consisting of 4-8 file types (.shp, .shx, .sbn, .sbx, .shx, .dbf, .prj, .xml) that together make up the Shapefile
- STR = Senior Technical Reviewer
- Vector = GIS point, line or polygon data type.

1.4 RESPONSIBILITY

EA personnel assigned GIS tasks will be responsible for adhering to the standards included in this SOP and for ensuring that all GIS deliverables meet any and all contract requirements and specifications. In accordance with EA QC procedures and STR policy, GIS deliverables should be reviewed by an appropriate STR.

1.5 RELATED STANDARD OPERATING PROCEDURES

This section will be revised as additional SOPs are developed.

2. EQUIPMENT

2.1 SOFTWARE

2.1.1 ArcGIS Platform

EA uses Esri's ArcGIS suite of products, which is the industry standard in GIS software. There are two main platforms for mapping, analysis, and database development:

- ArcGIS for Desktop
- ArcGIS Pro.

2.1.1.1 ArcGIS for Desktop

ArcGIS for Desktop is one of two GIS software platforms for mapping analysis and figure production. The software consists of three user levels based on increased functionality: Basic, Standard, and Advanced. ArcGIS for Desktop operates on a shared network server license structure.

This version of Esri's GIS software will be phased out in 2026 to be replaced by ArcGIS Pro, Esri's new mapping platform, which is currently in use at EA.

2.1.1.2 ArcGIS Pro

ArcGIS Pro follows the same user levels as ArcGIS for Desktop: Basic, Standard, and Advanced and operates on a named user-defined license structure. While it provides the same level of performance and functionality as Desktop, some main differences consist of:

- Ribbon-style user interface

- Project-based file type (.aprx), which allows for multiple maps and layouts within a single project versus ArcGIS for Desktop's single map (.mxd) file type

- Project-specific data storage and tools (see next section)

- Enhanced imagery analysis functions.

In ArcGIS Pro, a body of related work consisting of multiple maps, scenes, layouts, data, tables, tools, and other resources is typically organized as a "Project." Unlike ArcGIS for Desktop, when a new map is made, ArcGIS Pro will create a Project-specific folder in which the aforementioned elements are stored. The advantage of this structure makes data transfer more efficient by containing all project data within a single directory folder.

It is recommended that any new GIS project be created in ArcGIS Pro rather than ArcGIS for Desktop due to the eventual end of support for Desktop occurring in 2026. This will allow for a smoother transition of all projects to ArcGIS Pro since converting an ArcGIS for Desktop.mxd to ArcGIS Pro.aprx entails time-consuming modifications and corrections to the layout after conversion.

2.1.2 Other Geographic Information System Platforms

Other GIS software options include Quantum GIS (QGIS), GRASS GIS (USACE), and Global Mapper (Blue Marble); however, these are not supported by EA and may not be compatible with projects already using ArcGIS.

2.2 HARDWARE

2.2.1 Desktop/Laptop Computers

Most new computers should be able to adequately run GIS and all of its processing tools without any additional computing requirements. Below is a summary of the minimum standards:

- i7 processors 2.6 gigahertz
- 8GB random access memory
- 256 solid state hard drives.

3. PROCEDURE

There are multiple elements that must be considered when setting up a GIS project or GIS project subtask that will ensure adequate and consistent data management. These elements focus on GIS data sources and GIS data management for the development of a project-specific GIS structure. The following sections define each of the elements and describe the approved EA protocol for maintaining the GIS. Section 3.1 will identify the various GIS data sources and each subsequent section will describe how to manage these data sources through an organized directory structure (Section 3.2), as well as describing the protocols in setting up an initial project in GIS (Section 3.3). Additionally, some sections will provide Guidelines (bold/italics) that shall be followed, except in rare circumstances where guidelines cannot be applied.

3.1 GEOGRAPHIC INFORMATION SYSTEM DATA SOURCES

There are three main categories of GIS Data Source types:

1. EA Project-created data
2. Publicly available data
3. Client-provided data.

These data source types may include GIS vectors (i.e., feature classes and shapefiles), rasters, or xml metadata files. The GIS data from each source type is organized differently within the GIS directory structure based on deliverable requirements and to preserve original data. All data from each source type should have attribute and/or metadata information that describes the **source** and **date** of acquisition or creation. Publicly available and Client-provided data may come with attributes and metadata that do not require further documentation by EA unless the data are lacking in source and date.

3.1.1 EA Project-Created Data

This data source type consists of any GIS data generated by EA GIS analysts as a result of the mapping or analysis process, or Public/Client data that have been manipulated by EA and no longer fully represents the original source.

Vector/Raster Guidelines

- Data that are created by EA (or subcontractor) should be saved in the project geodatabase with full attribution and metadata.

3.1.2 Publicly Available Data

This data source type consists of any GIS data acquired from publicly available sources (e.g., non-profits; county, state, or federal agencies; or other third party GIS data sources).

Vector/Raster Guidelines

- If a publicly available data source is used, the vector or raster should be clipped to the project extent and saved within the project geodatabase. The area of the vector or raster that is beyond the needed extent of the project should be deleted or can be saved to a directory created for larger jurisdictional data (i.e., General Data Directory), as long as the data are not temporally or security sensitive (e.g., Wetlands data are time-sensitive and may become outdated; Private water well data may be security-sensitive and, if so, should not be shared with other projects).

- If metadata are not present, metadata shall be populated with source information, date of acquisition, and description, at a minimum.

Rest Services Guidelines

- Data in a map originating from a Rest Service should be documented as such in the map document properties (i.e., MXD or APRX metadata file).

3.1.3 Client-Provided Data

This data source type consists of any GIS data acquired from the Client that is to be used for the project. These data should be stored separately from Project-created data either in a separate geodatabase or a separate feature dataset within the project geodatabase (see Section 3.2.2 for more information on project-specific data storage).

Vector/Rasters Guidelines

- Any data from the client that are manipulated by EA should be saved in the project geodatabase, with original source and date documented in the metadata, at a minimum, and the attribute table.

3.2 GEOGRAPHIC INFORMATION SYSTEM DATA MANAGEMENT

Network-Based GIS Data Storage

It is important to maintain a centralized location for GIS data as well as shared GIS data in an organized manner with protocols in place to limit versioning errors and "data spread."[1] Additionally, GIS data should be maintained on a server or in a directory that is separate from the main project directory. This directory can be designated as the **GIS Data Directory**. Within the GIS directory, the data can be broken down into their respective projects as described in this section. Adhering to this structure will enhance data organization and allow those not familiar with the project to easily locate project GIS data files. It will also provide an element of protection from non-GIS users (e.g., project managers or project staff) that may rename, reorganize, or archive the main project directory.

This section will focus on developing a general directory structure for all projects within an office or Business Unit and identify the proper methods to store project-specific data.

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[1] "Data spread" is when a project is pulling data from multiple directories or geodatabases, making it prone to data loss and decreasing efficiency when preparing the data as a final deliverable.

3.2.1 Geographic Information System Data Directory Structure

Since GIS data should be stored separate from the main project directories, the directory structure for GIS data should be organized in an intuitive manner so that any users not familiar with the project can still locate the appropriate data as needed. This will ensure that GIS project data are still available after the project has been completed.

The recommended GIS directory structure for an office or Business Unit is based on three primary elements:

1. Client type (i.e., Federal, State/Local, Commercial)
2. Project Location (state, county or country)
3. Project Number_Client_Project (ex. 123456_USACE_PuchackPhaseII).

NOTE: Not all directory elements need to be created if there will be no data of the type utilized by the project. For example, local offices where work is performed within a limited geographic area may find it more useful to store data by client and project only. ***It is required, however, that a consistent structure be followed throughout the respective office or Business Unit GIS Data directory.***

Example Directory Structure

The structure below represents EA's Corporate GIS group, which performs work throughout the company's various geographic regions and client types ("\\lovetongis\GISdata\" represents the root directory name for the corporate EA GIS network):

- \\lovetongis\GISdata\Federal – Directory for Federal client project GIS.

- \\lovetongis\GISdata\StateandLocal – Directory for State and Local client project GIS.

- \\lovetongis\GISdata\Commercial – Directory for Commercial client project GIS (includes industrial and private).

- \\lovetongis\GISdata\Proposals – Directory for proposals that require GIS data. Meant to serve as a temporary storage location until project is won (whereupon data are transferred to the appropriate directory) or lost (data are deleted or archived).

- \\lovetongis\GISdata\Administrative – Contains administrative data such as figure templates, logos, style files, licensing info, training info, etc.

- \\lovetongis\GISdata\GeneralData – Contains publicly available data (e.g., Esri-supplied data layers, nationwide, and statewide general GIS data that are not subject to temporal or security restrictions (i.e., data that are periodically updated such as wetlands or public/private wells, etc.).

\\LovetonGIS Subdirectories

Within each of the main \\lovetongis\GISdata\ primary directories (Commercial, Federal, State and Local) are geographical regional folders that sub-divide the United States into seven geographic regions:

- Northeast
- Southeast
- Midwest
- Central
- West
- Pacific
- Overseas.

Refer to the EA GIS Regional Directory.pdf to identify which states are grouped into which region.

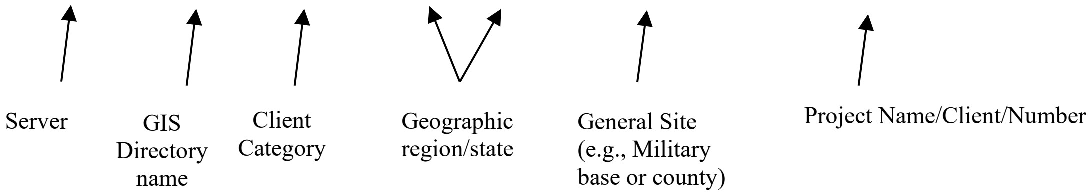
If a project encompasses a geographic region beyond the regions specified above, a directory can be added and named according to the project.

The Regional Directories are broken out further by:

- State or Country
    - County (if applicable)
        - [Project Name]_[Client]_[Project Number]

For example:

\\lovetongis\gisdata\Federal\Northeast\Maryland\APG\ProjectA_USACE_123456



GIS Data Directory Guidelines

- ***Data Access between GIS Data Directory and Project Directory***—To maintain easy access to the GIS data from the project directory and vice versa, a shortcut link should be saved in the main project folder and the project GIS folder.

- ***GIS Data File Version Tracking***—Shared data are required to have metadata filled in that specifies the source of the files, version date, description, and user constraints at a minimum. See Metadata Section 3.5 for required elements.

- Do not use spaces when creating directory names. Suggest using an underscore "_" in place of a space.

3.2.2 Geographic Information System Project Folder Structure

Once the GIS project-specific main directory folder has been created (e.g., *123456_USACE_PuchackPhaseII*) within the office network's GIS Data Directory, further organization is suggested to maintain consistency. Below is a list of folders that should be created within the project folder to organize current and future data (folder name in CAPS, example data types in parentheses):

Project Folder Structure

- ADMIN
- VECTOR_DATA (optional sub-folders listed below)
    - PROJECT_DATA (geodatabases and/or shapefiles for project-specific purposes)
    - DATA_IN (external data received [i.e., from clients, subs, primes, EA])
    - DATE_OUT (internal data sent to clients, subs, primes, EA not as final deliverables)
    - FIELD_DATA (Global Positioning System or other data received from field crew)
    - WORKING_DATA (temporary data to be re-filed into a geodatabase, archived, or deleted as appropriate)
- PROJECTS (.mxd, ArcGIS Pro data- recommend subfolders to organize projects as needed, which includes the ArcGIS Pro geodatabase)
- RASTERS (DEM, Hillshades)

- IMAGERY (.tiff, .jpg)[2]

- OTHER_DATA (REST Services information, associated tables)

- DOCUMENTATION (original source data [pdfs, reports], other metadata info)

- DELIVERABLES (final pdf maps, geodatabases)

  - FIGURES (i.e., pdfs, pngs, etc.)
  - VECTORS (final geodatabases, shapefiles, rasters, etc.)

- QA/QC (marked-up maps, checklists)

- ARCHIVE (old files no longer in use, but not ready for deletion).

ArcGIS Pro Project Folder Structure Guidelines

Since ArcGIS Pro automatically creates a project-specific geodatabase within its Project folder, it is recommended that the ArcGIS Pro geodatabase be used for vector data storage while actively working on the project. However, depending on data deliverable requirements, vector data from the ArcGIS Pro geodatabase should be exported to the deliverable geodatabase throughout the life of the project.

It should be noted that additional geodatabases, datafiles, rasters, etc. can also be stored in the ArcGIS Pro Project folder if there is frequent transferring of your project to/from network to local drives. As ArcGIS Pro is more suitable to moving from network drives to local drives, this will make working from home much more efficient.

3.3 WORKING REMOTELY

With the increased number of people working remotely, maintaining an organized data structure becomes more important when using GIS data in remote situations. While it is not recommended that data are copied off the network to local drives, it is understood that some circumstances may require to work on data locally. If this is the case, the Working from Home guidelines should be followed.

Remote Working Guidelines

- Ensure .mxd maps are saved with “relative pathnames” checked (file menu/document properties; this is not relevant to ArcPro maps).

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[2] Due to potential size of imagery files, server storage should be confirmed with EA Information Technology staff before downloads of files larger than 10 gigabytes.

- It is critical that any and all GIS data that have been created or updated on your local drive are copied back to the network location on a daily basis.

- To ensure no one will access the network version of your local data, temporarily rename the project folder with "BU_" at the beginning of the name. This will alert other users that the data are not the most current version.

    - Add a README.txt file inside the main project folder indicating who is using the current version and return time/date.

3.4 SETTING UP A PROJECT-SPECIFIC GIS

Once the project directory is set up, a **Project Summary** document should be filled out by the GIS lead for the project to address all aspects of the GIS for a specific project (saved in the project Admin directory). The **Project Summary Document** is the first step to maintaining a logical and organized GIS by detailing the following:

- Project Name
- Project Number/Phase/Task
- Project Manager
- Start Date
- Lead GIS Analyst
- Link to GIS Directory Location
- Link to Main Project Directory Location
- Coordinate System/Units
- Brief Summary of Project
- QA/QC checklist
- Notes on Project.

Additional details can be added as necessary such as data source information or links, directions on analyses processes, etc. This information will help in standardizing the resulting feature classes created over the life of the project. The Project Summary Template document is provided in **Attachment A**.

The Project Summary document will also include a QC Checklist and Sign-off (**Attachment B**) that should be filled out by the geospatial data reviewer (e.g., GIS project lead, GIS STR, or GIS analyst who is not directly associated with the project). Section 3.7 provides more details QA/QC procedures.

3.4.1 Geographic Information System File Naming

All geodatabase, rasters, feature classes, etc. should be named in a way that is intuitive to the common user. **ArcGIS does not allow spaces or special characters** to be used when naming files. Suggested naming structure may include a brief description (one or two words separated by underscores) as well as data type or date. To keep names brief, project name does not need to be included since the geodatabase or folder directory will include the project name. *Do not begin file names with numbers.*

Example: "Wetlands_NWI_06282019." This example shows what the data are, where obtained, and date created. Some combination of this structure should be used when naming GIS vector data files.

3.4.2 Geodatabases

Geodatabases should be used to store all features regardless of data type. Any geodatabase created for a project should be a **File Geodatabase**, as Personal Geodatabases are no longer fully supported. Store all Geodatabases under the VECTOR_DATA folder. When naming a geodatabase, include the project name and/or client name, and data source type (EA or Client or Public).

Example: "ProjectA_USACE_EA.gdb." This example shows the project name, client name, and data source type.

If the Geodatabase is to be a client deliverable, it must adhere to the QA/QC checks in Section 3.7. The schema documentation must be developed at the Project Management level in order to establish the criteria for project-specific checks.

It is recommended that you create Feature Datasets within the Geodatabase. The advantages of this practice are to:

- Enhance organization
- Ensure consistency among coordinate systems
- Allow a place to input generalized metadata for a collection of features within the feature dataset; this will save time until more feature-specific metadata can be applied.

NOTE: When using **ArcGIS Pro**, a geodatabase is automatically created when setting up a new Project (i.e., map). This geodatabase can be used as your project geodatabase or a working geodatabase for temporary files.

3.4.3 Shapefiles (shps)

There are occasions when shapefiles are created either through analysis outputs or as directed by a client for deliverables. These should be organized under the VECTOR_DATA folder with sub-folders depicting use type. See next section for "working files."

3.4.3.1 Working Files

"Working" files can be in any format (i.e., shapefile, feature class, raster). A "working" file is any file that you create that is used toward developing a new layer to be used in the final map or database deliverable. "Working" files should be discarded or archived on a regular basis and should not be stored with deliverable files. To save time, create a "Source" field in the attribute table and enter a brief description of its functionality toward the project rather than filling in metadata.

3.4.4 Coordinate Systems

Regardless of the format that data are created or received in, it is required that a coordinate system be defined for all features whether they reside in a database, shapefile, raster, etc. The coordinate system should be the same for all layers in the project that reside within the same geographic location (i.e., Universal Transverse Mercator zone or state plane) and should match contract requirements or standards based on geographic location. The project coordinate system should be relayed to any other GIS analysts working on the project not directly associated with EA (subs) as well as surveyors or computer-aided design technicians.

NOTE: When using geodatabases, creating a feature dataset within the geodatabase will require features to adhere to a single coordinate system.

Coordinate System Guidelines

- Any feature class or raster created or obtained must be projected to a coordinate system and should match the coordinate system listed in the Project Summary document/contract requirements.

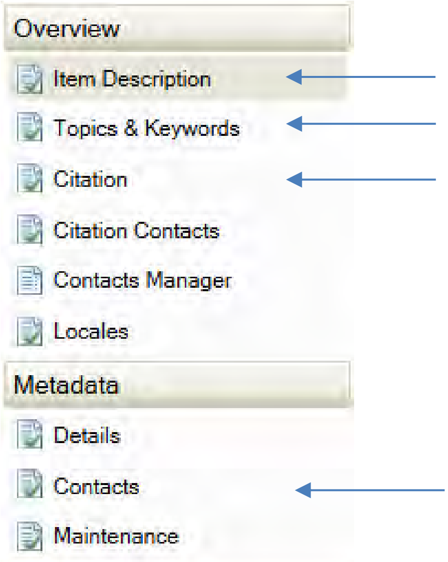
3.4.5 Metadata

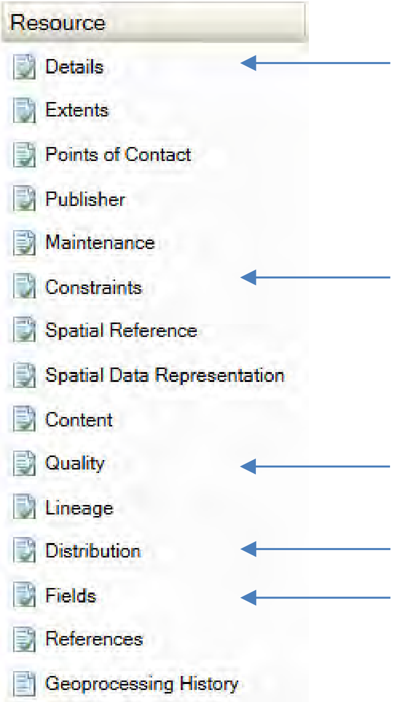
Metadata is an important aspect of any GIS project. Metadata are used for the following situations:

- Data deliverables; provide background information on the GIS data
- Information for users not familiar with the project
- Data source information
- Data use and constraints.

It is required that all files used in a project will have some aspect of its metadata filled out. If the file does not have an existing metadata file, then the GIS analyst will create one. The information to include is as follows:

Format





Minimum Entry Fields

Overview Section

- Item Description:
  - ***Title***—The title of the metadata record must be succinct yet descriptive, and include the topic, temporal information, geography, relevant time period, and the data owner or provider.
  - ***Tags***—Relevant identifiers to aid in search parameters
  - ***Description***—Should begin with (1) the data type (i.e., table, feature layer, map service, etc.), then (2) include what the data represent, (3) the data source, and (4) if applicable, the extent and scales at which the layer draws. Then, include the number of records and any details on the method of observation.
- Topics and Keywords
- ***Citation***—Enter the date when the geospatial data resource was Published, Created, or Revised, whichever is most applicable.

Metadata Section

- ***Contacts***—Who created the metadata.

Resource Section

- ***Details***—Do the data apply to a particular document (i.e., work plan, publication, report).

- ***Constraints***—Are there security constraints.

- ***Quality***—Document multiple measures of quality within the dataset, including completeness, positional accuracy, attribute accuracy, etc.

- ***Distribution***—Do these data exist elsewhere (e.g., online)?

- ***Fields***—Brief description of each relevant field.

If a client provides specific metadata standards, this will override EA's metadata minimum standards. For example, the U.S. Environmental Protection Agency (EPA) provides a quick guide to filling out metadata for EPA projects (EPA 2020a).

3.5 FIGURE PRODUCTION AND MAPPING

This section details the protocols for developing figures for reports, field use, meetings, etc.

3.5.1 Map Layout Templates

Templates are used to keep a consistent look across all maps and figures. EA has a set of standard templates that should be used on all projects company-wide (available through EA Sharepoint site: *TBD* or on the corporate \\lovetongis directory (**Attachment C**) unless otherwise specified (e.g., client requires a specific layout). In cases where templates are customized for a specific client or projects, the template should be saved in the project directory PROJECTS folder.

If creating new templates for a project, the following is required:

- Each figure should include a North arrow, scale bar, file path, source data, and a legend. The style and size of each should remain consistent throughout all figures.

- Label font size should be consistent within feature types regardless of the scale (i.e., all road names have the same font properties, and all stream names have the same font properties that may be different from the road layer). This means the font will be the same height per feature type on small and large scale figures when printed out.

- Unless otherwise noted, symbols should follow EA's standard for map symbology. See **Attachment D** for symbol standards (known as Stylefiles).

Mapping Guidelines

- The exterior neat line should allow for a minimum 0.5-inch margin for all sides if map is not intended to be bound in a report.

- A 0.75-inch margin is preferred on the binding edge.

3.6 DATA DELIVERABLES

Depending on project contract requirements, data deliverables may consist of geospatial databases, shapefiles[3], pdf maps, GIS project maps (.mxd or .aprx map files) or some combination thereof. When delivering geospatial data, most federal projects require a database schema as specified by the client. NOTE: A client specification for data deliverable format supersedes EA's standards.

Deliverable Preparation Guidelines

- All feature classes should have appropriate attribute information and metadata entries completed.

- All project map files (.mxd or .aprx) should be linked to it associated geodatabase.

  — Relative pathnames for mxds.

- A copy of delivered files should be stored in the "DELIVERABLES" directory within the project's GIS directory (as well as in the main project directory) to preserve exactly what was given to the client.

- As part of the deliverable preparation process, all files regardless of type must go through a QA/QC process, which is defined in Section 3.7.

- For any deliverable that includes client-specific requirements (Department of Defense's [DoD's] Spatial Data Standards for Facilities, Infrastructure, and Environment [SDSFIE] [https://www.sdsfieonline.org/].

- SDSFIE or EPA's Superfund Enterprise Management System (EPA 2020b); refer to the appropriate documentation. In most cases, EA's standards conform to client-specific

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[3] Shapefiles are provided as a deliverable only if requested. Otherwise, all geospatial data should be delivered in geodatabase format.

requirements; however, it is best practice to review client requirements and follow their deliverable checklist.

3.7 QUALITY ASSURANCE AND QUALITY CONTROL

The following QA steps have been developed for implementing QC of EA's GIS deliverables. QC should be integrated at all levels of the project. Specifics of EA's Quality Management Program can be found in the Corporate Quality Management Plan located on *Inside EA*. As appropriate, a project-specific QC planned shall be developed, communicated, and maintained in the project file. At a minimum, oversight by an appropriate GIS manager and review by a GIS STR is required for all client deliverables.

This section summarizes the three primary deliverables that should undergo a QC checks prior to submittal to the Client. Section 3.7.2 describes Geodatabase Deliverables, Section 3.7.3 describes Data Analysis Output Deliverables, and Section 3.7.4 describes Mapping Deliverables. All data quality checks by the GIS Analyst, GIS Manager, and STR should be recorded on the Project QC Checklist document. A template of this document is provided in **Attachment B**.

3.7.1 Project Quality Control Checklist

The Project QC Checklist should be included within the GIS Project directory for each individual project. The Checklist provides evidence that a QC procedure was completed for all data.

3.7.2 Geodatabase Deliverables

For any deliverable that includes a geodatabase, the following QC procedures should be followed before final submittal. This is to ensure that the geodatabase meets EA's requirements for data integrity and completeness. The QC procedures can be performed manually for simpler geodatabases or can utilize the Data Reviewer Extension to perform automated checks on the data.

A manual review of the geodatabase should include the following checks:

- Completeness of the features and attributes
- Metadata minimum requirements are met
- Specific geodatabase format requirements are met (e.g., SDSFIE for DoD Deliverables)
- Data Type Review.

3.7.2.1 Data Type Review

Specific data types may be required for geodatabases. The data types are project specific but should be organized properly. Below is a list of the different data types and purpose. Review the data types to ensure the proper data types are being used in the geodatabase. The user must understand the projects requirements and deliverables. If there are any questions about the requirements, consult with the Project Manager and a GIS Professional.

- ***Feature Datasets***—A collection related feature classes that share a common coordinate system. Feature datasets are used to spatially or thematically integrate related feature classes.

- ***Feature Classes***—A collection of features with the same spatial representation (points, lines, or polygons).

- ***Mosaic Datasets***—A data model within a geodatabase used to manage a collection of raster datasets stored as a catalog.

- ***Raster Catalog***—A container for managing raster datasets.

- ***Raster Datasets***—Representation of geographic features in cells laid out in a grid.

- ***Geometric Networks – ArcGIS Data Reviewer (https://www.esri.com/en-us/arcgis/products/arcgis-data-reviewer/overview)***—Connectivity Rules-Identifies features that are part of a geometric network and violating connectivity rules.

- ***Relationship Classes***—Manages the associations between objects in a one feature class or table and objects in another.

- ***Topologies – ArcGIS Data Reviewer – Topology Rules***—Identify features that violate topology rules defined in the geodatabase. **Attachment B** provides Esri's Topology Rules Poster. Rules are also described in the following section.

3.7.2.2 Data Reviewer

A Data Reviewer QC process uses the Data Reviewer Extension and the development of rules within the Reviewer that automates the QC process. The following information provides a summary of what should be tested, at a minimum, using the Data Reviewer:

- QC Geodatabase Preparation
- Schema Review
- Topology Checks
- Geometry Checks
- Table Checks.

Additional information can be found on the esri.com website (https://www.esri.com/en-us/arcgis/products/arcgis-data-reviewer/overview).

NOTE: In cases of client-specified geodatabase formats (e.g., DoD SDSFIE geodb format), the geodatabase should be reviewed by the GIS project lead or EA's GIS Coordinator to ensure formatting requirements are properly implemented.

Quality Control Geodatabase Preparation for Data Reviewer Process

This section outlines how to prepare the File Geodatabase to QA/QC. The QA/QC file geodatabase will be used to execute automatic checks and business logic. The purpose of the tool is to compare the default geodatabase to the exported one to ensure all data have been transferred properly.

Back Up File Geodatabase

- Export XML File, place in project folder and add the backup date to the XML file. The XML file stores the geodatabase schema and data.

Import File Geodatabase

- Create a file geodatabase and add QC and the data to the original name.

- Import the XML file into the QC file geodatabase.

- Verify data were transferred to geodatabase file using. The tool verifies all data have been transferred properly.

Schema Review

Schema is defined as the structure or design of a database. The schema for each project needs the proper data management and a concise deliverable matching the scope of work requirements. If there are any questions about the requirements or deliverable of a GIS data, consult the contract language for geospatial data deliverables. To QC the schema, some or all of the following should be run depending on the structure of the geodatabase.

- ***Geodatabase Schema Compare Tool – ArcGIS Data Reviewer***—Compares the default geodatabase schema to the completed geodatabase. The default geodatabase can be provided by the client or created during the project.

- ***Coordinate Systems – ArcGIS Data Reviewer***—Project specific (all data must be in the appropriate coordinate system). If the project requires two different coordinate systems, there should be two different geodatabases or multiple datasets within a geodatabase.

- ***Domains – ArcGIS Data Reviewer***—Identifies features that are not using the corrected coded or range domain assigned to the geodatabase. A domain is a drop-down list pre-populated in the geodatabase where the values can be project specific.

- ***Subtypes – ArcGIS Data Reviewer – Subtype Tool***—Identifies for features with incorrect subtypes.

- ***Relationship Classes – ArcGIS Data Reviewer – Relationships Tool***—Identifies records that have improper relationships. It is important to ensure the relationship classes are linked properly to display the correct data.

  - Type of Relationships

    - One to One
    - One to Many
    - Many to Many

  - ***Feature Classes/Tables***—Ensure the relationship class is linking the correct feature class and table.

  - ***Attribute***—The correct unique identification is being used to create the relationship class.

- ***Metadata***—While there is no Esri-specific tool for reviewing metadata quality, the summary, description, and tags should be created for all components of the geodatabase and the metadata file should be reviewed by a senior GIS Analyst. The summaries and descriptions should explain the purpose and include how the data were created.

  - Feature Class
  - Feature Datasets
  - Geodatabase
  - Attributes.

Data Reviewer Topology Default Checks

The following checks are standard checks that, at a minimum, should be performed based on the data types within the geodatabase (e.g., if there are no polylines in the geodatabase then there is no need for the polyline checks).

- ***INVALID GEOMETRY***—Identifies any feature where the geometry is empty.

- ***MULTIPART LINE***—Identifies polyline features with more than one path.

- ***MULTIPART POLYGON***—Identifies polygon features with more than one part or that contains a hole.

- ***NON-LINEAR SEGMENT***—Identifies polyline features with nonlinear segments such as arcs and curves.

- ***POLYLINE or PATH CLOSES ON SELF***—Identifies paths and lines in polylines that touch or cross themselves.

- Performs a schema comparison check.

- Performs a coordinate system check.

Duplicate Geometry Checks

- ***DUPLICATE GEOMETRY***—Identifies features with the same geometry type and shared attributes

- ***DUPLICATE VERTEX***—Identifies vertices from the same feature that are within a specified tolerance.

Feature on Feature Checks

- ***GEOMETRY ON GEOMETRY***—Identifies features that have a spatial relationship

- ***INTERSECTION on GEOMETRY***—Identifies features that are within a specific tolerance of an intersection between two other feature classes or within the same feature classes.

- ***POLYGON OVERLAP/GAP is SLIVER***—Identifies gaps and overlays between polygon features with two different feature classes.

Polygon Checks

- ***EVALUATE POLYGON PERIMETER AND AREA***—Identifies parts, rings, segments, or entire polygons for features whose area or perimeter is within a specific range.

- ***INVALID HOLE FEATURE***—Identifies features that have a spatial relationship with holes in a polygon feature class.

- ***POLYGON SLIVER***—Identifies polygons below a specific thinness ratio and whose area is within a specific threshold.

- ***UNNECESSARY POLYGON BOUNDARIES***—Identifies adjacent polygon features that share a boundary and have attribute values that are identical.

Polyline Checks

- ***CUTBACKS***—Identifies segments where the angle between segments in a polygon or polyline is below a specified minimum value.

- ***EVALUATE POLYLINE LENGTH***—Identifies polyline segments, polyline parts/paths, or polyline features whose length is within a specific range.

- ***FIND DANGLES***—Identifies polylines that have dangles within a specific tolerance.

- ***ORPHAN***—Identify polyline features that are not connected to other polyline, polygon, or point features.

- ***UNECESSARY NODES***—Identifies adjacent polyline features that share a node and have attribute values that are identical editable fields.

Z Value Checks (applicable only if the geodatabase has a z value)

- ***ADAJACENT VERTEX ELEVATON CHANGE***—Identifies polyline or polygon feature with elevation (z-value) is within the specified tolerance range at the point where they intersect.

- ***DIFFERENT Z AT INTERSECTION***—Identifies intersection polyline features whose difference in elevation (z-value) is within the specified tolerance range of the point where they intersect.

- ***EXALUATE Z VALUES***—Identifies features whose z-values within a specified range.

- ***POLYON/RING CLOSED***—Identifies unclosed rings in polygons based on the x-,y-, and z-values.

Table Checks

- ***UNIQUE ID***—Identifies value for text fields across the database.

3.7.3 Data Analysis Output Deliverables

If numerical spatial data (i.e., acreages, coordinates, volumes, etc.) are to be provided as a deliverable, they must first undergo a QC process prior to submittal. The following checks are required based on spatial data type:

Coordinates

- Coordinates match project standard (or specified request) geographic system or projection.
- Units (feet, meters, degree format) match project standard (or specified request).
- A final "Calculate Geometry" has been run on requested coordinates before exporting from the attribute table.
- Cross-check coordinates in a separate program such as Google Earth to verify projections match.
- Metadata are populated to identify units of attributes.

Area, Length, Volume (Dimensional) Calculations

- A final "Calculate Geometry" has been run on requested data type before exporting from the attribute table.
- The topology tool or Data Reviewer extension has been run to ensure polygon or polyline integrity before the geometry is calculated.
- Metadata populated to identify units attributes.

Final Coordinate and dimensional calculations should be run by the GIS Analyst and noted in the Project QC Checklist. The GIS Manager should only have to spot check to ensure data accuracy.

3.7.4 Mapping Deliverables

Mapping deliverables consist of both figures and GIS map files (i.e., .mxd or .aprx). **Attachment B** provides a checklist for items to consider when performing a QC on a map. Any figure or map file should adhere to a pre-determined figure template (Section 3.5.1) approved by the client and/or project manager at the start of the project and the QC reviewer should check this when beginning the review. If a map file is the deliverable, the associated geodatabase must go through a QC process as well.

Figures that are part of a larger report become part of the project's STR review; however, a GIS Manager should review the figures for GIS-specific elements before passing on to the report author for inclusion in the report.

Figure and/or Map File Guidelines

- The GIS project analyst should conduct a "self-QC" using the checklist before sending on to GIS manager for a final QC check.

3.8 DATA BACKUP AND ARCHIVING

An "**ARCHIVE**" folder should be created as part of the project directory folder structure. At a minimum, the project geodatabase should be backed up to this folder on a periodic basis as determined by the Project Manager, or prior to any major change to the data. The geodatabase should be renamed with the letters "BU" followed by the date of backup.

- EX. "APG_GIS**_BU04122019**"

Some projects may require archiving of a layer to preserve raw project data. These data should be added to the ARCHIVE folder under a sub-directory. Refer to EA's Records Retention Policy as a guide to determine the time needed to retain archived data.

4. REFERENCES

U.S. Environmental Protection Agency (EPA). 2020a. Metadata Quick Guide (for External EPA Partners) Version 1.3. Region 9 Technology and Data Solutions Center. June.

———. 2020b. Draft Superfund Geospatial Data Delivery Guidance Version 1.3. Region 9 Technology and Data Solutions Center. June.

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Attachment A

Project Summary Document Template

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PROJECT SUMMARY FOR: [PROJECT NAME]

PROJECT NUMBER/PHASE/TASK:
PROJECT MANAGER:
START DATE:
LEAD GIS ANALYST:

PROJECT DIRECTORY LOCATION (GIS):

PROJECT DIRECTORY LOCATION (MAIN):

COORDINATE SYSTEM:
UNITS:

SUMMARY OF PROJECT:
[Detailed explanation of project for inserting into metadata Summary field]

PROJECT STATUS:
[Proposal, Work Plan Final Report, etc.]

DATA DELIVERABLE REQUIREMENTS:
[SDSFIE, geospatial file type, EPA Geodb format, etc.]

NOTES:

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Attachment B

Quality Assurance/Quality Control Standards, and Checklists, and Sign-Offs

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PROJECT QC CHECKLIST FOR: [PROJECT NAME]

Data Check Sign-Off

Name of Project Lead Date

Geodatabase QC Sign-Off

Name of GIS STR or GIS Reviewer Date

Map Deliverable Sign-Off

Name of GIS STR or GIS Reviewer Date

Description of QC Methods:

Quality Control Checklists

Figure QC Checklist

Each figure should be checked for each of the following items to ensure consistency and data accuracy.

- ☐ Legend font and patch sizes
- ☐ Title Blocks
- ☐ Map date/References/Notes
- ☐ Dynamic File Path
- ☐ References listed for non-EA data layers
- ☐ Spellcheck all text
- ☐ Insets showing appropriate extent
- ☐ North Arrow
- ☐ North Arrow/Scale Bar/Scale Text present
- ☐ EA Logo/Client Logos
- ☐ Symbology consistency
- ☐ Legend matches layers shown
- ☐ Layers are drawn in logical order

Map Deliverables QC Checklist

For map file deliverables (e.g., .mxd or .aprx), each of the following items should be checked.

- ☐ Features linked to associated geodatabase deliverable
- ☐ Map coordinate system match layers and insets
- ☐ All QC checks from Figure QC Checklist
- ☐ All QC check from Geodatabase QC Checklist

Geodatabase QC Checklist

The geodatabase should undergo data validation via Data Reviewer or be checked by a data manager for the following items.

- ☐ Attribute Completeness
- ☐ Spatial Topology Review
- ☐ Attribute Accuracy
- ☐ Metadata filled out
- ☐ If specific format, run appropriate review tool (i.e., EPA Geodatabase Data Reviewer)

Data QC Checklist

For data outputs, the following items should be checked depending on data type.

- ☐ Cross-check of coordinates
- ☐ Coordinate System matches data requirements
- ☐ Area Calculations- geodatabase must undergo topology data review prior to calculating areas

- ☐ Has the project-specific QC planned been followed?

Attachment C

Map/Figure Templates

(\\lovetongis\GISdata\Administrative\FigureTemplates)

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Attachment D

Symbology Standards

(link to symbology stylefile will be inserted here; example provided below)

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Groundwater/Monitoring Wells

- ⊕ GW Sample Site (new well)
- ◐ Monitoring Well
- ◐ State/Municipal Well
- ◐ Private/Dom… Well
- ◐ Other Well
- ⊕ Extraction Well

Surface Water Sample Locations

- ◇ SW Sample Site (reference)
- ◆ SW Sample Site (downgrad)

Additional Sample Types

- ⊙ Soil Gas
- ⊕ Sub Slab Sample
- ⊕ Indoor Air Sample

Hydrology/Hydrogeology Points

- ▲ Public SW intake
- • Inlet
- ○ Outfall
- ⬟ Dam
- ▲ Drainage Area Outlet

Miscellaneous Points

- ★ Inset Star
- ◒ Oil/Water Separator
- ⊘ Leach Well
- ⊕ UST
- ◐ Fuel Dispenser

Hydrology/Hydrogeology Lines

- → SW Flow on
- Private/ Domestic Well
- → GW Flow Direction
- → Inferred GW Flow Direction
- ─ River/Stream
- - - - Intermittent Stream
- - - - Watershed

Miscellaneous Lines

- ×—× Fence
- ─ Aboveground Fuel Line
- - - - Subsurface Pipeline
- ----- Trench Drain
- -·-·- Suspected Piping

Site-Specific Boundaries

- ▢ Installation Boundary
- 🟩 Operational Area
- 🟧 Dudded Impact
- 🟧 Non Dudded Impact Area
- 🟩 Firing Range
- 🟩 Other Range

Site-Specific Boundaries continued

◻ Non Operational Area

▨ Historic

□ Area of Review

Hydrology/Hydrogeology Boundaries

▨ GW Receptor Zone

◻ Water Body

■ Wetland

▨ Emergent Wetland

▨ Forested Wetland

▒ Marsh

Miscellaneous Boundaries

🟨 State of Interest

🟧 Critical Habitat

▒ Trees

🟦 Floodplain

🟪 DU Area

Standard Operating Procedure No. 062
for
Electronic Document Submittals
(Using Acrobat Adobe DC Software)

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 2
May 2020

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 062	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	July 2018	Updated procedures for current Adobe Acrobat DC software	Mickie Predmore	Matt Bowman
2	May 2020	Update procedures with guidance on including digital signatures	Mickie Predmore Terri Smith	Matt Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide guidance on how to prepare EA documents for submittal in Adobe portable document format (pdf), using the current Adobe Acrobat DC software. This SOP applies to standard electronic EA document submittals. Specific client requests will take precedence. If there is a concern about metadata being included with the pdf file, this information can be removed from the original format (Microsoft Word, Excel, or PowerPoint) prior to creating the pdf file.

2. MATERIALS

An EA laptop/personal computer needs to be equipped with the Adobe software to print to and read documents in pdf (currently Adobe Acrobat DC on most EA machines).

3. PROCEDURE

3.1 FILE NAMING

The first step to preparing documents to be combined into a single pdf file for submittal is to name each file in an organized and clear manner. Having the files organized by their order within the final document will allow accurate and efficient file preparation. In many cases, using a numbering system to name the files to match the order in which they should appear aids the process with efficiency and accuracy.

3.2 CREATING THE DOCUMENT SUBMITTAL

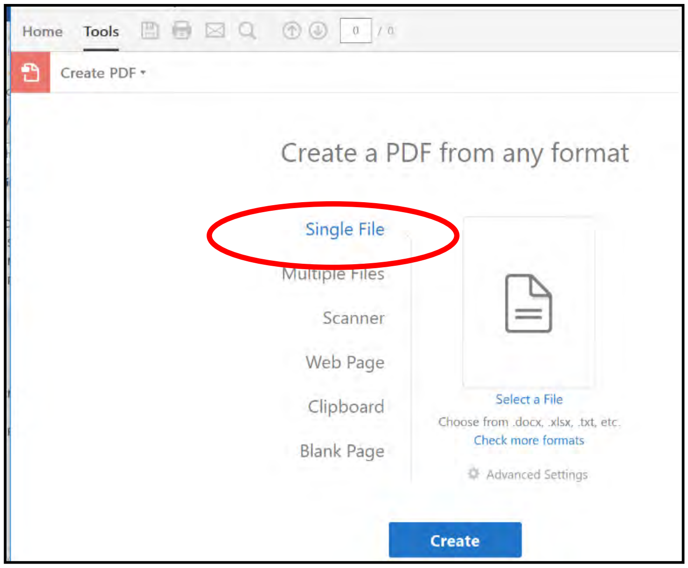
Once the files have been organized and named correctly, begin the process of creating a new file in Adobe format in the order in which it appears in hard copy. There are three options for creating a pdf file as detailed in the subsections below.

3.2.1 Create File via Adobe DC

There are two options available in Adobe DC to combine files.

- ***Single File Option***—May be used to create a single pdf file from a supported format (Word, PowerPoint, or Excel). The individual pdf and/or graphics files can then be combined individually as needed. Under Tools, select Create pdf, Single File.

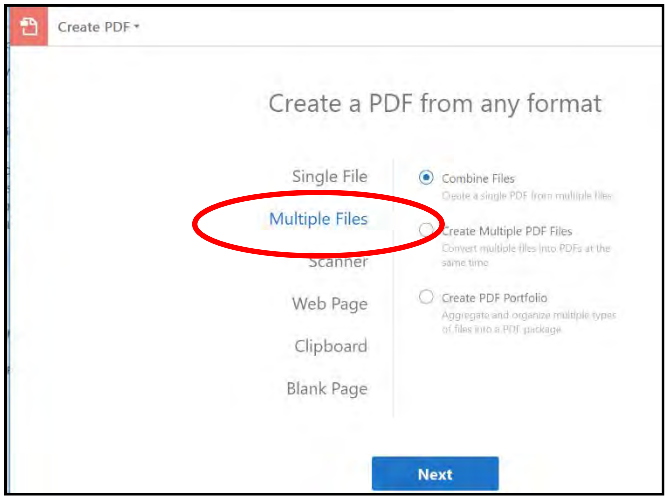
  NOTE: If you are inserting single files into one main document, be sure you are at the end of the last page in the newly created document before the next file is inserted.



  If this will be a large file, save frequently to avoid errors and lost effort if the system hangs up.

- ***Multiple File Option***—May be used to convert multiple files of supported formats into pdf files at the same time. This option will combine all selected documents and save them into a single combined pdf file.

  Under Tools, select Create pdf, Multiple Files. From this option, the choice is to select Combine Files or Create Multiple pdf files.



● Combine Files
Create a single PDF from multiple files

○ Create Multiple PDF Files
Convert multiple files into PDFs at the same time

○ Create PDF Portfolio
Aggregate and organize multiple types of files into a PDF package

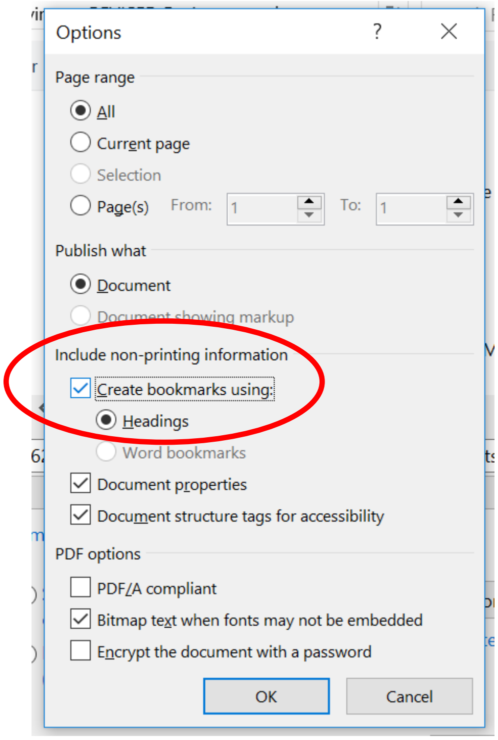
  NOTE: Advance knowledge of and accessibility to all figures, tables, and appendixes that belong to the submittal are necessary to ensure a complete file.

3.2.2 Create File via Print Feature

A pdf file may be created within Word, PowerPoint, or Excel using the Print feature. By selecting File/Print, you choose Adobe pdf from the list of printers, and click on Print. The system will automatically generate a pdf file and save it to the location you have selected.

3.2.3 Create File via Save As Feature

A pdf file may be created within Word using the Save As feature. By selecting File/Save As, select Save As Adobe pdf. Under More Options/Options, the menu to the right will appear. If you plan on using Bookmarks in the final deliverable, the box titled "Create bookmarks using" should be checked to include headings. The software will automatically generate a Table of Contents of bookmarks to which you can add or remove as needed.



Page range
● All
○ Current page
○ Selection
○ Page(s) From: 1 To: 1

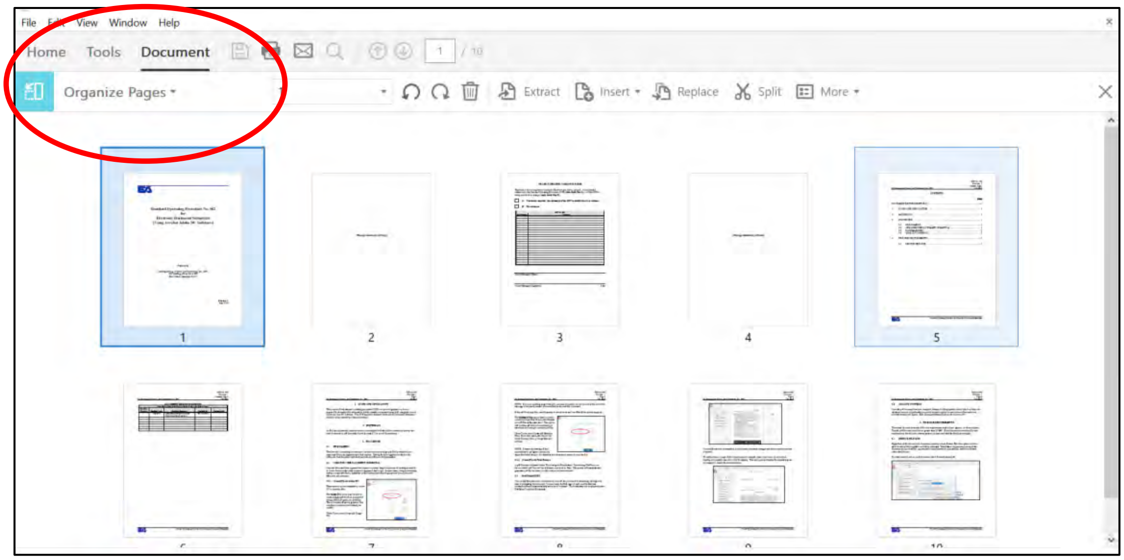
Publish what
● Document
○ Document showing markup

Include non-printing information
☑ Create bookmarks using:
● Headings
○ Word bookmarks
☑ Document properties
☑ Document structure tags for accessibility

PDF options
☐ PDF/A compliant
☑ Bitmap text when fonts may not be embedded
☐ Encrypt the document with a password

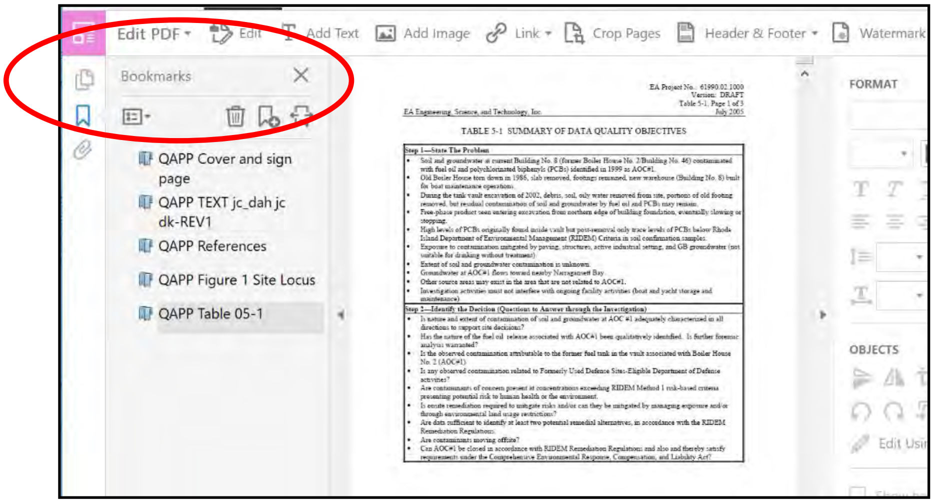
3.3 ORGANIZING THE DOCUMENT SUBMITTAL

Once the relevant files have been created/inserted into a single pdf file, the file can be easily reviewed, modified, and pages extracted as needed using the Organize Pages feature in Adobe DC. Under Tools/Organize Pages, the view screen will change to show all the pages within the document. This is helpful when performing a final quality control check and aids in adding/moving/removing pages as necessary.



3.4 BOOKMARKING

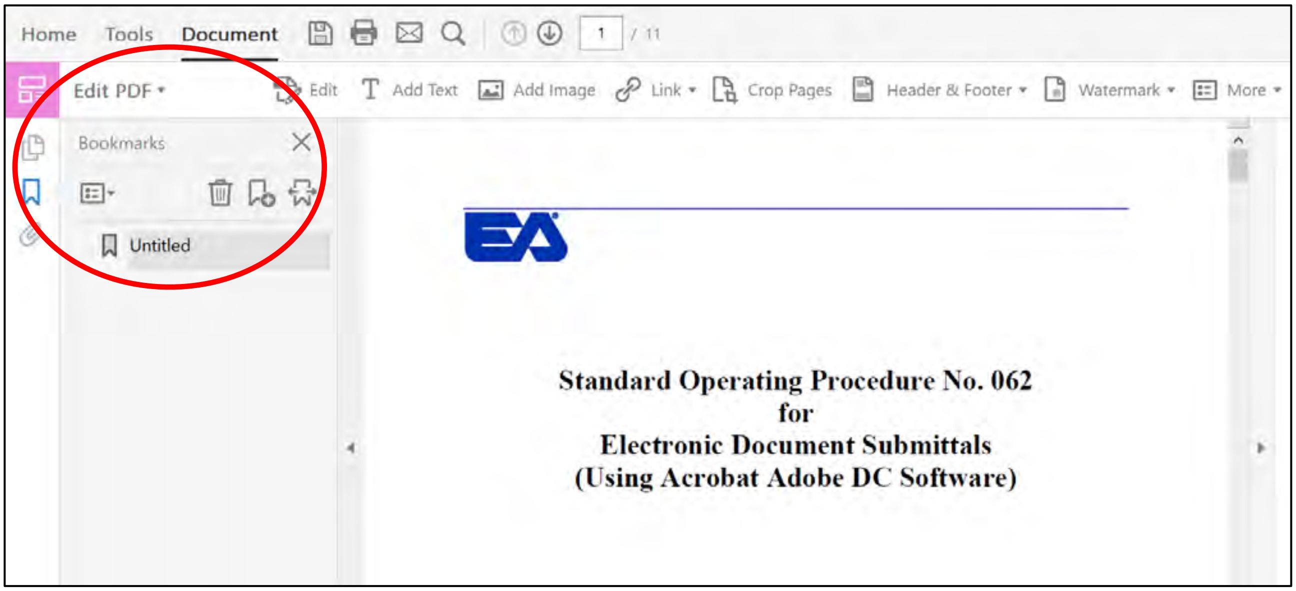
Once all the files have been combined into one pdf, the process of bookmarking can begin for ease of navigating the document. In most cases, the first page of each main heading that was inserted/combined is automatically added as a bookmark.



Once a file has been bookmarked, you can make any necessary changes and add/or remove sections as needed.

3.4.1 Create a Bookmark

To begin bookmarking a new file, select Edit pdf/More/Add Bookmark (or Ctrl B). The cursor should be on the page or section that you want the bookmark to appear. Once the selection or location is bookmarked, the bookmark can be renamed if necessary.



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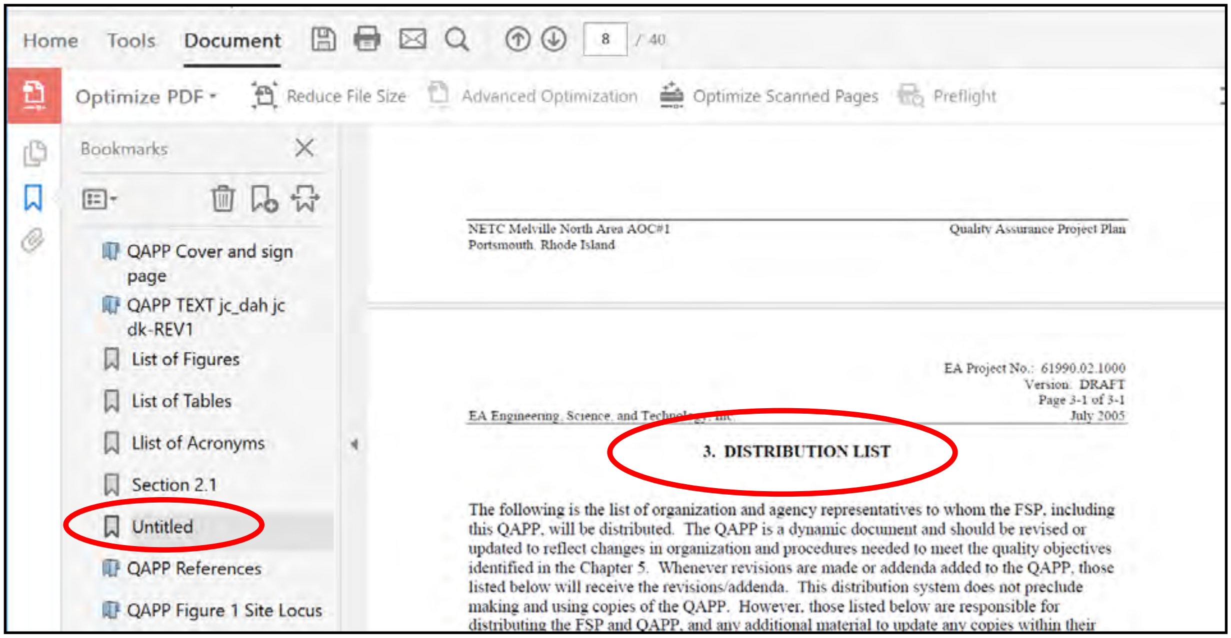
Instructions for creating a bookmark are as follows:

- Click the Bookmarks button on the left to open the Bookmarks panel.
- Open the page where you want the bookmark to link to.
- Use the Selection tool to select the area of the page you want to bookmark.
  - To bookmark a single image, click in the image or drag a rectangle around the image.
  - To bookmark a portion of an image, drag a rectangle around the portion.
  - To bookmark text, drag to select it; the selected text becomes the label of the new bookmark, which can then be edited.

3.4.2 Add a Bookmark

To add a section or page of the document as a bookmark, place your cursor on the section heading to be added, then select Add Bookmark. This will open an Untitled Bookmark that can be renamed to match the selected section.



NETC Melville North Area AOC#1
Portsmouth, Rhode Island

Quality Assurance Project Plan

EA Project No.: 61990.02.1000
Version: DRAFT
Page 3-1 of 3-1
July 2005

EA Engineering, Science, and Technology, Inc.

3. DISTRIBUTION LIST

The following is the list of organization and agency representatives to whom the FSP, including this QAPP, will be distributed. The QAPP is a dynamic document and should be revised or updated to reflect changes in organization and procedures needed to meet the quality objectives identified in the Chapter 5. Whenever revisions are made or addenda added to the QAPP, those listed below will receive the revisions/addenda. This distribution system does not preclude making and using copies of the QAPP. However, those listed below are responsible for distributing the FSP and QAPP, and any additional material to update any copies within their

3.5 DIGITAL SIGNATURES

This section addresses setting up and adding self-signed digital signatures to pdfs should the need arise. The instructional guidance with graphics is provided in Attachment A.

In addition, for basic Adobe Acrobat training, the link below is for EA's Application Training channel on Stream that has an Adobe Acrobat training video as well as a link to Adobe tutorials. If you have questions or need more information, please contact apphelp@eaest.com.

- ***EA Training***—https://web.microsoftstream.com/channel/03fdf6f8-ef04-4e0f-b8b5-6437ac359364.

- ***Adobe Tutorials***—https://helpx.adobe.com/acrobat/tutorials.html.

When using stamps/seals with a digital signature, please consult with the organization and/or state for exact requirements for digital signatures as they may not allow digital signatures, or they may require a digital certificates that is not self-signed, require text under a seal/stamp, or have other specific instructions.

4. QUALITY CONTROL

Once the pdf document has been compiled, perform a final quality control check on either the electronic version or (preferably) a printed out hard copy to be sure relevant files have been included within (text, figure, table, and appendixes) and are in the correct order. As noted in Section 3.3, the Organize Pages feature is helpful in performing this task on screen.

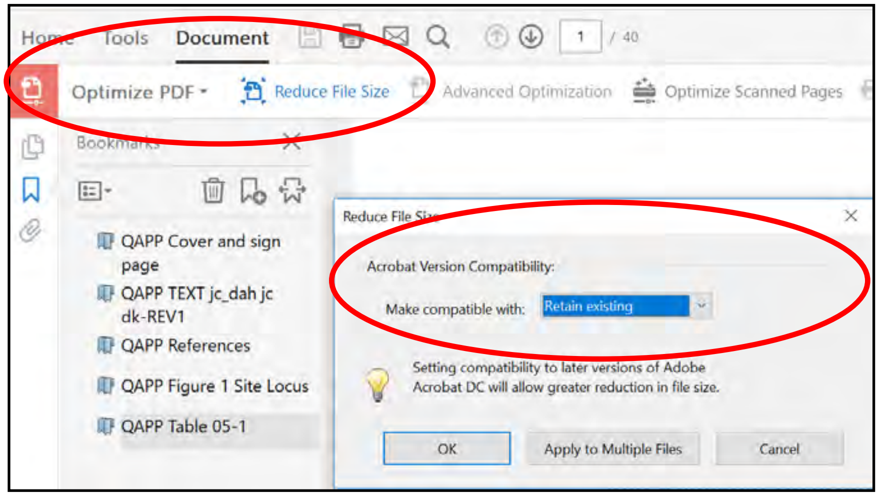
5. FILE SIZE REQUIREMENTS

There may be some instances of file size requirements with a client, agency, or other recipient. Typical pdf file sizes should be no greater than 25 MB. If the document exceeds the file size requirements, divide it into relevant sections or parts and label the file(s) accordingly.

5.1 REDUCE FILE SIZE

Regardless of the file size of a document, routinely use the Reduce File Size option in Adobe after the entire file is together and before submittal. This feature compresses portions of the document and provides the opportunity to limit backwards compatibility, which can further reduce the file size.

To reduce the file size in a pdf document, select Tools/Optimize pdf:



Acrobat Version Compatibility:

Make compatible with: Retain existing

Setting compatibility to later versions of Adobe Acrobat DC will allow greater reduction in file size.

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Attachment A

Adobe Digital Signatures with Graphics

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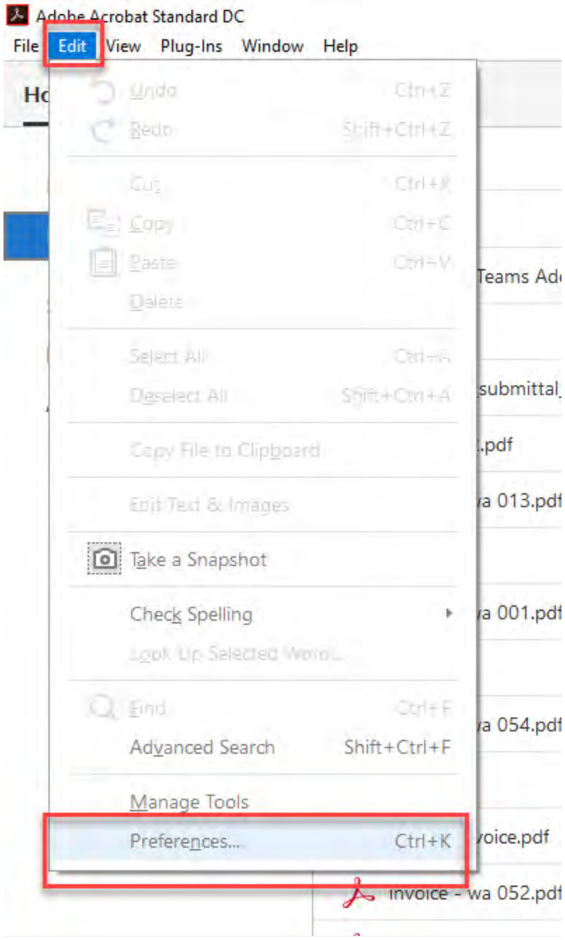
EA Engineering, Science,
and Technology, Inc., PBC

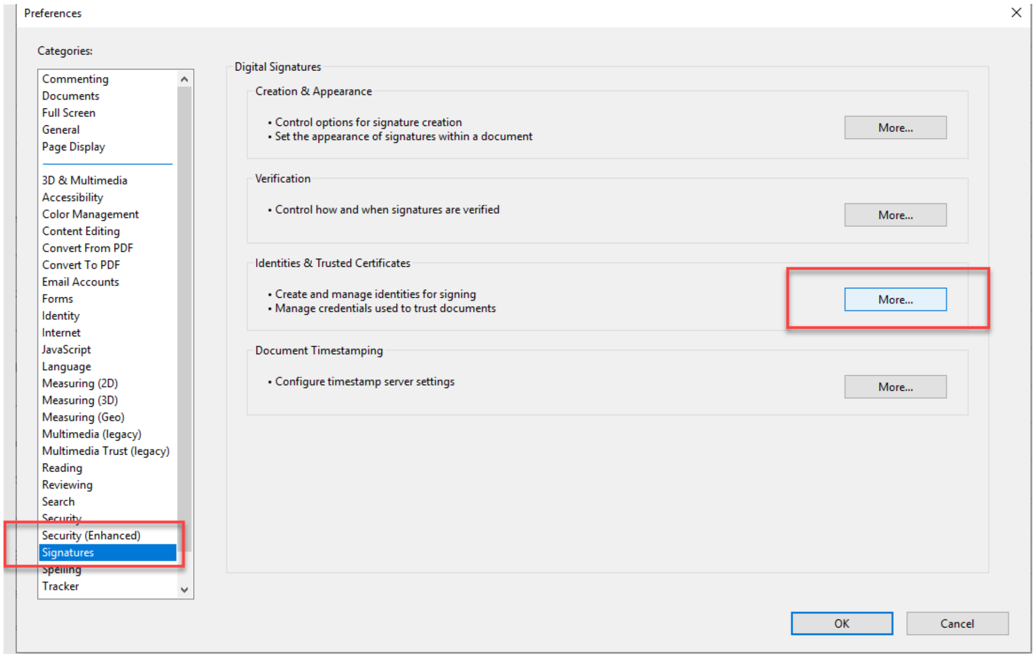
ADOBE DIGITAL SIGNATURES WITH GRAPHIC

Create a digital signature (This step can be skipped if you already have one set-up)

1. Open Adobe. Click on **Edit** then **Preferences**



2. Click on **Signatures** and then **More** next to Identities & Trusted Certificates



Digital Signatures

Creation & Appearance

- Control options for signature creation
- Set the appearance of signatures within a document

Verification

- Control how and when signatures are verified

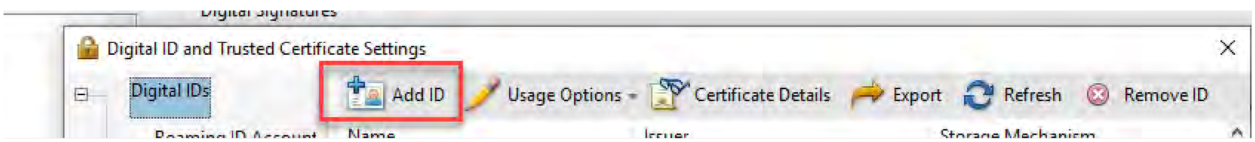
Identities & Trusted Certificates

- Create and manage identities for signing
- Manage credentials used to trust documents

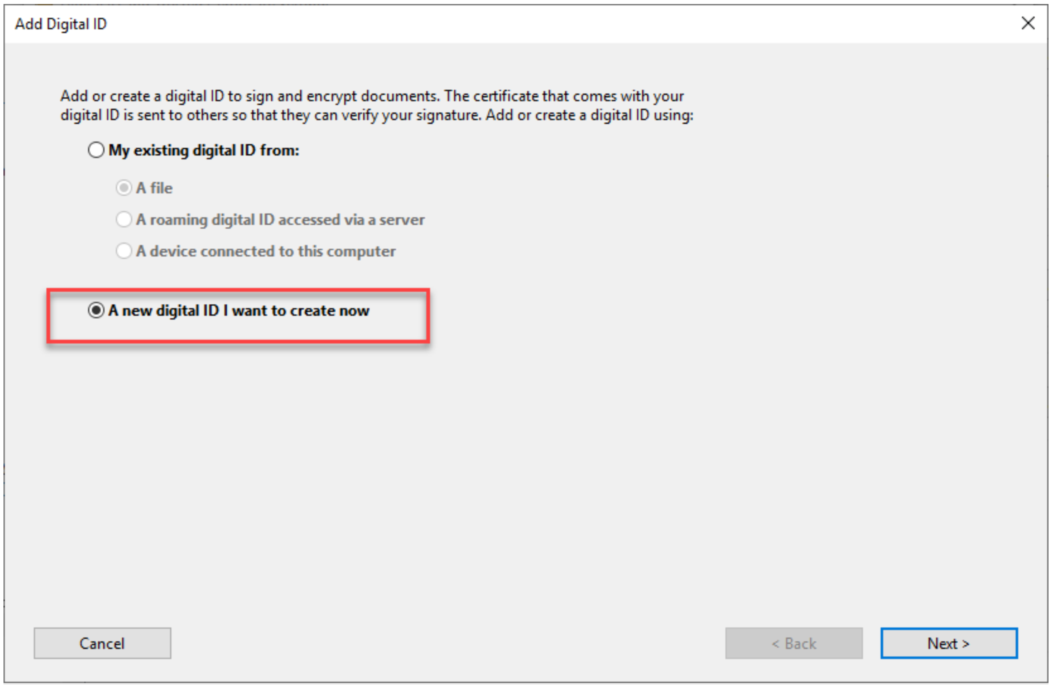
Document Timestamping

- Configure timestamp server settings

3. Click **Add ID**



4. Choose **A new digital ID I want to create now** and click **Next**

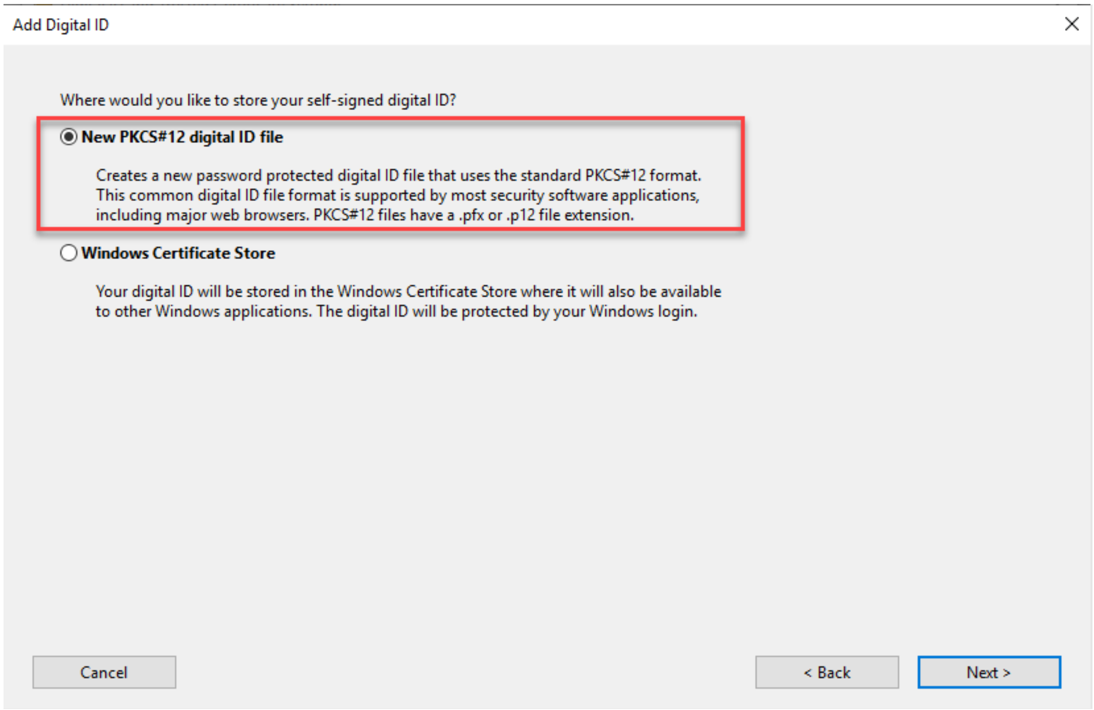


Add or create a digital ID to sign and encrypt documents. The certificate that comes with your digital ID is sent to others so that they can verify your signature. Add or create a digital ID using:

○ **My existing digital ID from:**
- ● A file
- ○ A roaming digital ID accessed via a server
- ○ A device connected to this computer

● **A new digital ID I want to create now**

5. Choose **New PCKS#12** and click **Next**



Where would you like to store your self-signed digital ID?

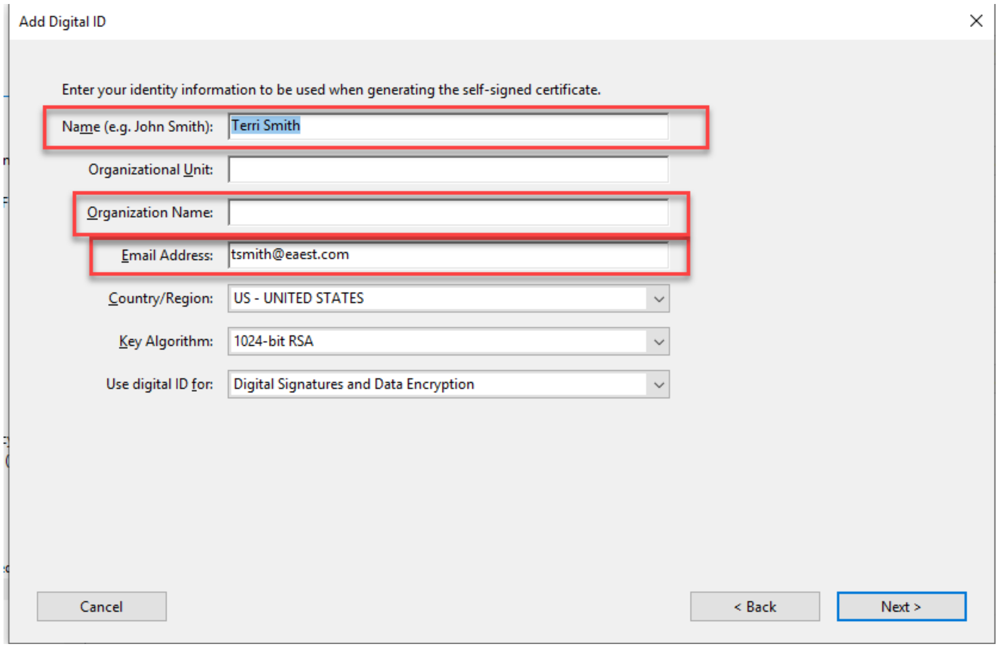
● **New PKCS#12 digital ID file**

Creates a new password protected digital ID file that uses the standard PKCS#12 format. This common digital ID file format is supported by most security software applications, including major web browsers. PKCS#12 files have a .pfx or .p12 file extension.

○ **Windows Certificate Store**

Your digital ID will be stored in the Windows Certificate Store where it will also be available to other Windows applications. The digital ID will be protected by your Windows login.

6. Make sure **Name** and **Email** are correct and fill out **Organization Name** if desired. The rest of the options should not change



Enter your identity information to be used when generating the self-signed certificate.

Name (e.g. John Smith): Terri Smith

Organizational Unit:

Organization Name:

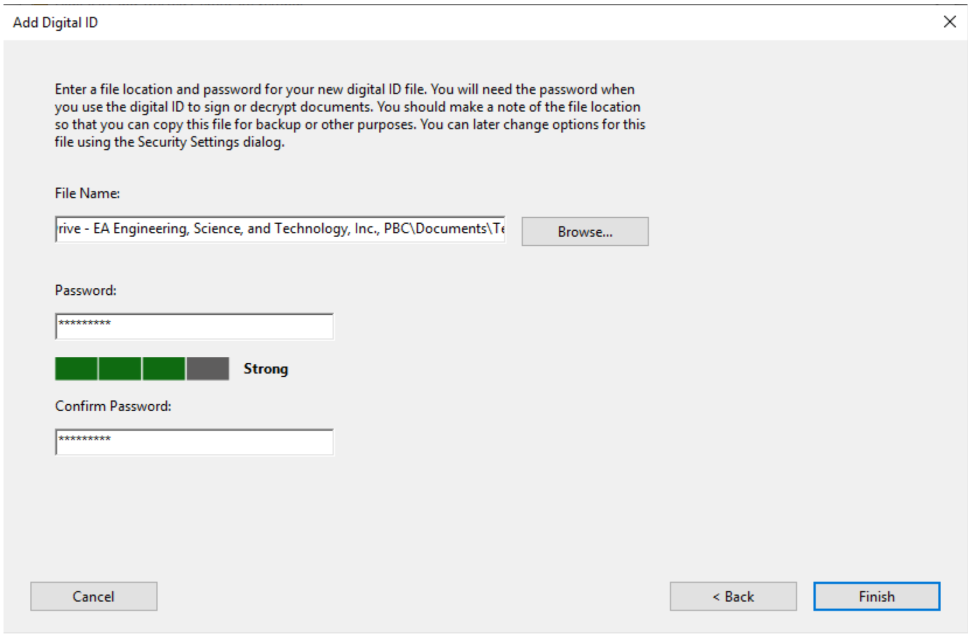
Email Address: tsmith@eaest.com

Country/Region: US - UNITED STATES

Key Algorithm: 1024-bit RSA

Use digital ID for: Digital Signatures and Data Encryption

Enter in a **Password** and then click **Finish**



Enter a file location and password for your new digital ID file. You will need the password when you use the digital ID to sign or decrypt documents. You should make a note of the file location so that you can copy this file for backup or other purposes. You can later change options for this file using the Security Settings dialog.

File Name: rive - EA Engineering, Science, and Technology, Inc., PBC\Documents\Te

Password: *********

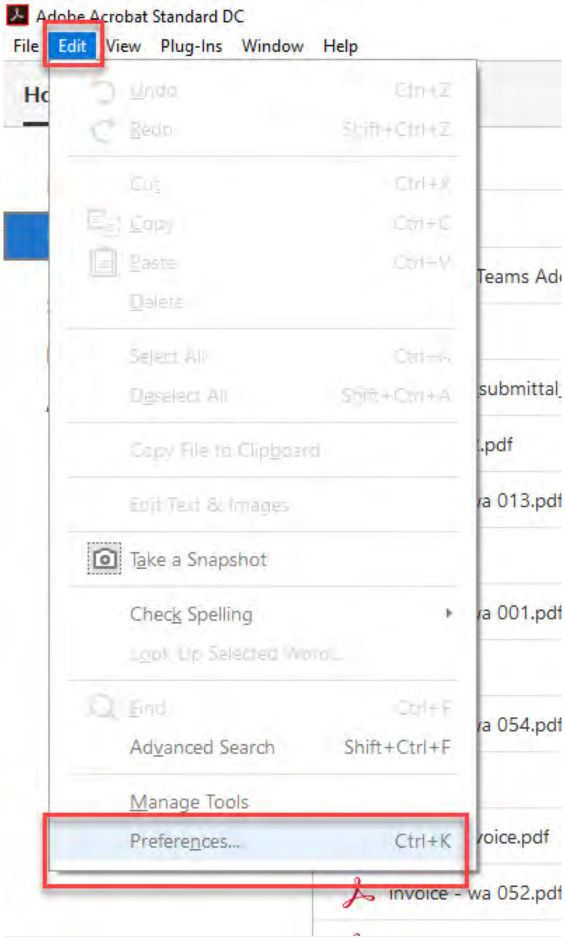
Strong

Confirm Password: *********

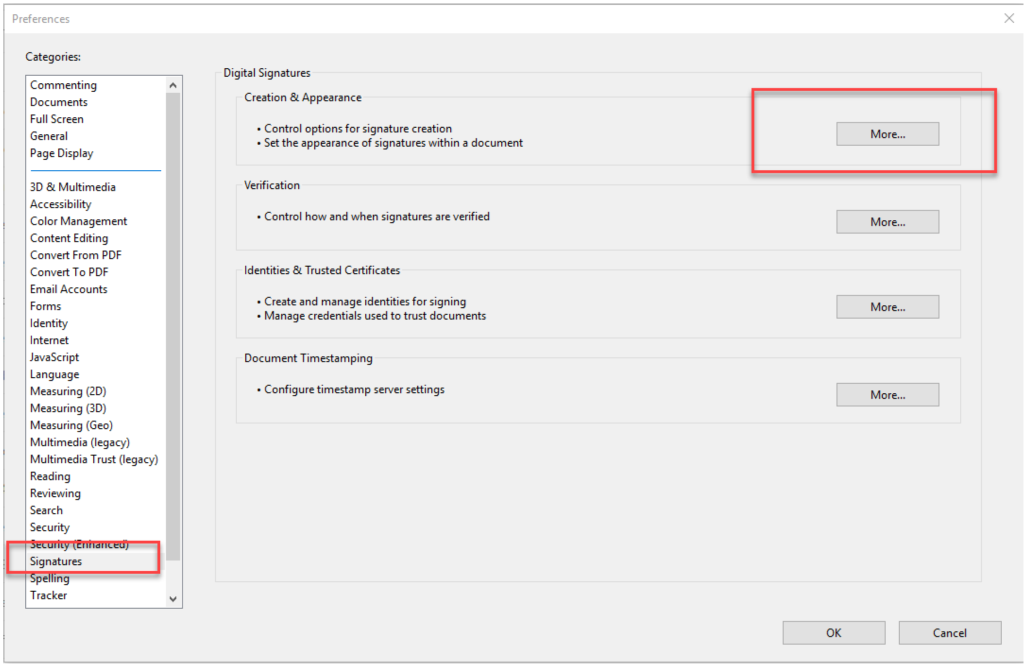
7. You can then close the ID and Trusted Settings window.

Adding a graphic to a Digital signature

1. Open Adobe. Click on **Edit** then **Preferences**



2. Click on **Signatures** and then **More** next to Creation & Appearance



Digital Signatures

Creation & Appearance

- Control options for signature creation
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Verification

- Control how and when signatures are verified

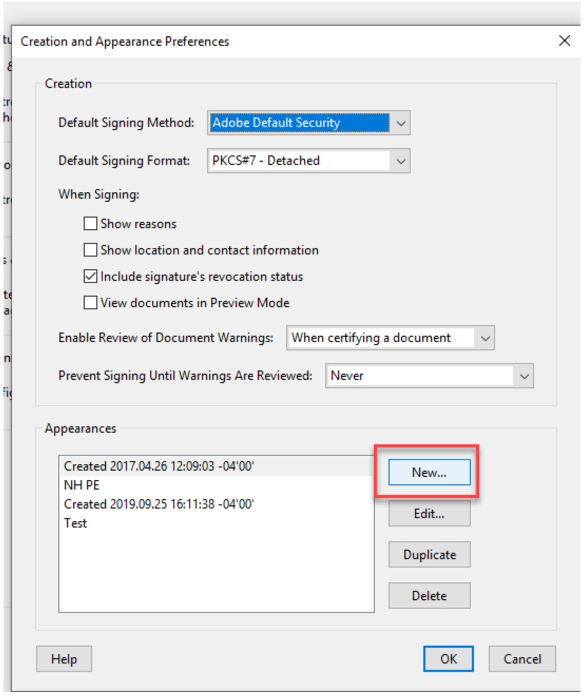
Identities & Trusted Certificates

- Create and manage identities for signing
- Manage credentials used to trust documents

Document Timestamping

- Configure timestamp server settings

3. Click **New**



Default Signing Method: Adobe Default Security

Default Signing Format: PKCS#7 - Detached

When Signing:

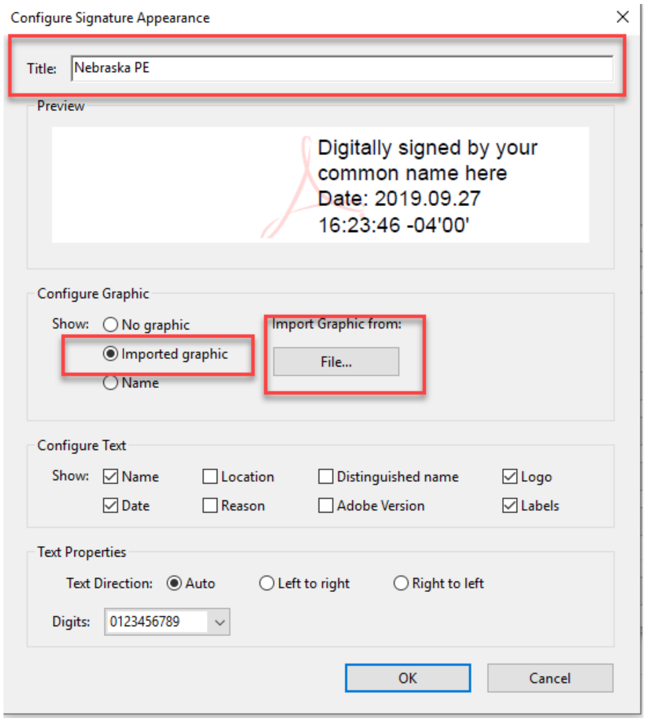
☐ Show reasons
☐ Show location and contact information
☑ Include signature's revocation status
☐ View documents in Preview Mode

Enable Review of Document Warnings: When certifying a document

Prevent Signing Until Warnings Are Reviewed: Never

Created 2017.04.26 12:09:03 -04'00'
NH PE
Created 2019.09.25 16:11:38 -04'00'
Test

4. Add a descriptive **Title,** click radio button next to **Imported Graphic** and then click **File to browse for image.**



Configure Signature Appearance

Title: Nebraska PE

Preview

Digitally signed by your common name here
Date: 2019.09.27
16:23:46 -04'00'

Configure Graphic

Show: ○ No graphic
● Imported graphic
○ Name

Import Graphic from:

Configure Text

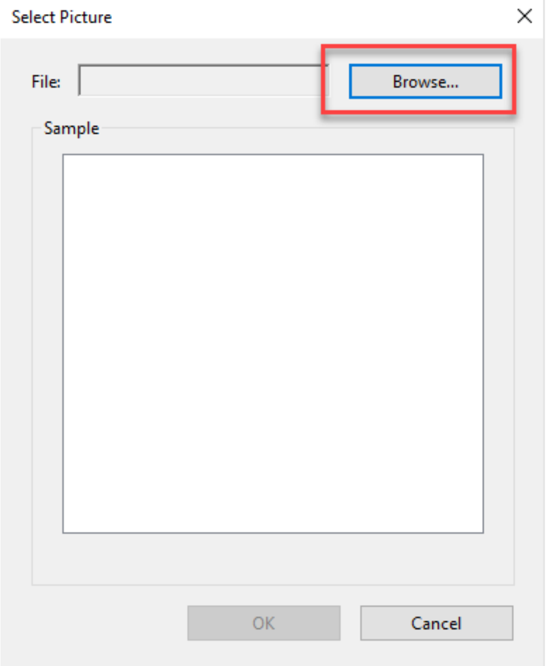
Show: ☑ Name ☐ Location ☐ Distinguished name ☑ Logo
☑ Date ☐ Reason ☐ Adobe Version ☑ Labels

Text Properties

Text Direction: ● Auto ○ Left to right ○ Right to left

Digits: 0123456789

5. Click **Browse**

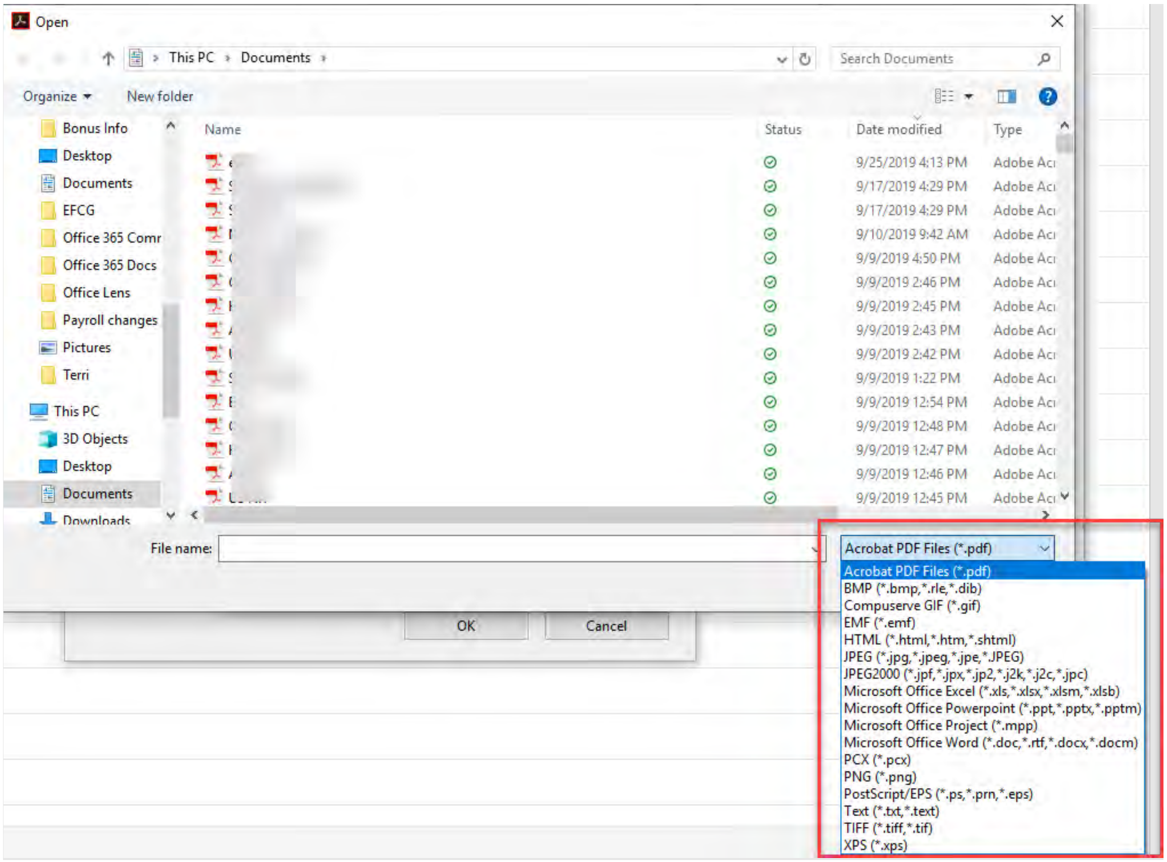


Select Picture

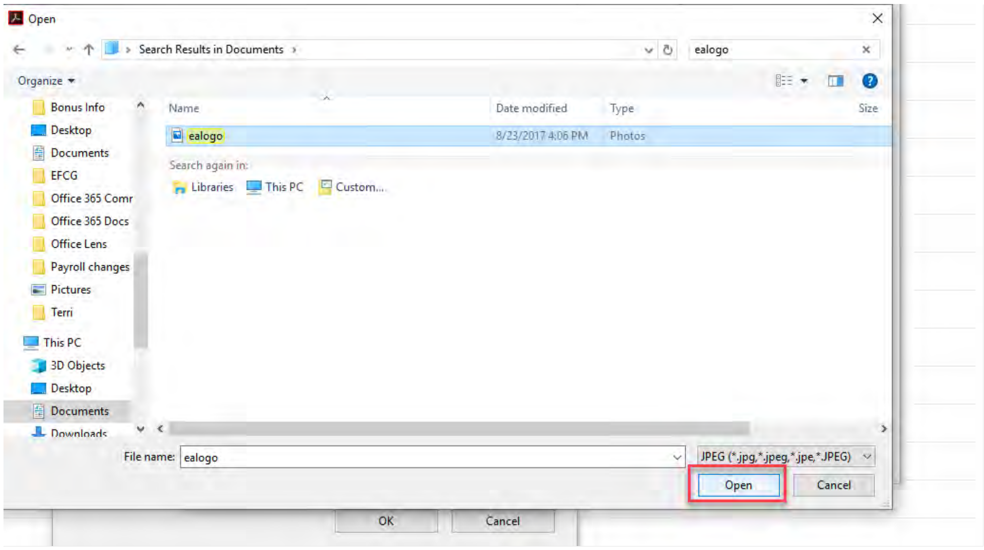
File:

Sample

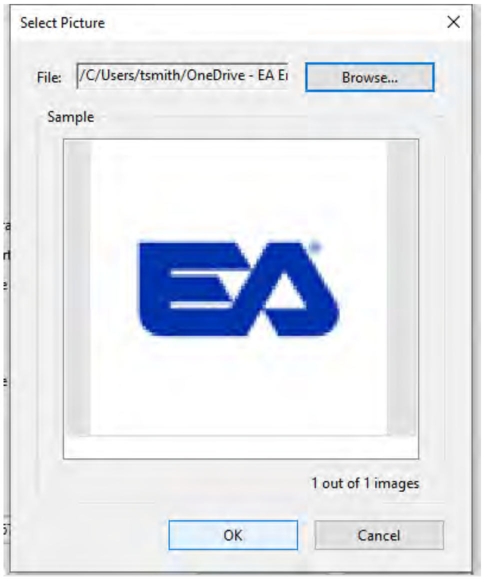
Choose File with picture, logo, seal. You may need to change the file type if not PDF.



6. After you selected file, click **Open**



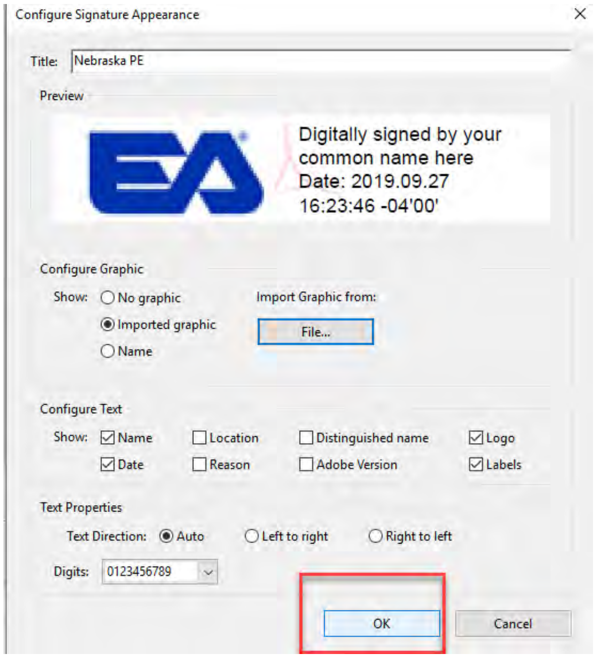
7. Click **OK**



File: /C/Users/tsmith/OneDrive - EA E

1 out of 1 images

8. Click **OK**



Title: Nebraska PE

Digitally signed by your common name here
Date: 2019.09.27 16:23:46 -04'00'

Show: ○ No graphic ● Imported graphic ○ Name

Show: ☑ Name ☐ Location ☐ Distinguished name ☑ Logo ☑ Date ☐ Reason ☐ Adobe Version ☑ Labels

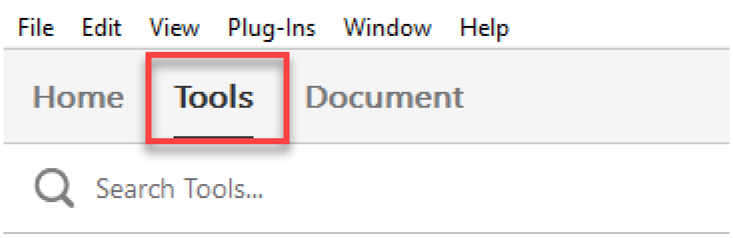
Text Direction: ● Auto ○ Left to right ○ Right to left

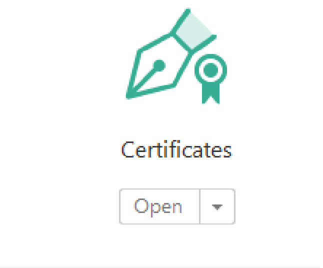
Digits: 0123456789

9. Click **OK** two more times to close the **Preferences** window.

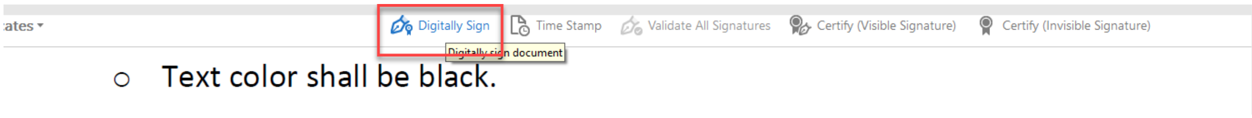
Using your Digital Signature in Adobe

1. With document open, click **Tools** then **Certificates**



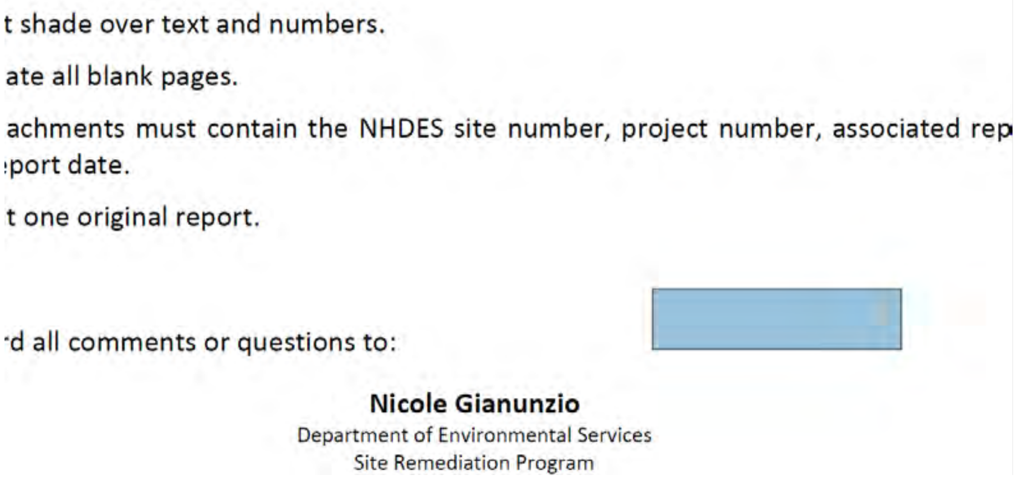


2. Now click **Digitally Sign**



- ○ Text color shall be black.

Scroll to where you want to sign and draw a box. Remember, the bigger box you draw the bigger the signature and picture will be.



t shade over text and numbers.

ate all blank pages.

achments must contain the NHDES site number, project number, associated rep
port date.

t one original report.

d all comments or questions to:

Nicole Gianunzio
Department of Environmental Services
Site Remediation Program

3. Choose your signature from **Appearance** drop down and then enter in your **Certificate password** and then click **Sign**

Sign Document

Sign As: Terri Smith (Terri Smith) 2024.09.27

Issued by: Terri Smith

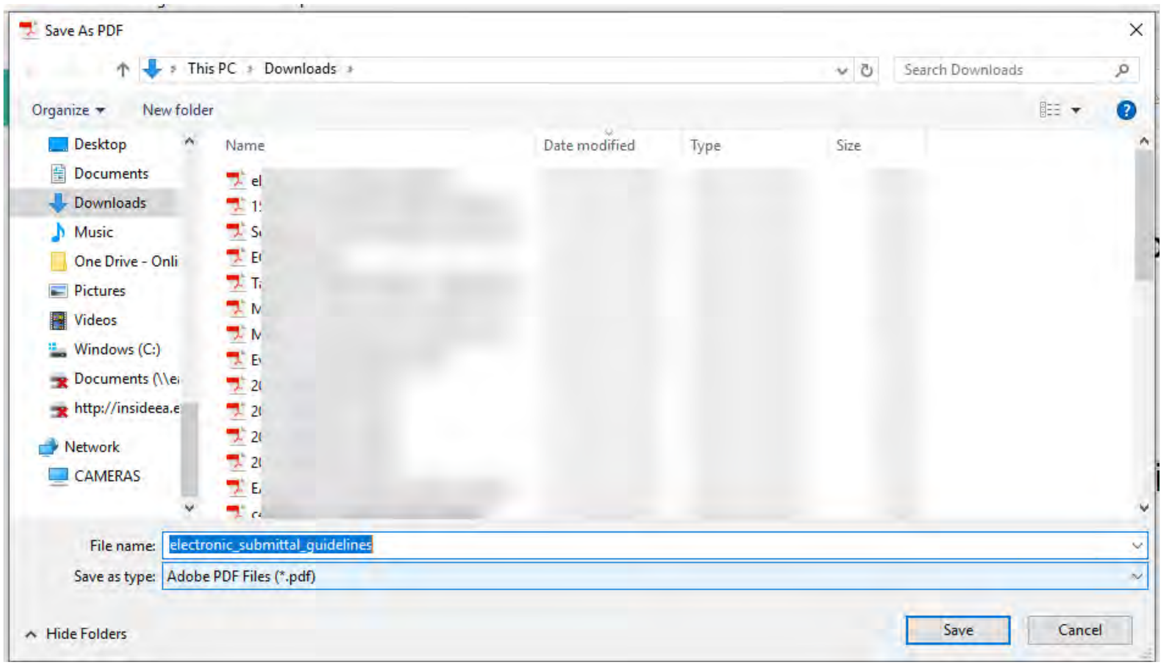
Appearance: Nebraska PE

Digitally signed by Terri Smith
Date: 2019.09.27 16:36:23 -04'00'

☐ Lock Document After Signing

Enter certificate password and click the 'Sign' button

4. It will prompt you to save the file and then it be locked for editing.



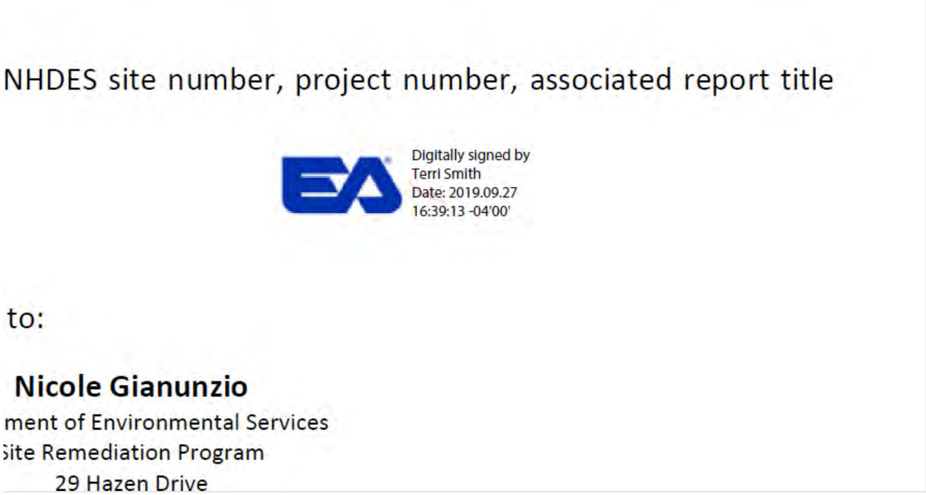
Save As PDF

This PC › Downloads ›

File name: electronic_submittal_guidelines

Save as type: Adobe PDF Files (*.pdf)

ADOBE DIGITAL SIGNATURES WITH GRAPHIC



NHDES site number, project number, associated report title

Digitally signed by
Terri Smith
Date: 2019.09.27
16:39:13 -04'00'

to:

Nicole Gianunzio
ment of Environmental Services
ite Remediation Program
29 Hazen Drive

Standard Operating Procedure No. 063
Chemical Data Management

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision No. 1
March 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 063	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	March 2019	Systematic review and update	Tara Lamond, Dan Hinckley, Amanda Smith	Matthew Bowman

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1. INTRODUCTION

Many engineering and environmental compliance projects require site sampling and generation of associated chemical analysis data. The chemical data are used for a wide variety of purposes such as site assessments, remedial design, long-term monitoring, litigation support, and human health and ecological risk assessments. A project may often have auxiliary or historical data components that must integrate with the chemical data.

Most project plans include development of a site sampling plan and quality assurance project plan/data quality objectives for the laboratory to ensure the correct sampling and analysis methods are used. There are many related standard operating procedures (SOPs) that specifically address field activities and sampling protocols. Although the field sampling and laboratory specifications are typically well documented, the actual management of the data also requires planning, organization, and documentation. The EA data professionals described in this SOP should be engaged from the proposal stage (to provide accurate estimates of budget, scope, and schedule) through to the execution of the project (to design and implement data processing and storage solutions).

1.1 PURPOSE

This SOP provides requirements, guidelines, and general information to consider in the planning, development, and execution of a Chemical Data Management Plan (CDMP). It will provide guidance on:

- Project requirements review
- Field sample plan review
- Laboratory specifications review
- Laboratory deliverables (report and electronic data deliverables [EDDs])
- Development of a CDMP
- Chemical data storage considerations and options
- Chemical data component structure
- Analysis and reporting options
- Commercial and agency-specific database systems.

If the CDMP is not a contract deliverable, it is recommended that one be generated regardless as an internal document for project staff use.

1.2 SCOPE

The requirements and guidelines are applicable to all projects with chemical data components.

1.3 DEFINITIONS

Auxiliary Data—Other project-specific data that may integrate with the chemical data (i.e., boring log data, well gauging data, geospatial coordinate data, and field analysis data).

Historical Data—Previously generated chemical data and associated auxiliary data (i.e., from past site investigations or regular periodic sampling events of monitored sites).

1.4 ROLES AND RESPONSIBILITIES

1.4.1 Project or Task Managers

The Project Manager or Task Manager specifically assigned to oversee the chemical data task is responsible for the planning and implementation of the CDMP that will define the project requirements and final data deliverable specifications. Specific responsibilities are to:

- ***Review Project Data Requirements***—Review the project requirements for the chemical data to ensure all client deliverables for analysis, reporting, and data storage will be met.

- ***Create Sampling Plan***—Design and/or review the field sampling plan to ensure the proper numbers and types of samples will be collected, documented, and tracked.

- ***Select Laboratory and Define Performance Criteria***—Select the laboratory that will meet the project requirements for methods, detection limits, quality control performance, and deliverables. Projects may require complex quality assurance project plan/data quality objectives. Establish point of contact, price, deliverables, and schedule with the laboratory. Project chemists and/or data managers can assist in this task because they have contacts and experience with laboratories such as knowing if a laboratory provides late or incomplete deliverables.

- ***Identify Other Data Sources and Plan for Integration***—Determine if auxiliary data or historical chemical data will need to be collected and integrated with the chemical data. Common sources of auxiliary data are boring log data, well gauging data, geo-spatial/ location coordinate data, and field analysis data. Plan for staff to evaluate, process, and integrate data sources. Integration of existing chemical data into the project database can be a time-consuming effort, even if the data are available electronically. Be sure to consider the level-of-effort associated with this task.

- ***Create the CDMP***—Prepare the CDMP to define:

  — Data tracking
  — Data processing and storage
  — Laboratory analysis and reporting requirements
  — Final data delivery requirements to the client.

- ***Designate Data Support Staff***—Depending on the size and complexity of the project, a Database Administrator (DBA) and/or Data Coordinator may be designated. Consult a DBA to review the data processing and storage options and make recommendations. Plan for the expertise and staffing to meet data processing and deliverable requirements.

- ***Monitor Progress***—Inform DBA, Data Coordinators, and analysis and reporting staff of all data sources, deliverable requirements, and schedules as defined in the CDMP. Monitor the progress and quality of data collection, processing, and reporting. This requires regular communication and status reporting with the designated DBA and Data Coordinators to ensure data tasks are completed on schedule and any problems are addressed in a timely fashion.

- ***Review Final Products***—All final deliverables (reports, data tables, data files, etc.) must be reviewed to ensure project requirements are met.

1.4.2 Database Administrator

The DBA has advanced data evaluation, data management, and programming skills. The DBA is able to evaluate a wide variety of complex data sources and project requirements, and to advise the Project Manager on appropriate solutions and staffing. Specific responsibilities are:

- ***Data Review Consultation***—As requested by the Project Manager, must review all relevant project information and then provide recommendations on data management and staffing options, and work with the Project Manager to create and implement the CDMP.

- ***Data Management***—Design and implement the data processing and storage solutions. The solution may consist of multiple databases and any applications or tools needed to manage the tracking, processing, security, storage, analysis, and reporting of data as assigned by the Project Manager.

- ***General Data Support Services***—As requested by the Project Manager or designated staff, may provide other support (i.e., data searches, queries, ad-hoc reporting, staff training, or other data services) as needed.

- ***Data Coordinator Oversight***—May function directly as the Data Coordinator, or may manage other Data Coordinators. The DBA will assign database maintenance or programming tasks as deemed appropriate to the skill level of the Data Coordinator. The DBA and Data Coordinator may share interchangeable tasks. The level of direct involvement and specific project responsibilities of the DBA will be defined by the Project Manager in the CDMP.

- ***Final Data Product Delivery***—Ensure that the final client data deliverable meets all specifications (including those associated with data validation), and provides the data in the designated format.

1.4.3 Data Coordinator

The Data Coordinator is responsible for the actual day-to-day tracking, processing, preparation of data deliverables appropriate for the specific project, and reporting of the project data to the project team and client. The specific tasks assigned to the Data Coordinator will depend on the skill level, tools, and applications provided. The Data Coordinator works closely with the DBA, or the DBA may serve directly as the Data Coordinator. The Data Coordinator should be engaged from project inception through data reporting. Specific responsibilities are:

- ***Field Sampling and Chain-of-Custody Tracking***—Review and compare the field samples to the sampling plan. Review chain-of-custody (COC) for accuracy and completeness. This task may be also completed by the project manager or chemist.

- ***Staff Communications***—Communicate with the field staff, shippers, and laboratory to ensure samples are collected and received on schedule. Alert the Project Manager, field staff, and laboratory of any discrepancies or problems. Maintain all records related to sampling, shipping, and COC. Communicate with other project staff (i.e., reporting or analysis staff), as needed. As with field sample comparison to the sampling plan and COC reviews, the project manager or chemist may also perform this task.

- ***Laboratory Communications***—Serve as the point of contact between the Project Manager and the laboratory. Receive and maintain all laboratory reports, correspondence, COC, and EDDs. Alert the laboratory to any sampling or data issues and document resolution of any problems.

- ***Laboratory Data Quality Review***—Examine all data deliverables and reports from the laboratory to ensure data accuracy, completeness, and adherence to the analysis and reporting requirements.

- ***Data Verification and Validation Review***—Examine all data verification and validation reports from the data validator (if required) to ensure all project measurement quality objectives have been achieved and appropriate qualifiers assigned to ensure that project data quality objectives as defined in the Quality Assurance Project Plan have been achieved.

- ***Data Processing***—Execute all data processing duties as defined in the CDMP. This includes tasks such as EDD processing, standardizing, and importing chemical data into the final database; organizing and storing original EDD files; and reviewing and preparing historical or auxiliary data to integrate with chemical data.

2. EQUIPMENT

2.1 COMMERCIAL AND AGENCY SOFTWARE

A wide variety of generic and program-specific software are available for the storage, analysis, and reporting of chemical data. Some of the more commonly encountered software products are as follows.

2.1.1 Microsoft Office® Excel, Access, SQL Server, or SQL Server Express

In certain cases, Microsoft Excel, Access, SQL Server, or SQL Server Express may be the best or only option for storing data. For projects that include very little chemical data, the data may potentially be stored in an Excel spreadsheet; however, this is not an optimal storage method and should be avoided. Data can also be managed in Access; however, an Access database is limited in its size, the data can easily be compromised, and report tables do not easily export out of the program. If an Access, SQL Server, or SQL Server Express database is required for a project, then EA's Technology Services division can create a custom database tailored to the client's needs. However, creating a custom database will add costs to the project. The creation of custom databases should be limited to projects that, for some reason, cannot be uploaded into Environmental Quality Information Systems (EQuIS®).

2.1.2 Equis®

EQuIS software by EarthSoft is the primary database utilized by EA. Licenses for the most current software (EQuIS 6) have been purchased by EA and can be utilized for any project without incurring additional costs. EA's EQuIS database utilizes a SQL Server and has the capability of storing data for hundreds of facilities. Unlike some databases, EQuIS includes a data processor that checks the EDDs against reference values to help identify any logic, formatting, or valid values issues prior to importation of the data into the database to reduce errors and maintain data quality. The software has the capability to utilize many different EDD formats for uploading and can also easily export EDDs for regulatory agency submittal. In addition to chemical data, auxiliary data such as geo-spatial coordinate data, lithology, well gauging data, and field analysis data can also be loaded into EQuIS. The data required for report tables can be easily exported out of the database, and screening levels can be imported into the database to be used in the report tables. Due to its capabilities, EQuIS is the preferred data management software and all Data Managers have access to the software.

2.1.3 Environmental Resources Program Information Management System – Air Force Civil Engineer Center

The Environmental Resources Program Information Management System (ERPIMS) database for the Air Force Civil Engineer Center utilizes ERPToolsX software. Data submission to ERPIMS is required for all Air Force installations and must be completed by a trained Data Manager who has access to ERPToolsX. For new projects, the ERPIMS data submission schedule will be submitted within 30 days of the contract award and annually, if applicable.

ERPIMS requires additional data beyond chemical data, such as hydrogeological information, site/location descriptions, subsurface lithology, monitoring well characteristics, etc. Project Managers should be aware that separate ERPIMS EDDs are required from the laboratory and not all laboratories have the capability to provide EDDs in the ERPIMS format. Coordination between the Data Manager, Project Manager, laboratory, and field personnel is imperative to ensure that all required data are collected during sampling and the appropriate EDDs are provided.

In most cases, historical data for current projects can either be exported through ERPWeb Tools by the Data Task Manager or can be submitted to the ERPIMS Help Desk. Data for report tables cannot be easily exported from ERPToolsX or ERPWeb Tools; therefore, another database, such as EQuIS, must be utilized for managing the project data.

There are many specific requirements associated with ERPIMS that should be discussed with the Data Task Manager during the proposal and start of a project.

2.1.4 Formerly Used Defense Sites Chemical Database – U.S. Army Corps of Engineers

The Formerly Used Defense Sites Chemical Database (FUDSChem) is the database that is a requirement on most, if not all Formerly Used Defense Sites as well as some Military Munitions Response Program projects. It replaces the original Automated Data Review and Environmental Data Management System formerly used by the U.S. Army Corps of Engineers (USACE). USACE has contracted management of this software to Environmental Synectics (Synectics) in California. When a USACE project is initiated that requires FUDSChem, a Synectics project manager will be assigned to assist with the software. The software is meant to be all-inclusive and becomes the USACE repository for many project deliverables beyond chemical data (e.g., project Quality Assurance Project Plan, well logs, munitions information, geographic information system data, etc.). The software also incorporates Automated Data Review in the process and can be used as an alternative to independent data validation. The software requires development of an electronic Quality Assurance Project Plan, which Automated Data Review utilizes for machine validation. The assigned USACE project chemist plays a crucial role in making sure that FUDSChem is set up and running correctly. The system is complex and, as with most of these software programs, requires training that is regularly held by Synectics.

The use of FUDSChem requires many specific tasks and the Data Task Manager and company Project Chemist should be included during both the proposal and project initiation stages.

2.1.5 Naval Installation Restoration Information Solution – U.S. Navy

The Naval Installation Restoration Information Solution (NIRIS) database is maintained by the Naval Facilities Engineering Command (NAVFAC) for data associated with Naval installations. NIRIS consists of a centralized database structure, tools, and applications that are used to store and manage environmental restoration data. NIRIS uses standardized protocols, valid values, and formats to ensure that data are loaded and accessed in a consistent manner. The NAVFAC Electronic Data Deliverable Specifications are a collection of tables that provide the requirements, precision, valid values, and definitions for Environmental Restoration Program data submittals. The NAVFAC EDD specifications standardize the data submittal process for both the Navy and Marine Corps Environmental Restoration program.

The NIRIS database is a web-based application and must be completed by a trained Data Manager who has access to the website. The secured homepage consists of end user tools that include data submission tools, environmental restoration search for documents, Land Use Control Tracker, Data Analysis and Download Tools, and NIRIS GRX Viewer for viewing geographic information system maps and data.

There are specific requirements associated with NIRIS that should be discussed with the Data Task Manager during the proposal and start of a project.

2.2 CUSTOM SOFTWARE

Depending on the size and complexity of the project data, custom applications can be defined and developed internally to meet the data tracking, processing, and reporting needs of the project.

2.3 HARDWARE

Not applicable.

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3. PROCEDURE

3.1 MANAGEMENT PROCESS OVERVIEW

The management of chemical data is often a component of a much larger engineering, site characterization, remediation, or environmental compliance project. The planning of the field sampling effort, selection of a laboratory, and establishment of laboratory data quality objectives must be well defined.

Because the chemical data management component can be a foreign topic to many Project Managers, its complexity can be underestimated, causing negative impacts on the project schedule, budget, staff, and overall project performance. The development of a successful CDMP depends on a full understanding of its precursors: project requirements (scope, budget, schedule, and deliverables), field sampling plan, and laboratory quality assurance project plan/data quality objectives.

The chemical data management process has been divided into four major steps:

1. ***Review Project Requirements***—Scope of work, schedule, budget, data deliverables, analysis, regulatory requirements, and reporting requirements.

2. ***Review Field Sampling Plan***—Numbers and types of samples, sample schedule, field quality control requirements, and sampling methods.

3. ***Review Laboratory Specifications***—Required certifications, methods, detection limits, analyte lists, validation requirements, reporting and EDD specifications, and quality assurance project plan/data quality objectives.

4. ***Develop and Execute CDMP***—The plan has four components:

   - Data tracking
   - Data processing and storage
   - Laboratory analysis and reporting requirements.
   - Final data delivery requirements to the client.

These steps are applied universally to all chemical data projects, regardless of size or complexity. Each step will require varying levels of detail as dictated by the objectives and requirements of each project. The chemical data management process overview is presented in Figure 1.

The requirements and guidelines of each step are presented in the following sections.

Attachment A provides additional supporting material and background information for each step.

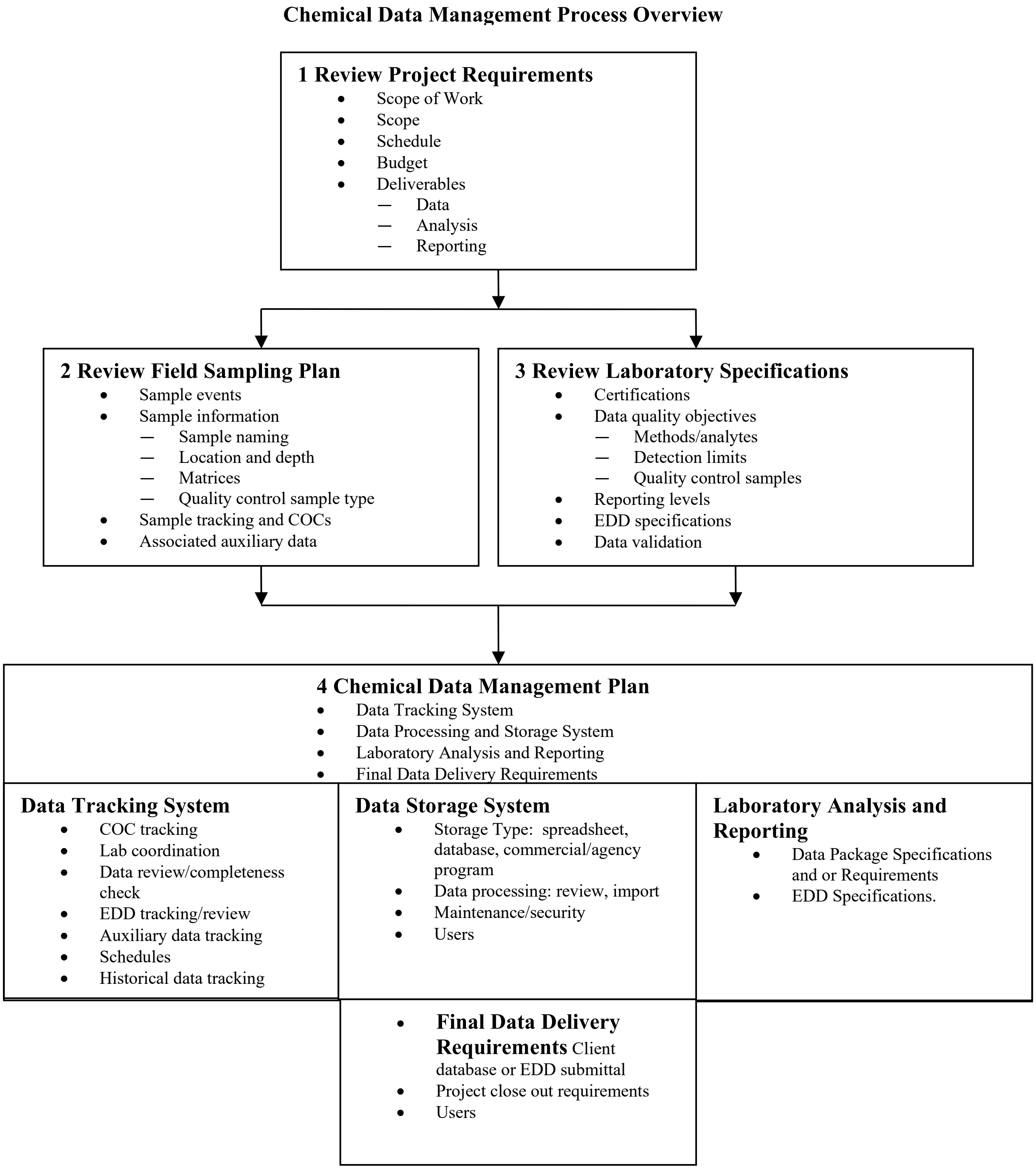

Figure 1. Chemical Data Management Process

3.2 REVIEW PROJECT INFORMATION

The project requirements define the project objectives, scope of work, deliverables, schedule, and budget.

Required

- Review the available project information (scope of work, schedule, budget, and deliverables) as they pertain to the chemical data requirements.

- Contact a DBA to review the requirements and assist in preparing the CDMP. Only extremely simple sampling and analysis projects are exempt from DBA review. The DBA will provide:

    - Options and specifications for data tracking and processing, data storage, software, analysis and reporting, verification that regulatory data requirements have been met, and final product delivery

    - Information on staffing and expertise required

    - Estimate of timing and level of effort for each task

    - Evaluation of auxiliary or historical data to be integrated with the chemical data.

- Prepare and review the data management effort estimates and confirm the estimates meet the project requirements. Revise as necessary to define and meet requirements.

Guidelines

Refer to Attachment A, Section 1, for additional support information on reviewing project information and considerations in defining chemical data management requirements.

3.3 REVIEW FIELD SAMPLE PLAN

The Project Manager must plan for field staff, training, equipment, schedules, site safety, and the actual sample collection strategy. The field sampling data will eventually be integrated and matched to its laboratory analysis data.

The sampling plan will include information on:

- Sample events and numbers of samples
- Sample locations and depths
- Sample matrices and field quality control samples
- Sample naming conventions

- Sample tracking and COC policies
- Sample techniques and containers
- Decontamination procedure
- Sampling schedule.

Required

- ***Prepare List of Expected Field Samples***—The list is prepared as an electronic (Excel) file that provides the field information to be linked to the laboratory results. The field sample list includes:

Field Sample Name	Naming system may consist of codes for location, depth, type, etc.
Field Sample Date	Date and time of sample collection.
Sampling Event	For projects that have long-term monitoring or sample collections, the sampling dates may be grouped into distinct events (i.e., quarterly sampling).
Field Sample Location	Location designation from sampling site. Sites may have designated well locations, test pits, vapor points, etc.
Field Sample Matrix	Specific matrix (i.e., groundwater, surface water, sediment, effluent, soil gas, etc.).
Field Sample Type	Used to identify field quality control samples (i.e., field duplicates, rinse blanks, trip blanks, etc.).
Field Sample Parent	Sample name of parent sample to a field duplicate.
Sample Start Depth	Typically used for soil boring samples, start depth of sample.
Sample End Depth	Typically used for soil boring samples, end depth of sample.
Field Filtered	Typically used for water samples to indicate field filtered for dissolved metals.
Other Data	Other data columns as needed to provide sample-specific information that will be captured in the final database.

- ***Prepare List of Locations***—The list is prepared as an electronic (Excel) file that contains the field location information to be linked to the field samples. The location provides details for each location (i.e., areas of concern, geographic information system coordinates, location type, etc.). The location list includes the following:

Location Name	Location naming system may be designated by the client (i.e., existing monitoring wells, or may be designated in the field sampling plan).
Alternate Location Name	Locations may have alternate historical names, or designated identifiers from state or local regulators.
Area of Concern	Large sites may have locations grouped into areas of concern.
Location Type	Designates the type (i.e., monitoring well, vapor point, discharge point, and soil boring).
X coordinate	Latitude coordinate.
Y Coordinate	Longitude coordinate.
Z Coordinate	Elevations.
Coordinate System	Name of standard system for location coordinate values.
Other Data	Other data columns as needed to provide location-specific information that will be captured in the final database.

Guidelines

- If the sampling plan includes auxiliary data to be captured in the database and linked to chemical data (i.e., for soil boring logs, field analyses, and well gauging), plan to organize and capture the data in an electronic format (Excel) to facilitate data integration. Consult a DBA for design specifications.

- For large, complex projects that have major field sampling plans, consult a DBA prior to starting field operations to ensure field data can be collected electronically in a consistent and standardized manner.

- Enforce consistency in naming and coding conventions when collecting all forms of field data. This will facilitate later linking of field sample data to its chemical laboratory results and any auxiliary data.

- Refer to Attachment A, Section 2, for additional support information on reviewing field sampling plans and considerations in defining chemical data management requirements.

3.4 REVIEW LABORATORY INFORMATION

The laboratory performing the sample analysis provides information on methods, reporting limits, analyte lists, and quality control procedures that will be applied to the project samples. The laboratory will produce deliverables, typically a laboratory report of the results (that includes a narrative of any analysis issues), and an EDD file of the results.

Required

- The analysis performance requirements (quality assurance project plan/data quality objectives) must be reviewed by the Project Manager or Project Chemist to ensure laboratory performance will meet project requirements. The documentation will define the methods, analyte list, reporting limits, and quality control procedures that will be applied to the project samples.

- All projects will have an EDD file format specified for result delivery. Consult a DBA to confirm the EDD format will meet database import specifications and contain all required laboratory data.

Guidelines

- Selection of a laboratory and preparation of a quality assurance project plan/data quality objectives are not part of the actual CDMP, but are critical precursors to the generation of analytical results that will meet project requirements. The Project Manager or Project Chemist should review all available laboratory project information prior to the sampling event to ensure the laboratory results will be acceptable for project use.

- Refer to Attachment A, Section 3, for additional support information on reviewing laboratory specifications and considerations in defining chemical data management requirements.

3.5 CHEMICAL DATA MANAGEMENT PLANNING

After the field sampling and laboratory requirements have been reviewed, the actual CDMP can be developed. The CDMP is divided into three main sections:

Section	Components
Data Tracking System of Sample Delivery Group and EDDs	Tracking of field samples and COC EDD and laboratory report tracking and review Sample Delivery Group tracking of validated data Linking field sample and laboratory data Linking auxiliary data Storing source data
Data Storage System	Data storage (spreadsheet versus database) Commercial or agency-specific data program Data review and processing Data security and maintenance Data deliverables
Data Analysis and Reporting System	Analysis requirements and deliverables Reporting requirements and deliverables

Projects can vary greatly in data quantity, complexity, storage, and reporting requirements. Especially for large, complex projects, a DBA can provide valuable information on the options for data storage and processing systems to be defined in the CDMP.

The three main sections of the CDMP are addressed in the following sections.

3.5.1 Data Tracking System

A formal data tracking system must be established to organize and monitor the incoming project data. The main objective of the tracking system is to discover missing, incomplete, erroneous, or otherwise unacceptable data as soon as possible in the project life cycle. Early discovery of problems may allow field crews, laboratories, or other subcontractors (e.g., data validators) to make corrections, or allow the Project Manager to make alternate plans to address project data issues. Data tracking should also include a means to verify that data validation, if required, has been performed and reported correctly before final storage of information.

Large projects have many types of data generating activities. Figure 2 presents a schematic diagram of the various project activities that produce sources of data that may need to be tracked, processed, and incorporated into the final data storage system. The individual files must be checked for accuracy and completeness, and compared against each other to verify the related information can be linked in the future for final data storage and reporting.

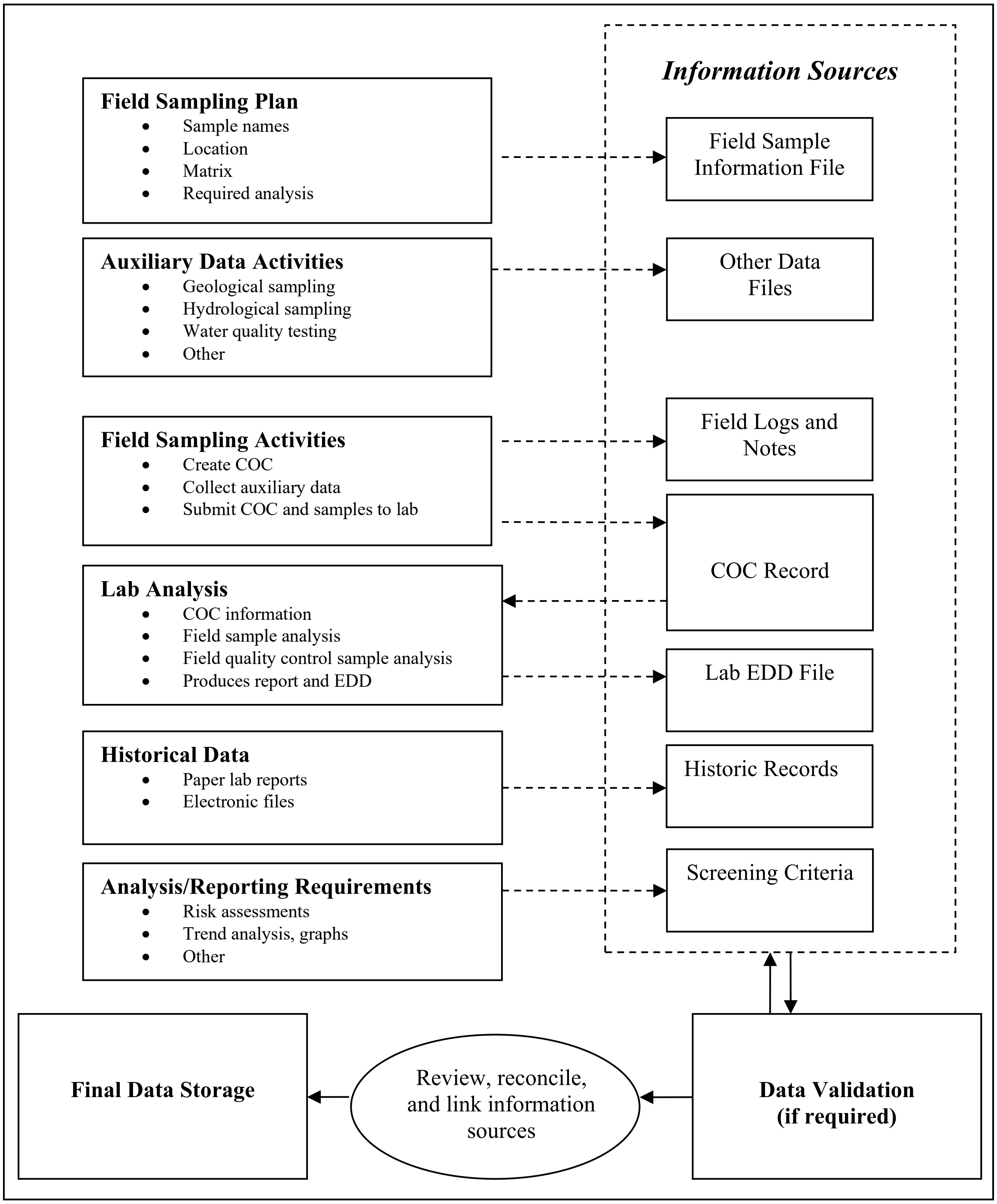

Figure 2. Project Information Sources

Required

- Consult with a DBA to define the project data sources and determine the type of tracking system to be developed. Tracking systems may be as simple as a series of Excel files managed and reviewed by a Data Coordinator, or customized database applications that provide forms, tools, reports, and automation to assist the Data Coordinator.

- A Data Coordinator must be assigned to manage the data.

- The tracking system should perform the following tasks:

Task	Description
Sampling Plan Verification	Correct number and types of expected field samples have been collected and recorded, and sent to the laboratory.
Sample Information Verification	Sample names, sample dates, depths, locations, coordinates, and other sample information are correctly recorded.
COC Verification	Laboratory COC is correct, with expected field samples, dates, matrices, methods for each sample, and signed as required.
Laboratory Deliverable Verification	Reports and EDD files contain all required samples, methods, analytes, and required supporting material. The EDD must be reviewed for accuracy and completeness, including tracking of Sample Delivery Groups through the data validation process.
Auxiliary Data Verification	If well gauging, soil boring, or other field analysis data (i.e., organic vapor analyzer readings, water quality parameters) have been collected, that data should also be verified for accuracy and completeness and standardized for linking to chemical data samples and locations.
Data Linking	There must be a mechanism for linking field samples to laboratory EDD data, and any auxiliary data.
Coordination and Communication	The system must include a mechanism for alerting the Data Coordinator or appropriate project staff, laboratories, other subcontractors regarding missing, incomplete, or incorrect data, and resolving any data tracking issues.
Source Data Storage	All original source files (sample lists, laboratory EDDs, field analysis files, etc.) must be stored in a secure location. Original files allow traceability back to original information sources.

- The laboratory must be notified of any errors in the EDD file. A corrected EDD file must be issued by the laboratory. For example, a field same name or sampling date must not be corrected directly in the database unless a corrected EDD is obtained.

Guidelines

Refer to Attachment A, Section 4, for additional support information on different data sources and considerations in defining chemical data management requirements.

The attachment includes detailed information on:

Data Type	Description
Laboratory EDD Files	EDD files must have a specific format, structure, and content.
EDD Validation Files	EDD files may go through a formal validation process that may change data or designate some data as not useable.
Screening Criteria Data	There are many types of federal, state, and local quality standards that can be used to screen the chemical concentrations in samples.
Historical Data	Some projects may have accumulated years of past chemical analysis data, stored in various file types, or hard copy that must be merged with the new data. The standardizations and processing of historical are often a major undertaking that requires analysis and planning.

3.5.2 Data Storage Systems

3.5.2.1 Overview

There are many factors to consider when selecting a chemical data storage system. The storage system will receive processed field and laboratory data from the tracking system, provide data to the analysis and reporting system, and may be the final data deliverable to the client. Chemical data storage systems typically fall into three main categories:

- Spreadsheets
- Commercial databases or agency software (e.g., EQuiS and ERPIMS)
- Custom design databases (designed specifically for a certain project).

Only the simplest of projects store chemical data in a spreadsheet. This document focuses on the management of chemical data projects that require the use of a database or commercial data management product such as EQuiS.

3.5.2.2 Implementation of Data Storage System

Required

- The Project Manager must consult with the DBA in the selection and implementation of a database system. After analyzing the project and data requirements, the DBA provides information on staffing and level of effort to implement and maintain the selected data system.

- If the client requires the use of a particular data product, the Project Manager must plan for the staff required to implement and maintain the product. The development of expertise to operate a commercial database system may require extensive staff training.

- To protect the original source data, all original EDDs or other source files used to populate the database must be protected from any type of corruption or editing to allow traceability back to source information and ensure data integrity. Most commercial laboratories maintain secure laboratory database systems that secure their data, and yet allow data users to gain access to download appropriate source files. Field generated data documented in field logbooks or worksheets should be maintained by project management for the required time following EAs policy on document archiving..

- The database system must be secure, properly maintained, and protected. A professional DBA can provide information on security, maintenance, and disaster recovery policies.

- Regarding data storage systems, the CDMP must address the following topics:

Topic	Description
Storage Selection	Provide criteria used to select particular data storage system (client specified, small project requires Excel only, etc.)
Data Security	Specify types and locations of data users, and data security policies at user and network levels. Determine if external programs or services will require access to the data.
Data Processing	Specify the system for reviewing, importing, and updating data within the data storage system. The processing of EDD data is of particular importance.
Data Maintenance	Specify the plan for short- to long-term maintenance, disaster recovery, and protection of the data.
Final Delivery	Specify the final data deliverable to the client. The client may require data to be delivered in a specific file format external to the storage data system.
Analysis and Reporting Options	Specify if the data storage system will interface with other programs, or produce data for outside programs. A wide variety of commercial and custom programs can be used to generate charts, reports, and tables, and to conduct statistical analysis.

Guidelines

- In general, the use of spreadsheets as a final data repository should be avoided, except in the case of simple projects that have few samples and simple reporting requirements.

- If a DBA is not used to manage the data:

  — Ensure that the staff assigned to manage data have sufficient training to perform the necessary tasks. Consultation with personnel who usually maintain data is encouraged.

  — Discuss plans for securing and protecting the data with the Network Administrator to arrange for proper user access and file backup.

  — Identify the major types of data to be processed; generally, EDD files are the most frequent, and develop a reliable, consistent process for reviewing and processing the data.

- — Protect the source data and data integrity. A common problem to avoid is allowing multiple users to access multiple Excel data files for purposes of table and chart generation. This situation often results in users altering values, cutting and pasting sections of data, and corrupting the original files to make verification of source data impossible.

- There are many options to consider when selecting and implementing a chemical data storage system. Refer to Attachment A, Section 5, for details on the following topics:

Topic	Description
Comparisons of Spreadsheets and Databases	The pros and cons of using spreadsheets or database to store, analyze, and report chemical data.
EDD File Formats and Contents	Details on the EDD formats and fields included in a laboratory EDD. A generic EDD file format example is provided (Attachment B).
Generic Chemical Database Structures (Attachment C)	Description of tables and fields that can be used as a generic chemical database. The actual database is available for use as an Access database.
Commercial/Agency Chemical Data Programs	Details on common commercial or government agency chemical data programs.
Data Processing and Database Updates	Details on updating data, data imports, corrections to data, and maintaining data integrity.
Network and Database Security	Details on network and database level security, user, and program access to data.
Long-Term Data Storage	Policy on long-term data storage and archiving.
Final Data Deliverables	Details on typical client data deliverables.

3.5.3 Data Analysis and Reporting System

A chemical database can be used as the central source data to satisfy a wide array of analysis and reporting requirements. Typically, the requirements consist of report tables, graphs, or data exports created in Excel. The basic approaches for creating tables, charts, and exports are:

- For projects with minimal requirements, the DBA can export data to spreadsheets that allow other users to create tables, charts, and reports from the export.

- For projects that have complex or long-term requirements, custom reports can be created to allow multiple users to select and create a wide variety of reports, tables, and charts directly from the database.

Required

- The Project Manager must have specifications on analysis and reporting requirements of the project.

- The Project Manager must evaluate the size, complexity, and frequency of the analysis and reporting requirements and determine the appropriate mechanism for generating the tables, charts, or exports.

Guidelines

- Using DBAs or skilled Data Coordinators to produce tables and charts directly from the database has several advantages over manually processing spreadsheet data:

  — Eliminates manual transcription or cut/paste errors

  — Outputs generated directly from the database often take less time to produce than transcribing to another format manually.

  — Database queries are able to produce summary data (sums, averages, counts, pivot tables) directly from the database

  — Database queries provide powerful linking, searching, and filtering options for data presentation

  — The source database remains protected.

- For long-term or complex reporting, implementation of a customized program can allow general users to produce automated tables and charts directly from the database. The programs provide flexibility in selecting sample dates, screening criteria, locations, and other fields contained in the database for reporting purposes. The program allows for multiple users and the source database remains protected.

- If using spreadsheets and manual creation of tables and charts, verification of reported data against the source data should be performed to ensure transcription/cut and paste errors have not occurred.

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Attachment A

Chemical Data Management Plan Supporting Information

CONTENTS

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1. REVIEW PROJECT REQUIREMENTS GUIDELINES

When defining the chemical data management requirements within the parent project, the following topics must be considered:

Topic	Considerations	Impacts
Project Objectives	What is the nature of the overall project? • Phase I investigation • Long-term monitoring • Remediation design and evaluation • Superfund • Commercial or government client? What are the data deliverables and schedules? • Report tables • Graphs/trends • Statistical analysis/modeling • Screening concentrations • Multiple event reporting • Actual data deliverable (database/electronic data deliverables [EDDs])	Reviewing the project plan gives the "big picture" of the scale of the project, requirements, schedule, and budget. Some project plans do not include any details on the chemical data component. Scrutinize any available requirements as early as possible and begin asking questions. Knowing the ultimate use of the data within the project helps to determine the level of technical expertise and staffing needed to manage, track, store, analyze, and report.
Technical Requirements	Are there any requirements supplied by the client such as: • Data Storage: Use of commercial or agency-specific chemical data programs • Are there any historical data to evaluate or incorporate • Data quality objectives: required laboratory certifications, detection limits, methods, types, and numbers of quality control samples • Reporting and Analysis Objectives: complex reports, risk assessments, trend analysis, permit limit evaluations • Final data deliverable specifications Will Information Technology/data technical support staff be required?	Many government agencies require specific data storage formats and programs that are generally very complex. Staff may require considerable training to develop the expertise. Standardization and merging of historical data (paper and electronic records) are generally labor intensive and require experienced database support. Using a non-approved laboratory or failing to provide the laboratory with the specific methods and data quality objectives can generate data that are invalid for project use. Complex reporting and analysis requirements may require Database Administrators (DBAs), statisticians, risk assessors, or report automation development. Some clients require the actual chemical data be supplied as a final product and may require a DBA to produce it. Data management experience levels and staffing costs must be considered.
Schedule, Budget, Logistics	Has the impact of the chemical data component on the overall project schedule, budget, logistics been evaluated? Has the level of effort for data management been realistically addressed in the parent project plan?	Must plan for limitations on laboratory data delivery, sample transport, holding times, laboratory capacity and capabilities, and analysis costs. Complex or long-term projects may require Information Technology support for database planning and report automation.

2. REVIEW FIELD SAMPLING PLAN GUIDELINES

When reviewing the field sampling plan, the following topics must be considered:

Topic	Considerations	Impacts
Sample Events	Will the project be a small single sampling event, or a long-term project, such as quarterly monitoring? What are the projected numbers and matrices of samples? What are the analysis methods (and analyte list) applied to each sample? Is regular analysis and reporting required per event?	Projects with large numbers of samples and methods will generally require a database system and a DBA to maintain it. Long-term projects benefit from the development of a sustainable, repeatable sampling, data processing, and reporting plan. Repeatable data analysis and report generation by staff may require development of an analysis/reporting automation program.
Sample Locations and Depths	Will the data be used by a geographic information system? Has client specified a coordinate system? Will soil samples require designation as surface or subsurface soils? Are there associated auxiliary data such as geological, hydrological, biological, or weather data?	Confirm the coordinates system to be used by the geographic information system. Defining depth levels for soil samples may be needed for later risk assessments or geological/hydrological studies, and generation of boring logs. The data may include water quality, well gauging, and soil boring information to be stored and linked to the chemical data.
Sample Matrices and Quality Control Types	Are samples clearly identified by proper matrix identifiers (groundwater, surface water, leachate, etc.)? Will water samples require “total” and “dissolved” parameters? Does project require dedicated field quality control samples such as field and trip blanks, field duplicates, or extra samples for matrix spikes?	Project may require specific matrix identifiers, not just generic soil or water matrix provided by laboratory. Sample data must be coded to differentiate between total and dissolved, particularly for metals. Sample data must be coded to differentiate between normal field samples and quality control samples.

Topic	Considerations	Impacts
Sample Naming and Chain-of-Custody	What is the sample naming system? There are two main approaches to sample naming: • Embed all information in the field sample name • Use a simple code name but store the sample detail in an external file.	The Project Manager may prepare in advance a sample table with pre-designated sample names and sample information (depth, coordinates, location grid name, and matrix code). Some database systems have limits on the length of field sample names.
	How will the complex sample information (i.e., location, depth, matrix, sample date, and type be associated to laboratory sample)?	The field sample name must be properly transferred from the container to the chain-of-custody, to the laboratory data system to allow later matching of field sample and laboratory data.
	By whom/how will the chain-of-custodies, laboratory data, and field sample information be tracked and integrated? What field sample information will the laboratory provide?	The laboratory will only provide the field sample name, sample collection date, and generic matrix (solid or water). All other original field sample information (location, depth, matrix, etc.) must be captured and maintained by the Project Manager.

3. REVIEW LABORATORY SPECIFICATIONS GUIDELINES

Environmental laboratories vary greatly in capacity, capabilities, certifications, areas of expertise, level of service, and pricing structures. The choice of a laboratory can be driven by many project requirements, or even specified by the client. After a laboratory has been selected, it is critical to establish a point-of-contact or laboratory Project Manager assigned to the project. The laboratory Project Manager must be informed of all project requirements, including the data quality objectives. For complex projects, the data quality objective plan will specify the methods, analyte lists, detection limits, precision and accuracy, numbers and types of quality control samples, and laboratory deliverable and reporting requirements. It is important that the laboratory Project Manager be provided a copy of the final project Quality Assurance Project Plan.

Developing a data quality objective document is a complex process that has been well defined by several agencies. Providing a data quality objective plan to the laboratory is critical to ensure the laboratory has the information it needs to produce the desired data deliverable. If the Uniform Federal Policy–Quality Assurance Project Plan is used, data quality objectives are contained in Worksheet Number (No.) 11.

In general, all laboratories produce a hard copy report package that includes sample lists, chain-of-custodies, result tables, a data narrative that describes any sample or analytical issues, and various other supporting tables and appendixes as defined in the reporting requirements.

Although the hard copy report package is a standard deliverable and the hard copy reported data represent the final results, every laboratory is capable of generating an EDD. All projects should require an EDD as part of the laboratory deliverable. The EDD is a file (usually Microsoft Excel, .csv, or text) that contains the sample and analysis data. Most laboratories have a standard EDD file structure that contains the most commonly used data fields: sample name, sample date, sample type, sample matrix, laboratory sample identification, method, total or dissolved, analysis date, preparation date, result, qualifier, unit. Most laboratories can easily create an EDD structure customized with extra fields as requested by the customer.

The laboratory data, whether hard copy or EDD, may include analysis results for field samples, quality control samples, laboratory control samples, dilution, and re-analyses. The Project Manager must be prepared to have the raw data reduced to the final sample results that will be reported to the client.

Some projects require that the laboratory results be validated. Validation is generally performed by a third party validation contractor. The validator performs an extensive review on all results and supporting material to determine if the analyses were performed to meet all performance specifications and analysis requirements. The validator marks the hard copy reports and edits the EDD file to flag the unacceptable results, and issues a validation report.

When reviewing the laboratory requirements, the following topics must be considered:

Topic	Considerations	Impact
Laboratory Certifications	Does a project require specific state or agency certifications? Is the certification current?	The laboratory data may be considered void if the laboratory does not hold the proper certifications, or has an expired certification.
Quality Assurance Project Plan/ Data Quality Objectives	Review the project quality assurance project plan/data quality objectives.	Project may have very specific lists of approved methods and reporting limits.
	Does the laboratory perform the required methods at the required levels of detection?	Laboratories provide published reporting and methods detection limits. Confirm that the methods will meet the project required detection limits.
	Does the project require use of reporting limits or method detection limits? Does the project require Department of Defense Quality Systems Manual limits (detection limit, limit of detection, limit of quantification)?	Confirm if the project requires non-detected results to be reported to the Reporting Limit or the Method Detection Limit. Generally, the Reporting Limit is 2-5 times higher than the Method Detection Limit. Under the Department of Defense Quality Systems Manual non-detects are reported to the limit of detection.
	Has the method analyte list been confirmed?	The list of chemical analytes for similar methods can vary. Confirm exactly which analytes are to be reported per method.
	Does the project require its own dedicated sample matrix spikes, duplicates, blanks, or other quality control samples?	If a project requires its own quality control samples, the laboratory must be informed and extra field samples must be supplied. Otherwise, laboratories batch multiple project samples together and select quality control samples at random. The project will pay for project-specific matrix spikes and matrix spike duplicates.
Laboratory Reports and EDD	Does the report include all supporting material as specified in the quality assurance project plan/data quality objective?	Clients may require all supporting material. The level of report detail must be specified.
	Does the laboratory EDD include quality control samples and re-analysis results that will require reduction?	Laboratory Information Systems are capable of producing almost any EDD structure specified by the client.
	Does the standard laboratory EDD structure contain all necessary fields for project?	The contents of the EDD may also be specified. Inclusion of laboratory quality control samples and re-analysis data require careful sorting and filtering to reduce and extract the desired final data.
Data Validation	Does the data require validation?	Validation increases the data delivery time and may also cause some results to be rejected from project use. As a result, edits may need to be made to the EDD.

4. DATA TRACKING SYSTEM INFORMATION

4.1 OVERVIEW

The Data Tracking System is needed to monitor and review the many types of files generated by project field activities and laboratories. Many projects store diverse types of information in separate files, usually as spreadsheets. For example, within the same project, there may be spreadsheet files for field sample lists, soil boring data with personal digital assistant or organic vapor analyte readings, well gauging data, a list of chain-of-custodies submitted to the laboratory, a list of EDD files produced by the laboratory, actual laboratory EDD files, laboratory report .pdf files, and an Excel file of state water quality standards that will be applied to the chemical data for screening purposes.

These individual files must be checked for accuracy and completeness, and compared against each other to verify the related information can be linked in the future for final data storage and reporting.

4.2 ELECTRONIC DATA DELIVERABLE

EDD files are the preferred delivery and storage mechanism for laboratory data. Laboratories store data in large Laboratory Information Management Systems. They are capable of producing EDD files of almost any configuration to contain as much detail as required. Most laboratories have a default EDD structure, but customers may specify the file format and content of the EDD file per project.

The use of EDD files has many benefits:

- Prevents manual data transcription errors
- Allows for easy upload into data systems
- Produces the EDD file and hard copy laboratory report from the same Laboratory Information Management System and contains identical data
- Produces EDD files on old historical data if they remain in the Laboratory Information Management System or in archive files
- Contains only field sample data, or can include a full array of laboratory and field quality control results.

General project EDD policies:

- All new projects should require EDD files as the part of the laboratory deliverable.

- Some commercial or agency-specific software programs have a required EDD structure that must be provided to the laboratory.

- If exact EDD fields are not specified by a client or software program, use the default EDD file specifications contained in Attachment B to Standard Operating Procedure No. 063. Other fields may be added to the default EDD structure as required by the project.

4.2.1 Data Validation

EDD files may require validation after the laboratory has produced them. Validation is generally conducted by a third-party company that specializes in laboratory data review. The laboratory data and documentation are reviewed against specific analysis protocols and data quality objectives to determine if the analyses were conducted as required. The validation process is complex and includes detailed review of items such as: instrument calibration logs, standard preparations, sample holding times, laboratory certifications, quality control procedures, and preparation and analysis logs. The validation process may flag and reject some data as not useable.

4.2.2 Other Electronic Files

The other data that may be provided electronically may include:

- ***Location Data***—Geographic information system coordinates, elevations, areas of concern, parcel designations, etc.

- ***Boring Log Data***—Geological strata, geological samples, organic vapor analyte, or photoionization detector readings, etc.

- ***Well Gauging Data***—Well construction data, water depths, elevations, product thickness, etc.

- ***Water Quality Data***—pH, oxidation reduction potential, turbidity, iron, etc.

- ***Field Analysis Data***—Soil gas analysis, metals by x-ray fluorescence, other mobile laboratory analysis, or field instrument data.

- ***Historical Records***—Paper or electronic files of chemical or hydrogeological data and associated auxiliary data.

- ***Screening Data***—Federal, state, or local limits for chemicals in water, soil, air, and tissue.

These other sources of data are generally supplied as spreadsheet files, or small database files. They may also be files produced from other software programs as text or .csv files.

Regardless of the file type, all sources of data that will be incorporated into the project must be reviewed, standardized, and prepared for linking to the samples and chemical data.

4.2.3 Screening Criteria

Many projects require that the chemical data be linked and compared to various federal, state, local, or permit-driven screening criteria. The screening criteria provide human health- or ecologically-based limit values on the concentrations of chemicals in various matrices. Some projects require multiple sources of limits for each matrix. Generally, the screening criteria chemicals and limit values are available in electronic form from websites. The Project Manager must supply the exact source of screening limit values. The screening criteria data must be processed, standardized, and imported into the database to link properly to the sample matrices and chemical results.

4.2.4 Historical Records

Projects may require the use and integration of historical chemical data.

When working with historical chemical data, it may be necessary to use hard copy project report tables and old laboratory reports as the data source. Hard copy data can exist in several forms. Some of the most common forms are listed below:

- ***Laboratory Reports***—The best source of hard copy data is an actual laboratory report. It is the original source of the raw laboratory data and will not suffer from any post-laboratory edits.

- ***Project Report Tables***—These are tables that have been created from the laboratory data and are generally found in documents produced for the project. They are usually in the form of "crosstab" tables that have samples listed as columns and methods/analytes listed as rows. Report tables vary greatly in quality as described:

  — Tables produced by manual data transcriptions are subject to transcription errors. Those produced by database automation may be reliable, but there is usually no way to confirm the production mechanism.

  — The same report may have several different versions/presentations of the same data (i.e., all results, hits only, hits that exceeded criteria, detects only, critical analytes only, etc.).

  — Some reports tamper with qualifiers, detection limits, and non-detected values. Some non-detected values may be displayed as "ND," thus losing the numeric value of the detection limit. Qualifiers other than "U" (non-detect) may have been removed.

- — Some reports create summed analytes (i.e., total polycyclic aromatic hydrocarbons; benzene, toluene, ethylbenzene, and xylenes; total volatile organic analyte; etc.) that are not part of the original laboratory data. It may not be known exactly which analytes are in the sum or how non-detects were handled.

- — Some reports have converted results from original laboratory units, such as changing milligrams per kilogram to micrograms per kilogram. Conversion errors may have occurred. Some tables may not have the units explicitly stated.

In general, try to select the report table that most closely resembles the results as typically presented in a laboratory report (i.e., where the numeric results and qualifiers appear to be intact).

When converting paper records to electronic files, the general process is to manually type the data into a spreadsheet or desktop database. Additional considerations of data conversion are:

- Any manually transcribed data must have a percentage of the data reviewed for completeness and correctness.

- For very large, complex records, consider the use of a data entry database system to enforce standardization, improve the data review process, and facilitate future data linking.

- Auxiliary data that are associated with the analytical results must be included.

4.3 DATA STORAGE SYSTEMS

There are two basic options for data storage: spreadsheet or database. If a database is needed, it can be a small-scale desktop database such as Access, or a large scale server database, such as EQuiS, SQL Server or Oracle. There are also many commercial and agency specific programs, all of which use database systems. There are many storage options described in the following sections.

4.3.1 Spreadsheets and Database Comparison

The first big decision to make in storage selection is to evaluate the need for using either a spreadsheet or database system. A summary of spreadsheet and database pros and cons are listed below.

Spreadsheets

Pros

- Are easy to use, no advanced technical expertise required

- Can cut and paste data to make new tables
- Can apply formulas to cells
- Can use filtering and sorting
- Can use macros for some automation.

Cons

- Poor data integrity: easy to destroy/corrupt original data by sorting, updating, and copying
- Poor standardization: sample, method, units, and chemical names can have multiple variations for same item
- Columns not enforcing data types (can have text in number fields, numbers in date fields, etc.)
- Large datasets cumbersome to store in multiple sheets or files
- Repeated data values: if a sample has 180 results, all of the sample information (location, depth, matrix, types, sample date, etc.) is repeated 180 times
- Data not stored in a relational structure: cannot link data, i.e., linking chemical results to chemical screening limits; requires manual comparison
- Limited security features for data or users.

Databases

Pros

- Provides many powerful benefits for storing data in a relational structure
- Better protects data integrity via enforcement of data types and elimination of redundant data storage
- Provides for data standardization: enforces standard method, chemical, and unit names
- Links and stores large amounts of data together
- Provides linked relationships to allow easy searching and comparisons
- Allows advanced programming, analysis, and report automation
- Provides better security, for users and data.

Cons

- Requires professional data staff to maintain and use the data.

In summary:

- Spreadsheets are extremely easy to use, but do not enforce data integrity/protection, and have no powerful searching, linking, or analysis capabilities. Spreadsheets should only be used on the simplest projects that have small data sets and limited analysis and reporting requirements.

- Databases provide better data integrity, standardization, and powerful searching, linking, analysis, and reporting capabilities, but require professional administration for use. Most projects will require the use of a database and services of a DBA.

4.3.2 Generic Chemical Database Structure

A generic desktop chemical database is available from the Information Technology Services group. The database incorporates the following features:

- The design incorporates the common data elements captured by most commercial or agency-specific database programs.
- Standardized table and field names are used to denote reference (look-up) tables, field types, and primary/foreign key fields.

- This database is suitable for scaling up to larger database systems, such as SQL Server, if needed.

- This database can be easily modified to include additional tables or fields as needed.

The structure and relationships of the generic chemical database are presented in Figure 1.

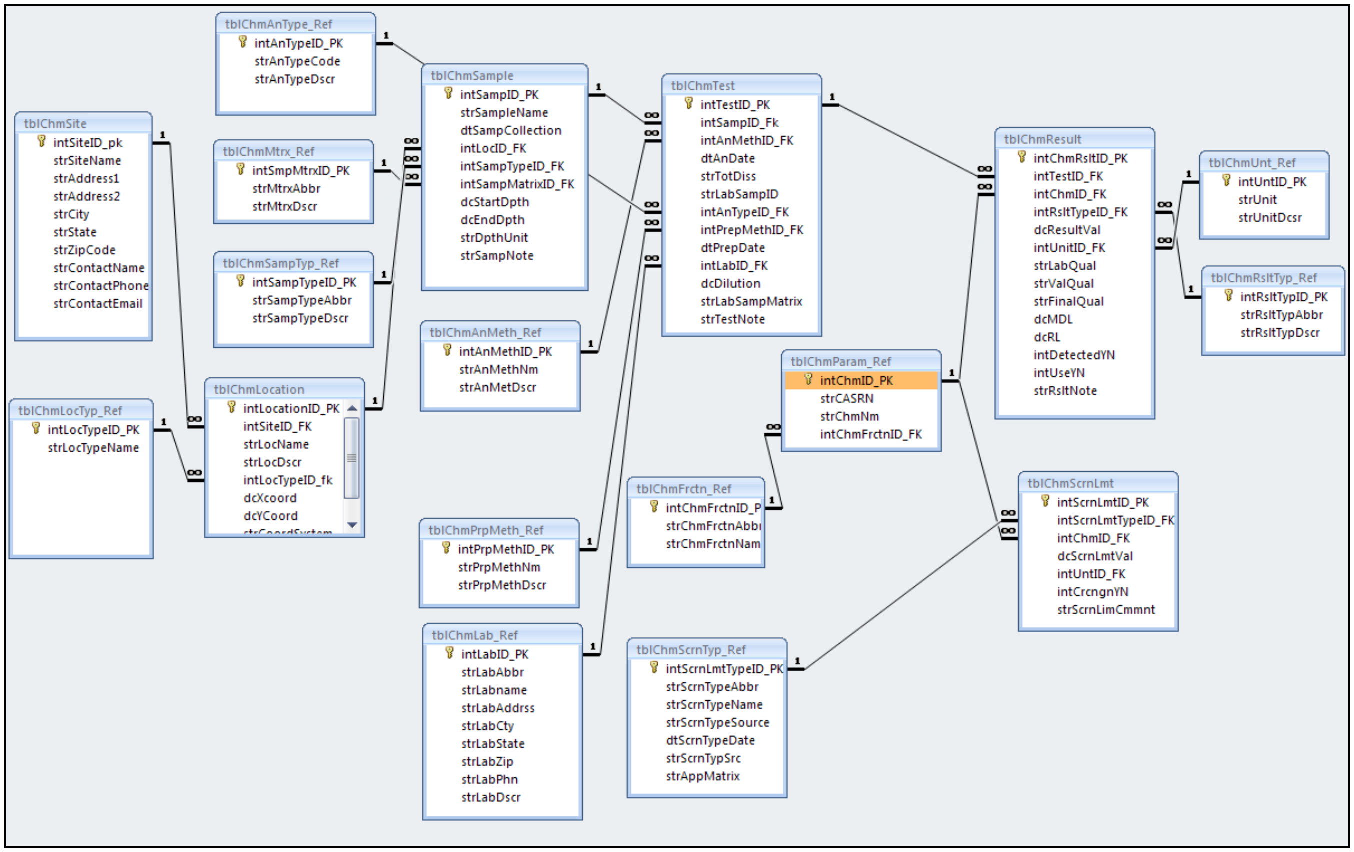

Figure 1. Generic Chemical Database Structure

The list of tables and fields in the generic chemical database is provided in Attachment C to Standard Operating Procedure No. 063.

4.3.3 Commercial and Agency Chemical Data Programs

There are several commercial and agency-specific chemical database programs available. These programs typically consist of a software application and an underlying database. The programs are generally complex and tailored to the needs of the agency that produced them. They require training and the development of staff expertise to use and maintain them.

Some of the commonly encountered chemical database products are:

- Equis®
- Formerly Used Defense Sites Chemical database (FUDSChem) – U.S. Army Corps of Engineers

- Environmental Resources Program Information Management System – Air Force Civil Engineer Center.

- Naval Installation Restoration Information Solution – Navy.

These programs vary greatly in the quality and levels of performance, features, documentation, and technical support. Some programs are free, some require formal registration. The Equis® software products, which are not government agency produced, have become increasingly popular and are in widespread use in many state agencies and U.S. Environmental Protection Agency regions, but are expensive to purchase and maintain.

Some database programs are "closed data source" and do not allow any access to the underlying database except via the software application. The user is limited to the importing, editing, reporting, and analysis features provided by the application. Database programs that provide open access to the database allow other customized tools to be developed and used with the database as a data source.

If a project requires the use of any commercial or agency chemical database programs, the Project Manager must investigate all costs, availability, training, and staffing issues associated with the procurement and use of these programs.

4.4 DATA MAINTENANCE

4.4.1 Database Updates

Many chemical database projects support long-term or periodic sampling programs. The Project Manager and Data Coordinator must plan for tracking and processing of new chemical data, from the laboratory source data to final data storage in the database. Many commercial and agency database programs include import modules to review and process the laboratory data into the database. Generic database systems can also include customized programs to review and process the data.

For large scale projects that may involve the review and processing of many chemical EDD files over time, it is critical to establish a uniform EDD file structure and content with the laboratory. Establishment of a standard, repetitive process for data review and importation will greatly increase the efficiency and quality of final data storage.

Database updates will be performed by the Data Coordinator or DBA.

4.4.2 Corrections and Data Integrity

As data are accumulated and reviewed, errors may be discovered. Depending on the type of error, corrections may be required to the database and to any source data files or documents.

It is of critical importance to maintain a chain of data integrity from the original data source to the database. If transcription errors were made on the chain-of-custody, laboratory report, or laboratory EDD file, the laboratory must be contacted to make the corrections and re-issue the source document or file. Making corrections to the database without notifying the laboratory will create discrepancies between the source data and the database.

Any reports generated from the database may be used for legal purposes and all results must be verifiable against the original source. Most chemical databases include fields to store information on the source of chemical data and, therefore, the database and the original data source must be kept synchronized; a change to the source data or a change to the database must be reflected in both to ensure data integrity.

The roles of Data Coordinator and DBA are designed to address the issues of tracking, coordinating, and documenting any data corrections.

4.4.3 Data Security

Access to the database and the source data must be controlled. There are many options available to protect data, depending on the type of database or data files used. Security guidelines are as follows.

4.4.3.1 Network Security

Most projects have a system of project folders established on a secure network. At a minimum, the chemical data source files and associated database can be organized and stored in folders accessible only to designated project personnel. Original source files must be protected from any modifications, and access to the database should be controlled using internal database security features.

4.4.3.2 Database Security

Many database programs have integrated security systems that allow secure user login and permissions for data operations within the database. Most database systems (generic, commercial, or agency programs) have features to long-in users, and assign editing or read-only permissions to various users. Many “front-end” user programs limit users to the reporting and analysis features only, and allow only assigned DBAs permission to import or edit data within the database.

4.4.3.3 Long-Term Data Storage

Some chemical data projects can be active for many years. At the completion of any project, it is company policy that electronic files will be maintained for 4 years. If the database and associated source EDD files are not part of the client deliverable, the files will eventually be destroyed when the storage time limit is reached.

Refer to the EA Company *Records Retention Policy*.

4.4.3.4 Final Deliverable

Most project plans will clearly state if the database or other data files are part of the final project deliverable. Some clients require only the analysis and reports of the data as the final deliverable, but not the data files. The Project Manager must confirm if any data files are required as a deliverable, and obtain the specifications for the files. In some cases, the client may require the original laboratory EDD files and the final database, or other final deliverable files that are created from the database.

Final deliverable files must be stored or archived in a secure location and are subject to the data storage policies of the company.

4.5 ANALYSIS AND REPORTING SYSTEMS

A database can be used as the source data to satisfy a wide array of analysis and reporting requirements. The Project Manager must define the analysis and reporting objectives. Typically, the requirements consist of report tables, graphs, or data exports. Suggested approaches for addressing those requirements are as follows.

For projects with minimal requirements:

- The DBA can export simple data exports to spreadsheets that allow other users to create tables, charts, and reports from the export.

- The DBA or other programmer can be directly used to create tables, charts, and graphs.

For projects that have complex or long-term requirements, custom programs can be written to allow multiple users to select and create a wide variety of reports, tables, and charts using the database as the data source. This approach is useful for long-term projects that have cyclical reporting of a complex nature. These customized programs allow users to select data by locations, samples, date ranges, analytes to generate reports, tables, graphs, and even support automated document production.

Although programming the analysis and reporting process may not seem to be necessary for some projects, any report, table, or graph produced directly from the database eliminates the possibility of manual typing or transcription errors.

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Attachment B

Generic
Electronic Data Deliverable Structure

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GENERIC ELECTRONIC DATA DELIVERABLE STRUCTURE

Laboratories are able to create a wide variety of electronic data deliverables from the Laboratory Information Management Systems. Many have default electronic data deliverables structures if one is not specified by the laboratory client. A generic electronic data deliverable structure is presented below that will serve most chemical data projects.

Column		Description	Column Name	Column Type
1	Field Sample Name	Name of sample as recorded on the chain-of-custody.	Fld_Samp_Name	Text
2	Sample Date/Time	Date (and time) of sample collection in field.	Fld_Samp_Date	Date/time
3	Lab Sample Identification	Laboratory sample identifier.	Lab_Samp_ID	Text
4	Lab Sample Matrix	Sample matrix, as assigned by the laboratory. Laboratories use a generic code to designate solid or liquid, and do not code for detailed matrix types such as groundwater, surface water, wastewater, etc.	Lab_Samp_Matrix	Text
5	Lab Sample Type	Sample type as assigned by the laboratory to identify laboratory quality control samples such as duplicates, matrix spike, and matrix spike duplicate. Laboratories should be blind to field blanks and field quality control samples.	Lab_Samp_Type	Text
6	Prep Method	Sample Preparation method code.	Prep_Method	Text
7	Prep Date/time	Sample Preparation date (and time).	Prep_Date	Date/time
8	Analysis Method	Sample Analysis method code.	An_Method	Text
9	Analysis Date/Time	Sample Analysis date (and time).	An_Date	Date/time
10	Analysis Type	Analysis Type such as normal, dilution, and re-analysis.	An_Type	Text
11	Total or Dissolved	Used to designate total or dissolved chemicals, usually metals in water samples.	Tot_Diss	Text
12	CAS Number	Chemical Abstracts Service (CAS) unique identifier for chemical. Some parameters such as total organic carbon, chemical oxygen demand, and oxidation reduction potential will not have CAS numbers.		Text
13	Chemical Name	Standard chemical name of analyte.	Chem_Name	Text
14	Result Value	Analysis result value, usually a concentration.	Res_Value	Number
15	Units	Result units of measure.	Res_Units	Text
16	Lab Qualifier	Laboratory assigned qualifier to the result, used to indicate details about the result. A "U" qualifier generally indicates a non-detected result.	Lab_Qual	Text
17	Method Detection Limit	The laboratory determined limit of detection for the given method, matrix, and analyte. The Method Detection Limit is generally 3-5 times lower than the Reporting Limit.	Method Detection Limit	Number
18	Reporting Limit	The laboratory Reporting Limit of detection for the given method, matrix, and analyte. The Reporting Limit is generally 3-5 times higher than the Method Detection Limit.	Reporting Limit	Number
19	Lab Name	Name or Code to identify laboratory.	LabID	Text
20	Validation Qualifier	Used for validated electronic data deliverable data only. The validation qualifier is used to flag results that do not pass the validation review, or to correct laboratory qualifiers.	Val_Qual	Text

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Attachment C

Generic Chemical Database Structure and Data Dictionary

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GENERIC CHEMICAL DATABASE STRUCTURE AND DATA DICTIONARY

The generic database was created using Microsoft Access, but can be scaled up for use on larger database systems, such as Microsoft SQL Server.

The tables and fields are defined in the following data dictionary.

tblChmAnMeth_Ref: Reference list of analysis methods, such as SW-8260, SW-8270

Name	Type	Size	Description
intAnMethID_PK	Long Integer	4	unique ID
strAnMethNm	Text	50	method name
strAnMetDscr	Text	50	method description

tblChmAnType_Ref: Reference list of analysis codes, used to sample designate tests as initial, re-analysis, dilution, etc.

Name	Type	Size	Description
intAnTypeID_PK	Long Integer	4	unique ID
strAnTypeCode	Text	255	Analysis type code, such as IN, DL, RE
strAnTypeDscr	Text	255	Analysis type description

tblChmFrctn_Ref: Reference list of chemical fractions used to group the chemical parameter list by VOA, SVOA, METALS, etc.

Name	Type	Size	Description
intChmFrctnID_PK	Long Integer	4	unique ID
strChmFrctnAbbr	Text	10	Analysis fraction (method group), such as VOA, SVOA, etc.
strChmFrctnName	Text	50	Analysis fraction description

tblChmLab_Ref: Reference list of laboratories, with lab contact information

Name	Type	Size	Description
intLabID_PK	Long Integer	4	unique ID
strLabAbbr	Text	10	short code for lab
strLabname	Text	50	long name of lab
strLabAddrss	Text	50	lab address
strLabCty	Text	50	lab city
strLabState	Text	50	lab state
strLabZip	Text	50	lab zip code
strLabPhn	Text	50	lab phone
strLabDscr	Text	255	lab fax

tblChmLocation: List of sampling locations including location coordinates.

Name	Type	Size	Description
intLocationID_PK	Long Integer	4	unique ID
intSiteID_FK	Long Integer	4	assigned site
strLocName	Text	255	location name
strLocDscr	Text	255	location description
intLocTypeID_fk	Long Integer	4	assigned location type (well, boring, vapor point, etc.)
dcXcoord	Double	8	x-location coordinate
dcYCoord	Double	8	y-location coordinate
strCoordSystem	Text	255	standard coordinate system
dcZcoord	Double	8	z-location coordinate (elevation)

tblChmLocType_Ref: List of sampling locations types, such as wells, borings, vapor point, etc.

Name	Type	Size	Description
intLocTypeID_PK	Long Integer	4	unique ID
strLocTypeName	Text	255	Location type name (monitor well, discharge point, etc.

tblChmMtrx_Ref: List of sampling locations types, such as wells, borings, vapor point, etc.

Name	Type	Size	Description
intSmpMtrxID_PK	Long Integer	4	unique ID
strMtrxAbbr	Text	5	short code for matrix (GW, SO, SS, SED, etc.)
strMtrxDscr	Text	70	matrix description

tblChmParam_Ref: List of chemical analytes, and other parameters such as DO, ORP, turbidity.

Name	Type	Size	Description
intChmID_PK	Long Integer	4	unique ID
strCASRN	Text	20	CAS registry number
strChmNm	Text	100	parameter name
intChmFrctnID_FK	Long Integer	4	assigned chemical fraction

tblChmPrepMeth_Ref: Reference list of preparation methods, such as SW-5030, etc.

Name	Type	Size	Description
intPrpMethID_PK	Long Integer	4	unique ID
strPrpMethNm	Text	50	method name
strPrpMethDscr	Text	255	method description

tblChmResult: Chemical analysis results for sample tests

Name	Type	Size	Description
intChmRsltID_PK	Long Integer	4	unique ID
intTestID_FK	Long Integer	4	assigned test identifier
intChmID_FK	Long Integer	4	assigned chemical or parameter ID
intRsltTypeID_FK	Long Integer	4	assigned result type (target, surrogate, normal)
dcResultVal	decimal	4	analysis result value
intUnitID_FK	Long Integer	4	assigned result unit (mg/L, ug/kg, etc.)
strLabQual	Text	10	laboratory result qualifier
strValQual	Text	10	validation result qualifier
strFinalQual	Text	10	final result qualifier
dcMDL	Double	8	method detection limit
dcRL	Double	8	reporting detection limit
intDetectedYN	Integer	2	detect/non-detect flag (yes/no)
intUseYN	Integer	2	reportable/ useable result flag (yes/no)
strRsltNote	Text	255	result note

tblChmResultType_Ref: List of analysis result types (TIC, Surrogate, normal)

Name	Type	Size	Description
intRsltTypID_PK	Long Integer	4	unique ID
strRsltTypAbbr	Text	10	result type code (TIC, SURR, N)
strRsltTypDscr	Text	50	description (tentatatively identified compound, surrogate, etc.)

tblChmSample: List of analysis result types (TIC, Surrogate, normal)

Name	Type	Size	Description
intSampID_PK	Long Integer	4	unique ID
strSampleName	Text	255	field sample name
dtSampCollection	Date/Time	8	date/time of sample collection
intLocID_FK	Long Integer	4	assigned location ID
intSampTypeID_FK	Long Integer	4	assigned sample type ID
intSampMatrixID_FK	Long Integer	4	assigned sample matrix ID
dcStartDpth	Double	8	sample start depth
dcEndDpth	Double	8	sample end depth
strDpthUnit	Text	255	depth unit (feet, meters, etc.)
strSampNote	Text	255	sample note

tblChmSampleType_Ref: List of sample types (normal, field duplicate, trip blank, etc.)

Name	Type	Size	Description
intSampTypeID_PK	Long Integer	4	unique ID
strSampTypeAbbr	Text	10	sample type code (N, FB, TB, etc.)
strSampTypeDscr	Text	255	description

tblChmScreenLmt: regulatory limit values, per chemical

Name	Type	Size	Description
intScrnLmtID_PK	Long Integer	4	unique ID
intScrnLmtTypeID_FK	Long Integer	4	assigned screen limit type ID
intChmID_FK	Long Integer	4	assigned parameter ID
dcScrnLmtVal	Decimal	16	screening limit value
intUntID_FK	Long Integer	4	assigned unit ID
intCrcngnYN	Byte	1	carcinogen yes/no
strScrnLimCmmnt	Text	50	screen limit note

tblChmScrnType_Ref: type of limit, such as Federal MCL, regional PRGS, etc.

Name	Type	Size	Description
intScrnLmtTypeID_PK	Long Integer	4	unique ID
strScrnTypeAbbr	Text	20	short code for limit type
strScrnTypeName	Text	75	long name of limit type
strScrnTypeSource	Text	255	limit source, such as document or web site.
dtScrnTypeDate	Date/Time	8	limit issue/ effective date
strScrnTypSrc	Text	250	limit source, such as document or web site.
strAppMatrix	Text	255	applicable matrices for limit type

tblChmSite: Stores list of sites, for projects that may have sample locations at multiple sites defined in the project.

Name	Type	Size	Description
intSiteID_pk	Long Integer	4	unique ID
strSiteName	Text	255	site name
strAddress1	Text	255	site address 1
strAddress2	Text	255	site address 2
strCity	Text	255	site city
strState	Text	255	site state
strZipCode	Text	255	site zip code
strContactName	Text	255	site contact person name
strContactPhone	Text	255	site contact person phone
strContactEmail	Text	255	site contact person e-mail

tblChmTest: Sample test, consists of sample ID, analysis and prep method, analysis date, and other testing information.

Name	Type	Size	Description
intTestID_PK	Long Integer	4	unique ID
intSampID_Fk	Long Integer	4	assigned sample ID
intAnMethID_FK	Long Integer	4	assigned analysis method ID
dtAnDate	Date/Time	8	analysis date
strTotDiss	Text	1	total or dissolved method (for metals)
strLabSampID	Text	255	laboratory sample name
intAnTypeID_FK	Long Integer	4	analysis type ID
intPrepMethID_FK	Long Integer	4	preparation method ID
dtPrepDate	Date/Time	8	preparation date
intLabID_FK	Long Integer	4	laboratory ID
dcDilution	Double	8	dilution factor
strLabSampMatrix	Text	255	laboratory matrix code (usually W or S)
strTestNote	Text	255	test note

tblChmUnit_Ref: list of result units

Name	Type	Size	Description
intUntID_PK	Long Integer	4	unique ID
strUnit	Text	20	unit (mg/L, ug/kg, etc.)
strUnitDcsr	Text	100	description

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Standard Operating Procedure No. 064
Sediment Boring Logs

Prepared by

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Revision No. 1
March 2020

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 064	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	March 2020	Systematic Review and Update	Caryn Kiehl-Simpson, Jesse Drummond	Matthew Bowman

LIST OF FIGURES

LIST OF TABLES

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1. INTRODUCTION

This Standard Operating Procedure (SOP) describes EA Engineering, Science, and Technology, Inc., PBC's (EA's) standard format for the completion of sediment boring logs. Applicable sample collection techniques considered for this SOP include traditional/sonic drill rig, sediment corers (manual, piston, vibracore, etc.), or grab type (Van Veen, Ponar, Peterson, etc.) sampling equipment. Adherence to a standard log format is necessary to ensure completeness of the log and to facilitate the comparison and correlation of logs completed by different personnel.

Project-specific plans will supplement and may modify this standard format. Generally, elements of a project-specific plan that modify and supersede the standard format are identified as such in the Project Plan. EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols that contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare both EA's and the client's protocols. The goal is to provide the client with the highest quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those specific protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

A pre-mobilization conference is generally held to ensure that all personnel understand the project objectives and protocols. During the pre-mobilization conference, the Project Manager and/or Principal Investigators will review the project plans and discuss their impact or lack thereof on EA's SOPs. Prior to the pre-mobilization conference, the field geologist/engineer must develop a thorough understanding of all project-specific plans, as well as EA's SOPs, for the planned field activities. This should ensure that any potential conflicts can be resolved before initiating work.

An EA geologist/engineer shall be present on each operating drill rig or sampling vessel and will be responsible for ensuring the proper equipment is onsite (Attachment A), logging of samples, monitoring of sampling operations, recording of relevant field conditions, and preparing the boring logs. Attachment B provides a checklist of field geologist/engineer activities during sampling. Each geologist/engineer shall have a copy of the Sampling Plan and the approved Safety and Health Plan onsite.

Figure 1 illustrates the standard form for sediment boring logs. Examples of completed logs for a drilling, core, or grab sample are provided in Figures 2 through 4. Logs shall be recorded directly on the standard forms in the field without transcribing from a field logbook or other documents. This procedure reduces offsite work hours for the field geologist/engineer, reduces the potential for errors of manual copying, and allows the completed document to be field reviewed closer to the time of collection.

2. PURPOSE

This SOP provides requirements, guidelines, and general information to consider in the planning, development, and collection of a sediment sample via drilling, core, or grab. It will provide guidance on:

- Standard log completion
- Soil/sediment classification
- Field condition assessment
- Documentation requirements.

3. SCOPE

The requirements and guidelines are applicable to all sediment site investigation projects with soil/sediment characterization components.

4. DEFINITIONS

Drilling—For purposes of this SOP, a boring generally refers to a sediment sample location where a drill rig is employed for sample collection. However, the term "boring log" is used to describe the documentation collected and standard form used at all sediment sampling locations independent of the sample collection method.

Core—Sediment cores provide a cross section of site sediment and allow for vertical delineation of site parameters. Core samples can be collected through a variety of methods such as manual coring, piston coring, and vibracoring. Core tubes may include a flexible or rigid liner that can be extracted for visual observation and/or subsampling.

Grab—Grab samplers are typically used for collecting surface sediments. Grab samplers can provide a horizontal delineation of surficial materials or can be subsampled with core tubes or other subsampling equipment.

5. PROCEDURE

A boring log is completed for all sediment borings collected for site characterization purposes and projects with sediment characterization components. All items are completed in the field by the responsible geologist/engineer. The first line of the log shall be completed to indicate the: **Client and Project Name**, assigned **Location/Boring Name**, and **page number and total number of pages**.

The upfront section of the log includes information on the sample location, sampling equipment and methodology, surface conditions, and other general information on Location/Boring that may be useful for interpreting results. Following the general information section of the log is the

Description of Materials section. This portion of the log is designed to collect required information on sediment characteristics and sediment classification.

5.1 GENERAL INFORMATION PORTION OF SEDIMENT BORING LOG

The items listed below follow the field numbering and categories as presented on the sediment boring log template (Figure 1).

1. ***Geologist Name/Signature***—The field geologist/engineer completing the log shall sign his/her full name on the first page of the log for each boring in a clear and legible fashion. Initials will suffice on succeeding pages of the log. The signature/initials are placed upon completion of each page of the log as certification of the accuracy and completeness of the log by the field geologist/engineer. In the event there is a personnel change prior to completion of the boring log, personnel involved, date, and time (24-hour clock) of change shall be documented in the descriptive portion of the log at the depth where the change occurred.

2. ***Drilling Subcontractor/Equipment Operator***—The full name (legal, business name) of the drilling/sampling company shall be placed on the first page of the log for each boring. For projects where a regulatory agency or EA personnel are operating the sampling equipment, Item 2 shall be completed with the name of the Equipment Operator (e.g., “EPA GLNPO Mudpuppy” or “EA”). Any change shall be documented as per Item 1.

3. ***Operator Name and License (if required)***—The full name of the individual operating the sampling equipment shall be placed on the first page of the log for each boring. In states that require a licensed driller for the type of work in progress, the driller’s license number shall also be placed on Line 3 of the first page of the log for each boring. Any change shall be documented as per Item 1.

4. ***Sampling Equipment and Methodology***—The drilling/sampling equipment and methodology shall be summarized on the first page of each boring log (and continued on succeeding pages as necessary). Record the type of sediment sampler used (drill rig, core, manual, and grab sampler) and any modifications made to the sampler.

    - ***Drill Rig Borings***—Record the barrel length, diameter, and sample interval. The field logbook should include general information on the drill rig manufacturer and model. Note such information as rod size, bit type and size, internal and external diameter of hollow stem augers, pump or compressor size, etc.

    - ***Core Samples***—Record the length and diameter of the core barrel and circle the type of corer used.

    - ***Grab Samplers***—Record the dimensions of the grab sampler and circle the type of grab sampler used (Van Veen, Ponar, Peterson, etc.).

- ***Other***—Use the other row to indicate alternative sampling equipment.

- ***Sampling Methodology***—Indicate the sample collection methodology intended for the core section. The method(s) for obtaining samples and subsamples shall be identified on the first page of each boring log (and continued on succeeding pages as necessary). For drilling operations, the citation of ASTM International designations on this portion of the log constitutes the field geologist/engineer's certification that the ASTM International standard was met.

5. ***Project Number***—EA's alpha-numeric job code shall be indicated on each page of each boring log.

6. ***Coordinate System***—Both horizontal (H) and vertical (V) control data shall be indicated on the first page of the log.

7. ***Latitude/Northing/Grid***—Coordinates of latitude/northing/grid shall be indicated on the first page of the log for each surveyed boring. This information may be acquired by on-vessel Global Positioning System equipment or a site survey if sediment sampling is occurring in a marsh, shallow stream, or other accessible location. Surveyed information may be added in the office or to a database in the field depending on project requirements. In either case, all quality assurance/quality controls for the survey data must be met. The use of a site datum shall be indicated on the log. If a site grid is utilized, the site grid coordinates shall be indicated on the field log and identified as such.

8. ***Longitude/Easting/Grid***—Coordinates of longitude/easting/grid shall be indicated on the first page of the log for each surveyed boring. This information may be acquired by on-vessel Global Positioning System equipment or a site survey if sediment sampling is occurring in a marsh, shallow stream, or other accessible location. Surveyed information may be added in the office or to a database in the field depending on project requirements. In either case, all quality assurance/quality controls for the survey data must be met. The use of a site datum shall be indicated on the log. If a site grid is utilized, the site grid coordinates shall be indicated on the field log and identified as such.

9. ***Start-Stop (Date/Time)***—The time (24-hour clock) and date drilling/sampling operations begin and end, including grouting or completion of well installation, shall be indicated on the first page of each boring log. The time and date of completion of sampling activities shall be documented in the descriptive portion of the log at the depth of penetration of the last sample or sample attempt. For borings completed in more than 1 day, the time and date drilling operations stop and resume shall be indicated to the descriptive portion of the log at the appropriate depth.

10. ***Sediment Surface Elevation***—The elevation of the sediment surface at the sample location shall be indicated on the first page of each boring log. This information may be acquired using on-vessel equipment or a site survey if sediment sampling is occurring in a marsh, shallow stream, or other accessible location. Sediment surface elevation must

be tied to a coordinate system. Water depth measurements (see Item 11 below) can be used to calculate sediment surface elevations if they are referenced to regulated gauging station and corrected for water level fluctuations. The appropriate gauging station should be identified in the Project Plan. Surveyed information is added or checked as per Item 7.

11. ***Depth of Water (Start)***—The water depth shall be determined and recorded at the beginning of sampling operations.

12. ***Depth of Water (End)***—The water depth shall be determined and recorded at the completion of sampling operations.

13. ***Sunny/Cloudy/Rain***—Surface conditions at the sampling site shall be indicated on the first page of the log and continued on succeeding pages.

14. ***Temperature (Degrees Fahrenheit)***—Air temperature at the sampling site shall be indicated on the first page of the log and continued on succeeding pages. Temperature should be recorded as degrees Fahrenheit.

15. ***Wind Direction***—Wind direction and wind speed at the sampling site shall be indicated on the first page of the log and continued on succeeding pages.

16. ***Total Boring Depth***—The total depth (+0.1feet [ft]) of penetration at the time of the sampling attempt shall be reordered for each sampling attempt. For drilling operations, casing depth shall be no greater than the shallowest portion of the attempted sample interval.

17. ***Recovery Depth***—The total length of recovery should be recorded and the percent recovery should be calculated and indicated on the boring log.

18. ***Location Notes***—Item 18 on the log provides a space for additional observations at a location. These observations may include but are not limited to:

    - A narrative description of problems and their resolutions (e.g., refusal, sample wash-out, hole caving, “running sands,” recurring problems at a particular depth, excessive grout takes, unrecovered tools, casing or screens, etc.)

    - Observations of surface features adjacent to a location (piers, pilings, tributaries, outfalls, etc.)

    - Field measurements collected at the location (e.g., photoionization detector, pH, redox, etc.).

5.2 DESCRIPTION OF MATERIALS

1. All information in the descriptive portion of the log is placed with reference to the depth scale in the **Interval (ft)** column. The field geologist/engineer shall indicate units on the depth in feet scale as appropriate. The sample interval shall be indicated on the left side of the column as shown on Figures 2 through 4.

2. Observations on the length and appearance of recovered cores shall be recorded in the **Recovery (ft & %)** column.

3. During drilling operations (this item does not apply to core or grab samples), for each sediment sampling attempt, the type of sampler shall be indicated at the appropriate depth.

4. For drilling operations (this item does not apply to core or grab samples), the total number of inches the sampler is advanced (actual penetration) into undisturbed sediment and the total number of inches of actual sample recovered shall be recorded for each sampling attempt.

5. For drilling operations between sampling attempts, wash samples, drill, or auger cuttings shall be described as to color and grain size, along with a description of drill action and water loss gains for the corresponding depth. The brand name and amount of any bentonite used for each boring, reason for use, and start (by depth) of this use shall be recorded. A narrative description of the grouting of the bore hole shall be recorded on the boring log (below the depth of completion and/or on succeeding pages).

6. The depth of each significant lithologic change shall be drawn to scale (+ 0.1 ft) on the **Description of Materials** column. Lithology shall be designated by the appropriate Unified Soil Classification System symbol (Attachment C). Changes observed in samples shall be indicated with a solid line. Changes inferred on the basis of cuttings or action of the drill rig shall be indicated with a dashed line on the graphic log and described in the narrative log. Gradational changes shall be indicated by a dashed, diagonal line extending over the depth of the gradational interval.

7. For drilling operations, the number of hammer blows required to advance a split-spoon sampler shall be recorded for each 0.5-ft advance for each sampling attempt. The number of blows and number of inches penetrated for a completed 0.5-ft interval shall be recorded (e.g., 75/3 inches [in.]). The letter "P" shall indicate that the sampler was advanced by the weight of the drill stem or the weight of the drill stem and hammer without driving. For the Standard Penetration Test (and only for the Standard Penetration Test), when less than 18 in. (but greater than 12 in.) are penetrated by a total (maximum allowable) of 100 blows, the number of blows for the last 12 in. of penetration (N) shall also be recorded (e.g., N=63).

8. The vertical location of samples shall be indicated in the **Sample ID Sample Interval** column as shown on Figures 2 through 4.

9. Each core/sample recovered shall be fully described on the log (for the complete depth of sediment collected at a location (i.e., if a 10-ft core was collected, the entire core should be logged including any intervals that were sampled). The descriptions of intact samples shall include in sequence the following:

   - ***Color (e.g., gray or reddish brown)***—Some project plans may specify the use of the Munsell Soil Color Chart or the Geological Society of America Rock Color Chart. If so, the chart shall be identified in the **Description of Materials** and both narrative and numerical descriptions of color shall be recorded in the log.

   - ***Moisture Content (e.g., dry, moist, or wet)***—Below the water table, moisture content is noted only for samples less than completely saturated.

   - ***Unified Soil Classification (e.g., sandy clay)***—Attachment D summarizes the Unified Soil Classification System Field Classification. Additional guidance is provided in Tables 1 and 2.

   - ***Secondary Components (e.g., with some silt)***—Descriptive terms for relative proportions of secondary components are provided in Table 1.

   - ***Unified Soil Classification Symbol (e.g., CL)***—Refer to Attachment D.

   - ***Density (non-cohesive soil) (e.g., medium dense)***—Refer to Table 1.

   - ***Consistency (cohesive soil (e.g., stiff)***—Refer to Table 1.

   - ***Sediment Structure – (e.g., interbedding and lamination)***—Refer to Table 1.

   - ***Other Observations***—Presence of biota or debris, oily sheen, the presence/location/thickness of the redox potential discontinuity layer.

5.1.1 ASTM International Designations D-2487 (2017a) and D-2488 Define Standard Engineering Practice (2017b)

1. Samples that are retained in jars and/or tubes (or other appropriate containers as per the Project Plan) shall be numbered sequentially down the core. Unsuccessful sampling attempts shall not be numbered. For drilling operations, individual samples from one sampler drive shall be numbered individually. The sample number and depth (+ 0.5 ft) of the top of that portion of the sample that is retained shall be recorded for each sample.

Each sample container shall be labeled. The label shall be permanently marked and shall identify the following:

- Client and project name
- Location/boring name
- Collected by
- Date of sample collection.

Chain-of-custody requirements may also apply as per the Project Plan. Containerization and handling of sediment samples scheduled for chemical analysis are defined in the Project Plan.

2. A number of field determinations may be made in the field as per the Project Plan. These include but are not limited to:

   - Sediment temperature
   - Dissolved oxygen concentration in the water column above the sediment surface
   - Salinity or conductivity of the overlying water column
   - Sediment redox potential
   - Pocket penetrometer readings
   - Screening for organic vapors with a photoionization detector or flame ionization detector
   - pH
   - Specific conductance.

   Protocols are established in the Project Plan. As appropriate, the protocol shall be identified in Item 18 and the data recorded in the **Description of Materials** column with reference to the depth scale.

3. Each boring log shall be checked for completeness and edited as appropriate by a qualified geologist or engineer (reviewer) to be assigned by the project manager or Director of Geotechnical Services. The review shall be completed prior to preparation of final boring logs in report format. Editing of sample descriptions and soil classifications shall be performed as appropriate for all samples for which laboratory physical testing (e.g., grain size distribution by sieve and hydrometer) has been performed. Sample descriptions and soil classification shall also be checked by visual examination of jar samples. Typically, a minimum of 25 percent of the jar samples are reviewed. The

reviewer shall initial and date Item 1 (Geologist Name/Signature) of each edited page of the log he/she reviews.

6. DOCUMENTATION

When sampling has been completed, the sampling technician should ship the samples or deliver them to the laboratory in accordance with project procedures. Appropriate sampling documentation should be provided to the project data manager in accordance with applicable project procedures.

7. REFERENCES

ASTM International. 2017a. D-2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). ASTM International, Philadelphia, Pennsylvania.

———. 2017b. D-2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). ASTM International, Philadelphia, Pennsylvania.

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Figures

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LITHOLOGIC LOG *Sediment Collection Log* *EA Engineering, Science, and Technology, Inc., PBC*	Client Name and Project Name	Location/Boring Name	Sheet of

1 Geologist Name/Signature	5 Project Number	8 Start - Stop (Date/Time)
2 Drilling Subcontractor/Equipment Operator	6 Latitude/Northing/Grid	9 Sed Surface Elevation *ft* 10 Coordinate System H V 11 Depth of Water (start) *ft*
3 Operator Name *(License # If Required)*	7 Longitude/Easting/Grid	12 Depth of Water (end) *ft* 13 Sunny/Cloudy/Rain 14 Temperature (start/high) *F*

4 Sampling Equipment and Methodology (Check One)

☐ Rotosonic: ____ -ft barrel ____ -in diameter ________ -ft spoon/sample

☐ Core: ____ -ft barrel ____ -in diameter ________ -VPM Manual/Vibracore/Other

☐ Grab Sample: -ft x -ft x -ft Box/Ponar/Van Veen/Other

☐ Other:

☐ Sample Collection Method:

15 Wind Direction Speed

16 Total Boring Depth *ft*

17 Recovery Depth ft %

18 Location Notes

Interval *(Depth)*	**Recovery** *(ft & %)*	**Description of Materials** Munsell Color; Moisture; Density; Consistency (Other Remarks)	**Sample ID** **Sample Interval**	**PID** *(ppm)*	**USCS** *Code*
1					
2					
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Figure 1. Sediment Boring Log Template

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LITHOLOGIC LOG *Sediment Collection Log* *EA Engineering, Science, and Technology, Inc., PBC*	Client Name and Project Name **GLNPO/Spirit Lake**	Location/Boring Name **GL-DS-01-001**	Sheet **1** of ***1***
1 Geologist Name/Signature **Jaime Smith**	5 Project Number **1234567**	8 Start - Stop (Date/Time) **6/19/14 12:00** **6/19/14 15:00**	
2 Drilling Subcontractor/Equipment Operator **Drill Company A**	6 Latitude/Northing/Grid **649999.89**	9 Sed Surface Elevation **580.018** *ft* 10 Coordinate System H **NAD83** V **NAVD88** 11 Depth of Water (start) **20** *ft*	
3 Operator Name *(License # If Required)* **Joe Smith 08976**	7 Longitude/Easting/Grid **10649999.89**	12 Depth of Water (end) **20** *ft* 13 [✓ Sunny]/Cloudy/Rain 14 Temperature (start/high) **65** *F*	

4 Sampling Equipment and Methodology (Check One)

X Rotosonic: **20** -ft barrel **5** -in diameter **2** [✓ ft spoon]/sample

☐ Core: ___ -ft barrel ___ -in diameter ___ -VPM Manual/Vibracore/Other

☐ Grab Sample: ___ -ft x ___ -ft x ___ -ft Box/Ponar/Van Veen/Other

☐ Other:

☐ Sample Collection Method: **2 ft sample intervals collected from split spoon**

15 Wind Direction Speed **NE**

16 Total Boring Depth **20** *ft*

17 Recovery Depth **20** ft **100** *%*

18 Location Notes **Location was adjacent to a cluster of pilings, just north of West Ditch Tributary.**

Interval *(Depth)*	**Recovery** *(ft & %)*	**Description of Materials** Munsell Color; Moisture; Density; Consistency (Other Remarks)	**Sample ID** **Sample Interval**	**PID** *(ppm)*	**USCS** *Code*
1 (0-3)	2/100%	Strong Brown (7.5YR 5/6); dry; SILT and fine SAND; non-plastic; soft		0.0	ML-SW
2		Poorly graded.		0.1	
3				0.1	
4 (3-5)	2/100%	Brown (7.5YR 4/3); moist; SILT little SAND and CLAY; nonplastic; soft	*GL-DS-01-03-05*	0.0	ML
5		well graded.		0.2	
6 (5-6)	1/100%	Light Greenish Gray (Gley 1 10YR); moist; fine SAND and SILT; nonplastic; med stiff.		0.0	SM
7 (6-10)	4/100%	Dark Greenish Gray (Gley 1 4/1); fine SAND some SILT; m. dense;		0.1	SM
8		well graded.		0.1	
9				0.1	
10				0.1	
11 (10-15)	4/80%	Greenish Gray (Gley 1 6/1); fine SAND some SILT, m. dense; well graded.		0.2	SM-ML
12				0.1	
13			*GL-DS-01-13-14*	4.5	
14		Increasing silt percentage.		0.1	
15				0.1	
16 (15-19)	5/100%	Light Yellowish Brown (2.5Y 6/4) with Light Greenish Gray (Gley 1 10/1)		0.2	CL
17		mottles; CLAY some SILT trace fine SAND; low plasticity; stiff; well graded.		0.1	
18				0.2	
19				0.5	
20			*GL-DS-01-19-20*	1.1	
21		*Total depth = 20 feet below top of surface.*			
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Figure 2. Example Sediment Boring Log for Drilling

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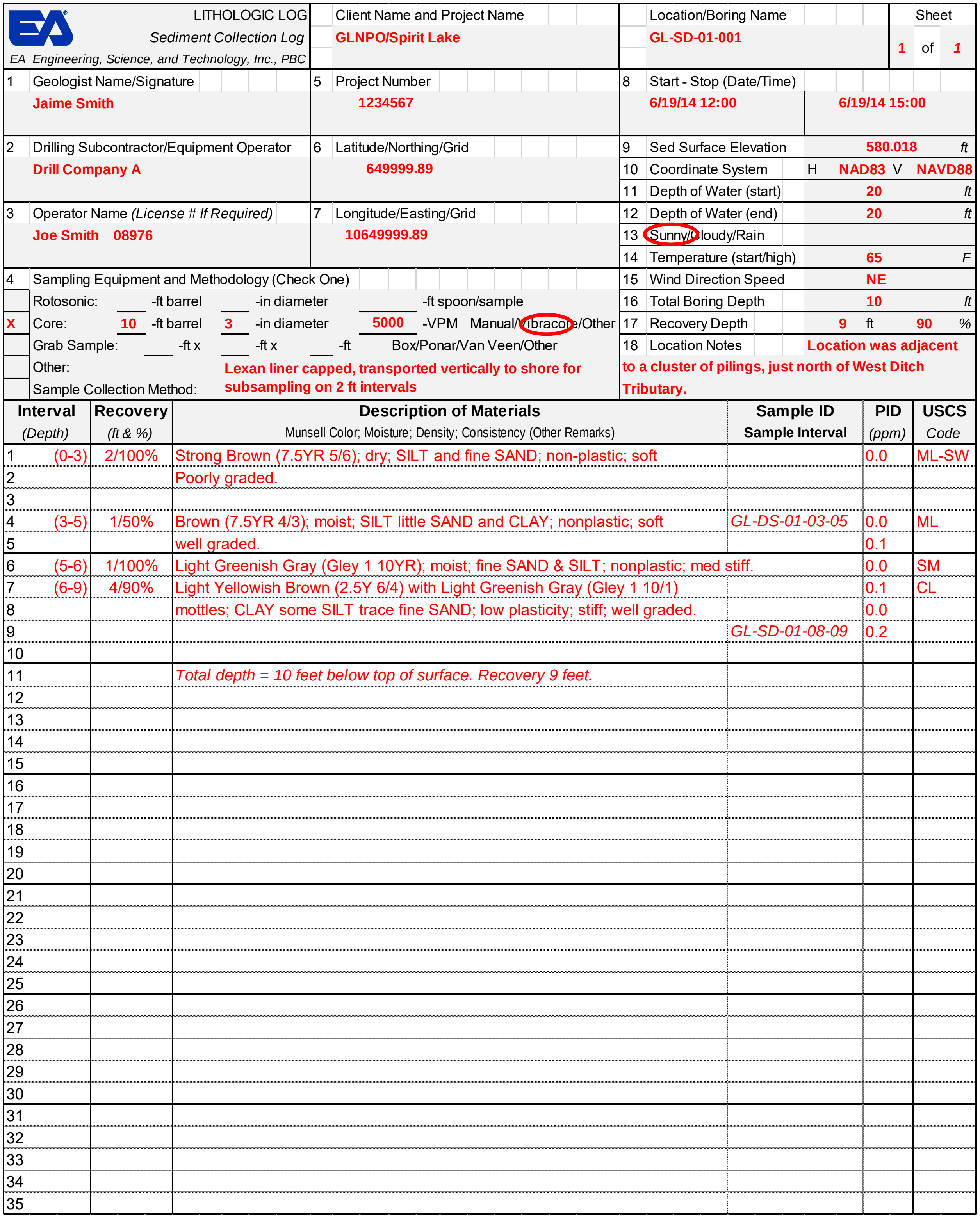

LITHOLOGIC LOG
Sediment Collection Log
EA Engineering, Science, and Technology, Inc., PBC

Client Name and Project Name **GLNPO/Spirit Lake**	Location/Boring Name **GL-SD-01-001**	Sheet **1** of ***1***	
1 Geologist Name/Signature **Jaime Smith**	5 Project Number **1234567**	8 Start - Stop (Date/Time) **6/19/14 12:00**	**6/19/14 15:00**
2 Drilling Subcontractor/Equipment Operator **Drill Company A**	6 Latitude/Northing/Grid **649999.89**	9 Sed Surface Elevation	**580.018** *ft*
		10 Coordinate System	H **NAD83** V **NAVD88**
		11 Depth of Water (start)	**20** *ft*
3 Operator Name *(License # If Required)* **Joe Smith 08976**	7 Longitude/Easting/Grid **10649999.89**	12 Depth of Water (end)	**20** *ft*
		13 [✓ Sunny]/Cloudy/Rain	
		14 Temperature (start/high)	**65** *F*

4 Sampling Equipment and Methodology (Check One)

	Rotosonic: ___ -ft barrel ___ -in diameter ___ -ft spoon/sample	15 Wind Direction Speed	**NE**
X	Core: **10** -ft barrel **3** -in diameter **5000** -VPM Manual/[✓ Vibracore]/Other	16 Total Boring Depth	**10** *ft*
	Grab Sample: ___ -ft x ___ -ft x ___ -ft Box/Ponar/Van Veen/Other	17 Recovery Depth	**9** ft **90** %
	Other: **Lexan liner capped, transported vertically to shore for**	18 Location Notes	**Location was adjacent to a cluster of pilings, just north of West Ditch Tributary.**
	Sample Collection Method: **subsampling on 2 ft intervals**		

Interval *(Depth)*	**Recovery** *(ft & %)*	**Description of Materials** Munsell Color; Moisture; Density; Consistency (Other Remarks)	**Sample ID** **Sample Interval**	**PID** *(ppm)*	**USCS** *Code*
1 (0-3)	2/100%	Strong Brown (7.5YR 5/6); dry; SILT and fine SAND; non-plastic; soft		0.0	ML-SW
2		Poorly graded.			
3					
4 (3-5)	1/50%	Brown (7.5YR 4/3); moist; SILT little SAND and CLAY; nonplastic; soft	*GL-DS-01-03-05*	0.0	ML
5		well graded.		0.1	
6 (5-6)	1/100%	Light Greenish Gray (Gley 1 10YR); moist; fine SAND & SILT; nonplastic; med stiff.		0.0	SM
7 (6-9)	4/90%	Light Yellowish Brown (2.5Y 6/4) with Light Greenish Gray (Gley 1 10/1)		0.1	CL
8		mottles; CLAY some SILT trace fine SAND; low plasticity; stiff; well graded.		0.0	
9			*GL-SD-01-08-09*	0.2	
10					
11		*Total depth = 10 feet below top of surface. Recovery 9 feet.*			
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15					
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17					
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Figure 3. Example Sediment Boring Log for Core Samples

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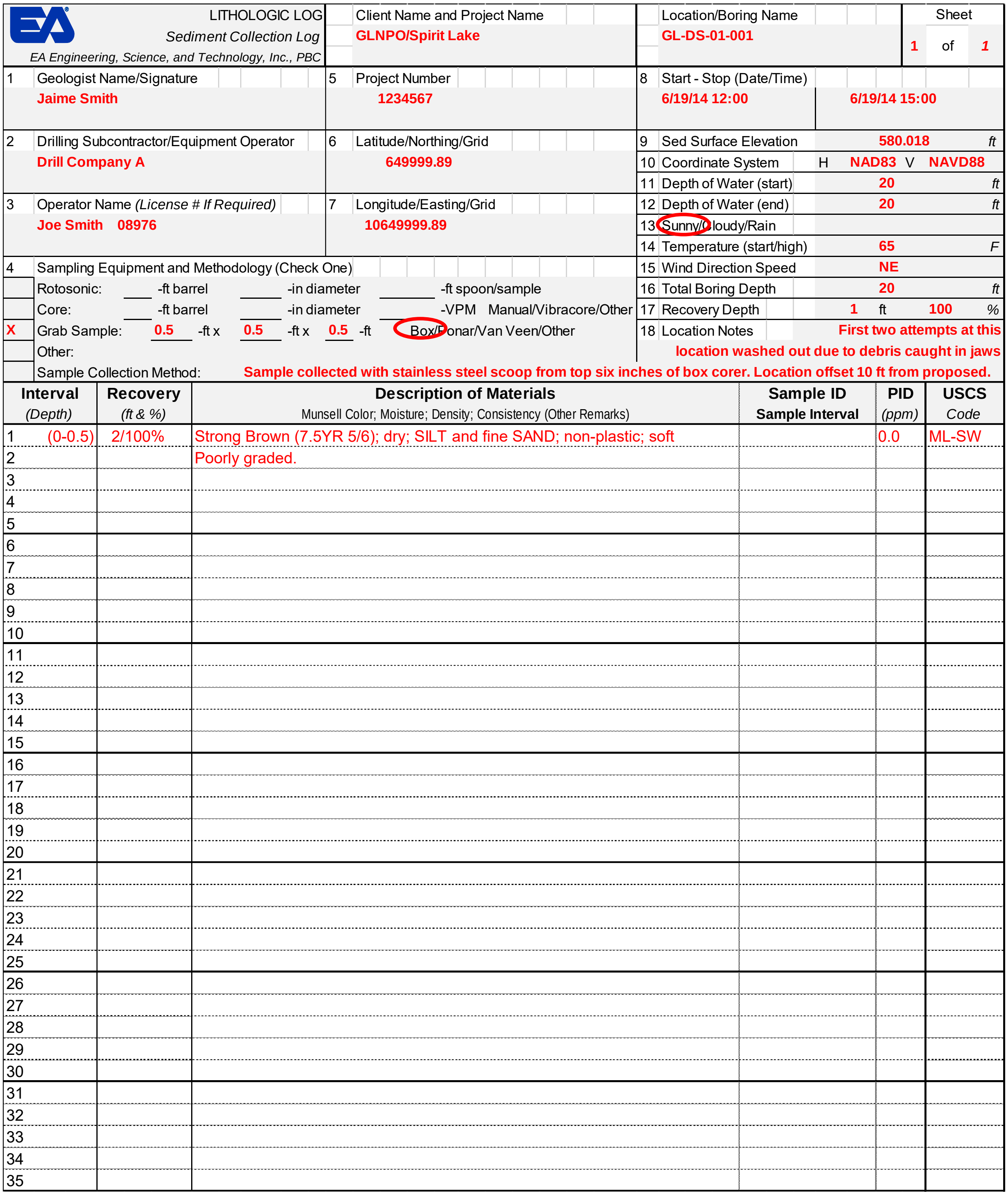

LITHOLOGIC LOG *Sediment Collection Log* *EA Engineering, Science, and Technology, Inc., PBC*	Client Name and Project Name **GLNPO/Spirit Lake**	Location/Boring Name **GL-DS-01-001**	Sheet **1** of ***1***

1 Geologist Name/Signature **Jaime Smith**	5 Project Number **1234567**	8 Start - Stop (Date/Time) **6/19/14 12:00** **6/19/14 15:00**
2 Drilling Subcontractor/Equipment Operator **Drill Company A**	6 Latitude/Northing/Grid **649999.89**	9 Sed Surface Elevation **580.018** *ft* 10 Coordinate System H **NAD83** V **NAVD88** 11 Depth of Water (start) **20** *ft*
3 Operator Name *(License # If Required)* **Joe Smith 08976**	7 Longitude/Easting/Grid **10649999.89**	12 Depth of Water (end) **20** *ft* 13 [✓ Sunny]/Cloudy/Rain 14 Temperature (start/high) **65** *F*

4 Sampling Equipment and Methodology (Check One)
☐ Rotosonic: ___ -ft barrel ___ -in diameter ___ -ft spoon/sample
☐ Core: ___ -ft barrel ___ -in diameter ___ -VPM Manual/Vibracore/Other
X Grab Sample: **0.5** -ft x **0.5** -ft x **0.5** -ft [✓ Box]/Ponar/Van Veen/Other
☐ Other:
☐ Sample Collection Method: **Sample collected with stainless steel scoop from top six inches of box corer. Location offset 10 ft from proposed.**

15 Wind Direction Speed **NE**
16 Total Boring Depth **20** *ft*
17 Recovery Depth **1** ft **100** %
18 Location Notes **First two attempts at this location washed out due to debris caught in jaws**

Interval *(Depth)*	**Recovery** *(ft & %)*	**Description of Materials** Munsell Color; Moisture; Density; Consistency (Other Remarks)	**Sample ID** **Sample Interval**	**PID** *(ppm)*	**USCS** *Code*
1 (0-0.5)	2/100%	Strong Brown (7.5YR 5/6); dry; SILT and fine SAND; non-plastic; soft		0.0	ML-SW
2		Poorly graded.			
3					
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Figure 4. Example Sediment Boring Log for Grab Samples

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Tables

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Table 1 Field Application of Unified Soil Classification System

Description Order	
(Depth Interval) Color (Munsell); Moisture; Principal components with descriptors; Minor Components with descriptors; Sorting; Density/Consistency	
Separate each description using a semicolon;	*Constituents should be capitalized (i.e., SILT, CLAY, SAND, etc.)*

Moisture:	**Dry** – Absence of moisture, dry to touch, dusty.	**Moist** – No visible moisture, not dry.	**Wet** – Visible free water (typically saturated).

Minor Component Percentages:	0-10% *(Trace)*; 10-20% *(Little)*; 20-35% *(Some)*; 36-50% *(And)*.

COARSE-GRAINED SOILS

Symbol	*Grain Size*	*Primary*	*Fines*	*Grading*	*Clean/Fines*	*Description*
GW	Coarse	Gravels	Little-None	Well	Clean	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
GP	Coarse	Gravels	Little-None	Poor	Clean	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
GM	Coarse	Gravels	Some Silt	Poor	Fines	Silty gravels, gravel-sand-silt mixtures.
GC	Coarse	Gravels	Some Clay	Poor	Fines	Clayey gravels, gravel-sand-clay mixtures.
SW	Coarse	Sands	Little-None	Well	Clean	Well graded sands, gravelly sands.
SP	Coarse	Sands	Little-None	Poor	Clean	Poorly graded sands, gravelly sands.
SM	Coarse	Sands	Some Silt	Poor	Fines	Silty sands, sand-silt mixtures.
SC	Coarse	Sands	Some Clay	Poor	Fines	Clayey sands, sand-clay mixtures.

Density:	Very Loose	N<4	Loose	5<N<10	Medium Dense	11<N<30	Dense	30<N<50	Very Dense	50<N

FINE-GRAINED SOILS

Symbol	*Grain Size*	*Primary*	*Strength*	*Dilatency*	*Plasticity*	*Consistency*	*Description*
ML	Fine	Silt	None-Slight	Slow Quick	Low	V. Soft-Soft	Inorganic silts, clayey silts of low-med plasticity.
CL	Fine	Clay	Med-High	None V. Slow	Low	M. Stiff-Stiff	Inorganic clays of low-med plasticity (gravelly/sandy/silty clays).
MH	Fine	Organic	Slight-Med	Slow Quick	Low	Soft-M. Stiff	Inorganic silts, micaceous/diatomaceous silty soils, elastic silts.
OL	Fine	Organic	Slight-Med	None Slow	Low	Soft-Stiff	Organic silts/clays of low-med plasticity, sandy organic silts/clays.
CH	Fine	Clay	High-V.High	None	High	Stiff-Hard	Inorganic or sandy clays of high plasticity, fat clays.
OH	Fine	Organic	Med-High	None V. Slow	High	M. Stiff-Hard	Organic silts/clays of high plasticity; sandy organic silts/clays.
Pt	Fine	Peat	Odor and spongy and fibrous texture			Not Applicable	Peat.

Plasticity:	
Non-	3-millimeter thread cannot be rolled at any moisture content.
Low	Thread barely rolled; lump cannot form below plastic limit.
Med-	Barely able to be rolled; lump cannot form below plastic limit.
High	Thread is easy to roll; lump formed without crumbling.

Consistency:		
Very Soft	N<2	Easily penetrated several inches by thumb.
Soft	2<N<4	Easily penetrated 1 inch by thumb.
Medium Stiff	5<N<8	Thumb penetrates 0.5 inches with difficulty.
Stiff	9<N<15	Thumb penetrates 0.25 inches with difficulty.
Very Stiff	16<N<30	Indented readily by thumbnail.
Hard	30<N	Indented with difficulty by thumbnail.

SEDIMENT STRUCTURE

30-100 centimeters = Thickly bedded	1-3 centimeters = Very thinly bedded
10-30 centimeters = Medium bedded	3-10 millimeters = Thickly laminated
3-10 centimeters = Thinly bedded	<3 millimeters = Thinly laminated

Dilatency	
None	Water not observed when shaken/squeezed.
Slow	Water appears/disappears slowly when shaken/squeezed.
Rapid	Water appears/disappears quickly when shaken/squeezed.

Examples	
(10-20) Brown (7.5YR 4/3); moist; SILT little SAND and CLAY; non-plastic; soft; well graded.	*ML*
(20-30) Strong Brown (7.5YR 5/6); dry; fine SAND; dense; well graded.	*SW*

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Table 2 Comparison of Grain Size Scales for Sediments

Grade Limits		U.S. Standard Sieve Sizes	Grain Size Classification System				
Millimeters (mm)	Inches		Modified Wentworth			Unified Soil Classification System	
4096	161.3	---		Boulders	Gravel	Boulders (greater than 300 mm)	
			Very large				
2048	80.6	---					
			Large				
1024	40.3	---					
			Medium				
512	20.2	---					
			Small				
256	10.1	---				Cobbles (75-300 mm)	
			Large	Cobbles			
128	5.0	---					
			Small				
64	2.52	63 mm		Pebbles		Coarse Gravel (19-75 mm)	Gravel (4.75 mm No. 4 sieve to 75 mm)
			Very Coarse				
32	1.26	31.5 mm					
			Coarse			Fine Gravel (4.75 mm No. 4 sieve to 19 mm)	
16	0.63	16 mm					
			Medium				
8	0.32	8 mm					
			Fine				
4	0.16	No. 5				Coarse Sand (2.0 mm No. 10 sieve to 4.75 mm No. 4 sieve)	Sand (0.075 mm No. 200 sieve to 4.75 mm No. 4 sieve)
			Very Fine				
2	0.08	No. 10		Sand	Sand		
			Very Coarse			Medium Sand (0.425 mm No. 40 sieve to 2.0 mm No. 10 Sieve)	
1	0.04	No. 18					
			Coarse				
1/2 or 0.500	---	No. 35					
			Medium				
1/4 or 0.250	---	No. 60				Fine Sand (0.075 mm No. 200 sieve to 0.425 mm No. 40 sieve)	
			Fine				
1/8 or 0.125	---	No. 120					
			Very fine			Silt (no specific grain size use Atterberg Limits)	Fines (less than 0.075 mm No. 200 sieve)
1/16 or 0.062	---	No. 230					
			Coarse	Silt	Mud		
1/32 or 0.031	---	---					
			Medium				
1/64 or 0.016	---	---					
			Fine				
1/128 or 0.008	---	---					

Grade Limits		**U.S. Standard Sieve Sizes**	**Grain Size Classification System**				
Millimeters (mm)	**Inches**		**Modified Wentworth**			**Unified Soil Classification System**	
			Very Fine				
1/256 or 0.004	---	---					
			Coarse	Clay Size		Clay (no specific grain size use Atterberg Limits)	
1/512 or 0.002	---	---					
			Medium				
1/1024or 0.001	---	---					
			Fine				
1/2048 or 0.0005	---	---					
			Very Fine				
1/4096 or 0.00025	---	---					

Attachment A

Equipment that May Be Required for Core Logging

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ATTACHMENT A

EQUIPMENT THAT MAY BE REQUIRED FOR CORE LOGGING

- Sample Location Coordinates and Figure
- Safety Equipment
- Global Positioning System
- Pencil
- Log of Core Boring Forms
- Notebook
- Hand lens
- Geologist's pick
- Knife
- Needle
- Magnet
- Core splitter
- Ruler (graduated in tenths of a foot)
- Steel tape (graduated in tenths of a foot)
- Tape recorder
- Camera
- Clinometer/protractor
- Waterproof marking pen (for core boxes)
- Assisting muscle power (to move core boxes)
- Guides (Logging, Grain Size, Munsell Color)

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Attachment B

Checklist for Sediment Boring Log

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ATTACHMENT B

CHECKLIST FOR SEDIMENT BORING LOG[1]

The Sediment Boring Log should include the following items:

- Project Name/Number
- Project Location
- Client
- Date/Time Collected
- Drilling/Sampling Contractor (Company and name of Team Member)
- Drilling/Sampling Equipment
- Drilling/Sampling Method
- Person completing the log
- Sample Coordinates
- Sediment Surface Elevation
- Surface Conditions
- Water Depth
- Penetration Depth
- Sample Recovery Depth
- Field Measurements (collected during boring)
- Information as to location and possible cause of core losses
- Details of delays and breakdowns
- For Drilling Only

    — Date and depth of sample/hole at start and end of working day or shift
    — Depth of start and finish of each core run
    — Depth and size of any casing at start and end of each core run
    — Core diameter and changes in core size
    — Type and condition of bit
    — Start and stop time of each core run
    — Time and description of interruptions in coring
    — Depths of changes in coring rate
    — Gain or loss of water, mud, or air flush; type of cuttings
    — Standing water level at start and end of each working period
    — Backfilling and grouting

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[1] This list excludes any special items that may be required for contractual record purposes or for special engineering tests (e.g., Project Plan).

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Attachment C

Unified Soil Classification System Field Identification Procedures for Fine-Grained Sediments/Soils or Fractions

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ATTACHMENT C

UNIFIED SOIL CLASSIFICATION SYSTEM FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SEDIMENTS/SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 inches. For field classification purposes, screening is not intended; simply remove by hand the coarse particles that interfere with the tests.

DRY STRENGTH (CRUSHING CHARACTERISTICS)

After removing particles larger than No. 40 sieve size, mold a pat of soil/sediment to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil/sediment. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dry specimen. Fine sand feels gritty, whereas a typical silt has the smooth texture of flour.

Calcium carbonate or iron oxides may cause higher dry strength in dried material. If acid causes a fizzing reaction, calcium carbonate is present.

DILATANCY (REACTION TO SHAKING)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil/sediment with a volume of approximately 0.5 cubic inches. Add enough water if necessary to make the soil/sediment soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat that changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil/sediment.

Very fine clean sands give the quickest and most distinct reaction, whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)

After removing particles larger than No. 40 sieve size, a specimen of soil approximately 0.5 cubic inches is molded to the consistency of putty. If too dry, water must be added and, if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms, into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil/sediment. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay or low plasticity, or materials such as kaolin-type clays and organic clays that occur below the A-line.

Highly organic clays have a very weak and spongy texture at the plastic limit.

Non-plastic soils cannot be rolled into a thread at any moisture content.

The toughness increases with the Plasticity Index.

Attachment D

Unified Soil Classification System

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ATTACHMENT D
UNIFIED SOIL CLASSIFICATION SYSTEM

Field Classification				**Symbol**				**Symbol**
COARSE-GRAINED SOILS More than half of material (by weight) is of individual grains visible to the naked eye	GRAVEL AND GRAVELLY SOILS More than half of coarse fraction (by weight) is larger than 0.25-inch size		CLEAN GRAVELS Will not leave a dirt stain on a wet palm	Wide range in grain sizes and substantial amounts of all intermediate particle sizes				GW
				Predominantly one size or range of sizes with some intermediate sizes missing				GP
			DIRTY GRAVELS Will leave a dirt stain on a wet palm	Non-plastic fines or fines with low plasticity (for identification of fines, see characteristics of CL below)				GM
				Plastic fines (for identification of fines, see characteristics of CL below)				GC
FINE-GRAINED SOILS More than half of material (by weight) is of individual grains not visible to the naked eye	SAND AND SANDY SOILS More than half of coarse fraction (by weight) is smaller than 0.25-inch size		CLEAN SANDS Will not leave a dirt stain on a wet palm	Wide range in grain size and substantial amounts of all intermediate particle sizes missing				SW
				Predominantly one size or a range of sizes with some intermediate sizes missing				SP
No. 200 sieve size is about the smallest particle visible to the naked eye	For visual classification, the 0.25-inch size may be used as equivalent to the No. 4 sieve size		DIRTY SANDS Will leave a dirt stain on a wet palm	Non-plastic fines or fines with low plasticity (for identification of fines, see characteristics of ML below)				SM
				Plastic fines (for identification, see characteristics of CL below)				SC
	SILTS AND CLAYS (low plastics)		Slight	Rapid	Low to none	None	Dull	ML
			High	Medium to None	Medium	Weak	Slight to shiny	CL
		Pronounced	Medium	Slow to none	Low	None		
	SILTS AND CLAYS (highly plastic)	ODOR Pronounced	DRY CRUSHING STRENGTH Medium	DILATANCY (SHAKE) Very slow to none	TOUGHNESS Medium	RIBBON (near the plastic limit) Weak	SHINE (near the plastic limit) Dull to slight	OL
			Very High	None	High	Strong	Slight	MH
			High	None	Low to medium	Weak	Shiny	CH
							Dull to Slight	OH
HIGHLY ORGANIC SOILS				Readily identified by color, order, spongy feel, and frequently by fibrous texture.				Pt

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Table D-1 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between the thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

Table D-2 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface on the specimen during shaking and disappears quickly upon squeezing.

Table D-3 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and lump have very high stiffness.

Table D-4 Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch (3-millimiter) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Table D-5 Identification of Inorganic Fine-Grained Sediments/Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Touch
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

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Standard Operating Procedure No. 065
for
Data Verification and Usability

Prepared by

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Revision No. 0
March 2016

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are client-, project-, or site-specific variances to this standard operating procedure (SOP) (**check Box A**), or if this SOP is being used with no changes (**check Box B**). This form should be archived with the project files.

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 065	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

Page

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**

1. SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide a standard method for project managers and other project staff to evaluate the completeness, correctness, and technical compliance of environmental data sets relative to the project objectives and contractual requirements. This SOP is intended for projects (typically for state, local, and commercial clients) that often lack planning documents that address data evaluation and usability such as formal Quality Assurance Project Plans and, in some cases, sampling and analysis plans. All projects, no matter how small, should have some level of data verification and usability evaluation to ensure that data quality objectives are achieved and decisions made using the project-generated data are valid and appropriate.

This SOP includes procedures for verification and usability assessment of both field and laboratory data, but does not include formal data validation, which is covered in a separate SOP.

Data verification includes completeness checks to confirm that all required data collection activities were conducted (both in the field and in the laboratory), all required records are present, and the contents of the records are complete. Verification also includes a comparison to historical data, if available, to assess whether any of the reported results appear anomalous.

A data usability assessment is performed after data verification and is an evaluation of whether the project data are of the correct level of quality and sufficient quantity to support the project decisions. The usability assessment also includes the elements of what is sometimes referred to as a “data quality assessment,” such as assessment of data precision and accuracy.

If project- or program-specific requirements for data verification, data validation, or assessment of data usability are available (as is often the case for federal projects), then deferral of data usability to project- and client-specific guidance under the purview of program or project chemists is appropriate.

The quality assurance and quality control requirements needed to meet data quality objectives will vary by project. This SOP serves to describe the minimum amount of data review that should be performed, particularly on data that will not undergo formal verification or validation. The outcome of data review may include the following:

- Correction to chain-of-custody (COC) forms, field forms, laboratory documentation, electronic data deliverables (EDDs), or data presented in deliverables such as reports

- Discussion of any significant deviations that affect data usability in the Results section of the project report, as appropriate for client preferences and requirements

- Summary of results of the data review in the project report in a data quality or data usability section, as appropriate based on client preferences and requirements.

2. MATERIALS

The following documents are commonly required for review of analytical data:

- Project Work Plan or equivalent
- Quality control planning documents (e.g., Quality Assurance Project Plan and/or Quality Assurance Program Plan), if available
- COC and analytical request documentation
- Field sampling logs and field logbooks, including sampling locations for field duplicates
- Laboratory analytical reports and EDDs (see Definitions below).

3. DEFINITIONS

Accuracy—The comparison between experimental and known or calculated values, expressed as a percent recovery. Accuracy is a measure of the bias of a measurement system.

Analytical Data Report—Project-required data report including both project sample results and quality control data, along with "case narratives" that highlight any quality issues encountered during analysis. These reports include pages summarizing analytical data for project samples (including quality control samples) in tabular format, which are sometimes referred to as "Form 1 equivalents." Additional information (e.g., detailed calibration and integration information) may (or may not) be included depending on the level of report required by client. These reports are provided in portable document format (PDF) (or hard copy) format, and are sometimes referred to as "data packages."

Completeness—A measure of the relative number of analytical data points that meet the requirements for use in the manner intended.

Detection Limit—The minimum concentration of a substance (i.e., an analyte) that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte.

Electronic Data Deliverable—Electronic, tabular format of data transmittal, typically in a database or Microsoft Excel format. A wide variety of EDD formats is available; the preferred format is often driven by client and/or EA database requirements.

Holding Time—The holding time is the length of time that is acceptable between collection of a sample and the analysis of that sample, as defined by the analytical method. For methods requiring extraction of the target analytes prior to analysis, there may be an acceptable holding time between sample collection and extraction, and another holding time dictating the time before analysis of the extract.

Precision—The reproducibility of measurements of the same parameter for a sample under the same or similar conditions.

Quality Assurance—A series of planned and systematic actions that assure that the project is in control (e.g., the actions typically presented in a Quality Assurance Project Plan).

Quality Control—A system of quality monitoring activities (e.g., collection of field duplicates) built into the project and sustained during the life of the project.

Reporting Limit—Also known as a limit of quantitation or practical quantitation limit: the minimum levels, concentrations, or quantities of a target compound (e.g., target analyte) that can be reported with a specified degree of confidence. These values are adjusted for percent moisture, dilutions, and sample size on an individual sample basis.

Sensitivity—Associated with detection and reporting limits, sensitivity is the ability of the method or instrument to detect and/or quantify the target analyte, contaminant of concern, or other required data at the level of interest.

4. PROCEDURE

The procedure described below includes specific quality assurance parameters that are typically associated with environmental data. Although an attempt has been made to present widely applicable parameters, the items requiring review may vary with the analytical parameters and the project objectives.

A checklist for recording the completion and outcomes of the data review steps described below is provided in Attachment A.

Project-Specific Requirements:

1. Prior to beginning the process of reviewing analytical data, locate the critical documents for understanding the project requirements (Section 2), including those relating to quality assurance, if available. Make sure you understand the objectives of the project, the sampling scheme presented in the project plans, and the overall quality requirements for the analytical data.

2. Identify the site- and project-specific contaminants of concern, based on site history and/or available historical data. Many analytical procedures provide data for a whole host of chemicals, along with site-specific contaminants of concern. Quality issues associated with other non-target analytes may not pose the same level of quality variances as those associated with the project-specific contaminants of concern. With client and regulatory approval, and as captured with the planning documentation, you can ask the laboratory to limit the reported analytes to contaminants of concern prior to data reporting.

3. Identify your specific project samples. Many laboratory reports may provide data for quality control samples (i.e., matrix spikes) along with your specific project sample data. Quality issues associated with non-project quality control samples are not as important as quality variances associated with your project-specific matrices.

Field Verification:

4. Assess whether all planned samples were collected, and whether there were variances with respect to these samples (e.g., moved location, depth differences, etc.). Confirm that field sampling SOPs were followed, and identify any deviations.

5. Check the field forms, field logbooks, and any other field data for completeness and accuracy. Make sure the values of any parameters measured in the field are reasonable (e.g., values are within a reasonable range when compared to historical field data, values that should be positive are not negative, etc.). If any problems are found, note the deviation and any implications for data usability.

Chain-of-Custody and Laboratory Login:

6. Check the COC forms to confirm that they are complete and accurate, and signed by each party that maintained custody of the samples (field personnel, courier, laboratory personnel, etc.) as required to show a continuous COC. If samples were transferred to another laboratory facility, the subcontract COC forms should be provided by the laboratory.

7. Confirm that the samples were properly preserved and collected in the appropriate containers.

8. Confirm that samples were logged in accurately (i.e., no typographical errors in sample identifications, correct analyses requested, correct turnaround time, project identification, etc.) by the laboratory.

Laboratory Documentation:

9. Check the COC forms against the analytical data reports to confirm that the sample identifiers and analyses (including methods) are consistent with the planning documents, unless a deviation was noted in the field documentation.

10. Confirm that the following information is provided in the analytical data reports:

    - Sampling date(s), and date(s) and time(s) of laboratory receipt
    - Condition of samples when received by the laboratory
    - Dates and times of analyses
    - Units for each result
    - Laboratory data qualifiers for each result and associated definitions
    - Reporting and detection limits, as required, consistent with the planning documents.

11. If provided within the laboratory report, review the case narrative or cover letter, and note potential data quality issues mentioned in the narrative (including analytes detected in method blanks, issues with spike or surrogate recoveries, holding time exceedances, etc.). If you have questions regarding the implications of these issues in terms of data usability, discuss with the laboratory and/or EA chemistry staff.

12. Double-check the times between sampling and analysis (or between extraction and analysis, as applicable) against the acceptable sample holding times specified for each method to confirm that any exceedances are correctly noted in the Case Narrative and data qualified by the laboratory. Typically, minor exceedances in holding times do not affect data usability (less than 7 days past the method hold time); discuss with the laboratory and/or EA chemistry staff as needed.

13. Perform a spot check (at least 10 percent) of the information (data, qualifiers, etc.) included in the EDDs against the analytical report PDFs. Technically and legally, the correct concentrations are those shown in the hard copy (or PDF), not the EDD; consequently, if discrepancies are found, contact the laboratory and obtain corrected reports or EDDs. If any data (e.g., field data) were hand-entered into electronic files, perform 100 percent quality control check for transcription errors.

Additional Checks:

14. Check that the reporting and detection limits meet the sensitivity requirements for the project. The sensitivity requirements should be presented in the planning documents if they exist. Sensitivity is the ability of the method or instrument to detect the contaminant of concern or other required data at the level of interest. Sensitivity is typically expressed in the form of detection or reporting limits. If sample dilutions were applied at the laboratory, this will increase the detection and reporting limits by the dilution factor. Ideally, the reporting limits achievable by the laboratory should be below

the applicable screening levels to minimize the potential for false positives and ensure the project goals in terms of actionable concentrations are met. However, analytically achievable reporting limits are not always low enough to meet this goal. If the analytes for which reporting limits do not meet sensitivity requirements are not site-specific contaminants of concern, this is not likely to impact data usability.

15. Calculate the relative percent differences (RPDs) for field duplicate pairs collected using the equation below. Note that RPDs are typically calculated for analytes that were detected in both the parent and duplicate samples. However, if an analyte is reported in the field sample at an elevated concentration and is not detected in the field duplicate, consideration should be given to further assess the data results for field sampling or laboratory error. Compare the RPDs to the precision goal presented in the planning documents, if applicable. If no goal was presented in the planning documents, note RPDs greater than 50 percent for solid samples or greater than 30 percent for aqueous samples. High RPDs may indicate sample matrix heterogeneity, which is a potential source of uncertainty in the data.

$$\boldsymbol{RPD = \frac{\frac{100 * |parent\ result - field\ duplicate\ result|}{parent\ result + field\ duplicate\ result}}{2}}$$

16. If contaminants of concern for the site were detected in method, trip, or rinse blank samples, compare the sample concentration(s) of these analytes to the blanks. This information can often be found in a specialized quality control section of the analytical data report PDF, if available. Compare the detected blank concentration(s) to your screening criteria or action levels, and assess whether the blank detection may have caused results exceeding the criteria or action level for analytes of concern. Typically, a sample concentration that exceeds the concentration in the blank by more than 5-10 times is considered usable without qualification. If the concentration in a sample is less than 10 times the concentration in the blank, more detailed assessment may be required to determine the usability of the data.

17. Assess the completeness of the dataset. Were there any planned samples or analyses for which no usable data were collected? Were any data determined to be unusable based on criteria above? If a completeness goal was indicated in the planning documents, calculate the percentage of usable results for each analyte and compare to the goal. For example, if 100 samples were planned for analysis of lead, but one sample could not be collected and five lead results were determined to be unusable, then the completeness for lead is as shown below. If the completeness goal was 80 or 90 percent, then the goal was met.

$$\frac{(100 - 1 - 5)}{100} \times 100 = 94 \text{ percent}$$

18. Review the data in the analytical reports and derived data tables to verify that they are reasonable. Are the reported data lower than the detection limits? Are results for water samples higher than historical results (or possibly higher than the solubility of the analyte in water)? Are the most recent results orders of magnitude different from historical results? Such issues could indicate a unit conversion error, a sample dilution error, or other errors in the data.

4.1 DATA USABILITY DOCUMENTATION

If required or acceptable to the client, include a summary of the results of the data review in the project report. In some cases, a complete data usability assessment is appropriate or required, and a copy of the data usability review checklist (Attachment A) may also be included as an attachment. In other cases, the client may request that limited or no data quality/usability discussion be included in the project report. At a minimum, maintaining a copy of the data usability review checklist with your files is recommended.

If a minimal (e.g., paragraph-long) discussion of data quality/usability is requested in the project report, it may be appropriate to briefly summarize the level of agreement between field duplicates and parent samples, the magnitude and quantity of analytes detected in the blanks, and any other major issues affecting data usability, and conclude with a statement regarding data usability.

Where a separate section or subsection regarding data usability (or data quality assessment) is included in the project report, it typically includes a discussion of the following data quality indicators:

- ***Precision***—Precision is determined by assessing variability, measured as the RPD for field duplicates, laboratory duplicates, and/or matrix spike/matrix spike duplicate pairs and relative standard deviation for field replicates. If the case narrative notes that one or more of the RPDs exceeded acceptance criteria, or if the analysis of field duplicate pairs indicates an RPD exceeding project criteria (Item 15), note this issue in the discussion. If the high RPD is for a laboratory duplicate or a low flow groundwater sample duplicate, note this as a deviation and potential data quality issue.

- ***Accuracy***—Accuracy is expressed as a percent recovery, and measures the bias of a measurement system. Percent recoveries are derived from the analysis of standards of known concentration spiked into a clean reference matrix (standard recovery) or into actual samples (matrix spike/matrix spike duplicates or surrogate spike recovery), as appropriate for each method. If the case narrative notes that percent recovery for one or more analytes was below acceptance criteria (typically defined in the analytical method or project planning documents), note this issue in the discussion. Such a deviation may be due to issues with the analytical system or, in the case of matrix spike/matrix spike duplicates, could be attributable to the nature of the sample matrix. If analytes were detected in the blanks, also note these in the accuracy section, as detection of analytes not from the sample matrix could bias data and thus decrease its accuracy. Note that if the native analyte concentration in the sample selected for spiking for matrix spike/matrix spike duplicate samples is greater than four times the concentration spiked, the percent recovery criteria are generally not applicable.

- ***Completeness***—Did you meet the project completeness goal (Item 17).

- ***Sensitivity***—If the detection limits for contaminants of concern at the site are greater than the screening levels, discuss this deviation and its implications on the uncertainty of the data screening, particularly as it relates to non-detected values (Item 14).

- ***Data Usability***—Finally, the results of the data review are used to make an overall statement regarding data usability.

If questions arise, contact an EA chemist, data manager, or laboratory project manager.

5. MAINTENANCE

Not applicable.

6. PRECAUTIONS

None.

7. REFERENCES

None.

Attachment A

Basic Data Verification and Usability Checklist

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BASIC DATA VERIFICATION AND USABILITY CHECKLIST

Verification Step	Yes/No	Notes/Deficiencies
Field Verification		
Were all planned samples collected?		
Were there variances that modified collection of planned samples (e.g. moved sample locations, insufficient sample volume)?		
Were field forms and field logbooks completed correctly?		
Were all field Standard Operating Procedures followed?		
Are any field data unreasonable (e.g., pH > 14, or negative dissolved oxygen or turbidity)?		
Chain-of-Custody and Laboratory Login Information		
Were chain-of-custodies prepared according to Standard Operating Procedures, and signed and dated for each transfer?		
Were samples preserved appropriately (<6 degrees Celsius, chemical preservative as necessary, containers, headspace, etc.)?		
Were samples logged in properly by the laboratory? Was the condition of samples at receipt documented?		
Laboratory Checks		
Does the analytical data report contain the proper information (e.g., sample identifications, sample date, reporting units, etc.)?		
Were samples analyzed and data reported according to the chain-of-custody?		
Were holding times achieved?		
Were there any blank (field or method) detections that affected the usability of data for project samples?		
Were any other laboratory quality control issues (e.g., laboratory spike or surrogate recoveries) that affect the usability of data noted in the case narrative?		
Are data in the electronic data deliverables consistent with those reported in the analytical data reports, based on a spot-check (recommended minimum 10 percent)?		
Additional Checks		
Calculate relative percent differences for field duplicates and associated original sample results to verify acceptable values (30 and 50 percent for solid and liquid samples, respectively).		
Assess data completeness (planned analyses versus usable analyses).		
Check reporting/detection limits against sensitivity requirements.		
Are the data reasonable? Are there any unexpected anomalies relative to historical data?		

As necessary, add additional page(s) documenting any data usability issues.

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Standard Operating Procedure No. 073
for
Sampling for Per- and Polyfluorinated Alkyl Substances

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
June 2019

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**check Box A**), or if this SOP is being used with no changes (**check Box B**). This form should be archived with the project files.

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 073	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

Page

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	June 2019	Note regarding water-tight lids	F. Barranco	F. Barranco

1. SCOPE AND APPLICATION

The objective of this Standard Operating Procedure (SOP) is to delineate protocols for collecting environmental samples for analysis of per- and polyfluorinated alkyl substances (PFAS), also known generally as perfluoroalkyl compounds or chemicals (PFCs).

This SOP includes sampling procedures and requirements specific to analysis of PFAS, which are ubiquitous and have a high potential for cross-contamination from common consumer products and sampling materials, even when new and clean. This SOP should be used in combination with appropriate SOPs applicable to the target medium and sampling methodology (e.g., but not limited to SOP No. 007 Surface Water Sampling, SOP No. 013 Collection of Monitoring Well Samples, SOP No. 21 Sediment Sampling, SOP No. 25 Soil Sampling, or SOP No. 047 Direct-Push Technology Sampling).

This SOP was developed primarily based on guidance from the U.S. Army Corps of Engineers (2016) and the Interstate Technology Regulatory Council (ITRC 2018).

2. ACCEPTABLE MATERIALS

Table 1 provides a summary of Prohibited Items that should NOT be used or present during sampling for PFAS because they may contain PFAS, along with Acceptable (PFAS-free) Alternatives that may be used if appropriate for project requirements. In general, in the context of sampling events, PFAS are commonly found in waterproof and nonstick materials (including food packaging, rain gear, and anything containing Teflon®), personal care products, and certain plastics (e.g., low-density polyethylene [LDPE]) and synthetic fibers.

Table 1. Prohibited Items and Acceptable Alternatives for Use during PFAS Sampling

Prohibited Items	Acceptable Alternatives
Field Equipment	
Teflon-containing or LDPE materials (including tubing, bailers, tape)	HDPE or silicone materials
Waterproof field books, plastic clipboards, binders, or spiral hard cover notebooks	Loose paper (non-waterproof) on aluminum or Masonite clipboards
Sharpies®/markers, waterproof pens	Non-waterproof pens or pencils
Sticky notes (e.g., Post-It®) and glues	Not applicable
Re-usable chemical (blue) ice packs	Regular ice in polyethylene bags (double bagged)
Aluminum foil	Thin HDPE sheeting
Plastic spoons used in soil/sediment sampling	Stainless steel trowels/spoons
Reusable core liners	Single-use PVC or acetate liners
LDPE HydraSleeve	HDPE HydraSleeve
Field Clothing and Personal Protective Equipment	
New cotton clothing; synthetic water resistant, waterproof, or stain- treated clothing; clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of natural fibers (preferably cotton)
Clothing laundered using fabric softener	No fabric softener
Boots (e.g., steel-toed or waders) containing Gore-Tex™ or waterproof coatings	Boots made with polyurethane or PVC with no waterproof coating

Prohibited Items	**Acceptable Alternatives**
Coated Tyvek® suits	Uncoated/plain Tyvek suits not containing PFAS
Cosmetics, shampoo, conditioner, body gel, moisturizers, hand cream, waxed dental floss, or other personal care products used <u>on the day of sampling</u>.	Use bar soap not containing moisturizers and rinse well on the day of sampling (including for hand washing). Use any other required products the night before (rather than the day of) sampling.
Paper towels	Air dryers (for hand drying)
No sunscreens or insect repellents except approved 100% natural products such as those noted in the Alternatives column.	**Acceptable Sunscreens:** Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss My Face, "free" or "natural" sunscreens for babies **Acceptable Insect Repellents:** Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect Repellant, Herbal Armor, California Baby
Sample Containers	
LDPE or glass containers	HDPE containers (or polypropylene if required)
Teflon-lined caps	Unlined HDPE (or polypropylene if required) caps
Rain Events	
Rain gear that has been treated to make it waterproof/resistant and breathable (e.g., Gore-Tex™ treated)	PVC or polyurethane- or wax-coated rain gear that is confirmed not to contain PFAS, or utilize a gazebo tent that is only touched or moved prior to and following sampling activities.
Equipment Decontamination	
Decon 90	Alconox®, Liquinox®, and/or Citranox®
Water from an onsite well	Potable water from municipal drinking water supply (not containing PFAS), and "PFAS-free" deionized water for final rinse
Food Considerations	
All food and drink, with exceptions noted in the Alternatives column. Paper food packaging (e.g., fast food wrappers, drink cups, paper bags) and foil, in particular, often contain PFAS.	Bottled water and hydration drinks (i.e., Gatorade® and Powerade®) to be brought and consumed only in the staging area
NOTES: HDPE = High-density polyethylene. PVC = Polyvinyl chloride.	

If a plastic product or chemical not included in the Acceptable Alternatives column of Table 1 is proposed for use, it is recommended that Safety Data Sheets and other references be reviewed prior to use to confirm that the material does not contain PFAS. Indications of potential PFAS ingredients, in addition to the items listed in Table 1, include the following materials (ITRC 2018):

- Polytetrafluoroethylene (fluorocarbon solids such as Teflon)
- Fluorinated ethylene propylene
- Ethylene tetrafluoroethylene
- Polyvinylidene fluoride
- Generally, any other ingredient names containing the prefix "fluoro."

Specific to the use of HDPE sample containers, note that the associated lids are not typically "water-tight." Therefore, HDPE sample containers should be individually placed in water-tight bags prior to placement in shipping containers loaded with ice.

3. PROCEDURES

As stated above, this SOP includes procedures specific to analysis of PFAS, and should be used in combination with the appropriate SOPs applicable to the target medium and sampling methodology.

3.1 GENERAL CONSIDERATIONS

Materials listed in the Prohibited Items column of Table 1 and other materials containing PFAS ingredients should not be used. However, in some cases, these materials must be used due to factors outside the control of the scope of the work or utility of the project team (e.g., health and safety requirements where other hazardous chemicals are present, or where the sampling requirements are prescriptive, unexpected, or time-sensitive). In these cases, the sampling team should purge/rinse equipment adequately with PFAS-free water where available, and collect additional quality control samples (Section 3.7) to assess the degree of cross-contamination associated with the use of known or suspected PFAS-containing materials during sampling.

NOTE: Most steel-toed boots are made from coated leather and synthetic fibers. PVC or polyurethane are preferred PFAS-free materials for boots. If not possible to obtain PFAS-free footwear that comply with specified health and safety requirements for personal protective equipment, then field personnel should minimize contact with footwear while in the sampling area, and always change gloves after touching footwear.

Disposable nitrile gloves shall be worn at all times during PFAS sampling activities. A new pair of nitrile gloves shall be donned after contacting potential contaminants including all non-decontaminated surfaces. New gloves shall also be donned before touching containers used for storage of PFAS samples, decontaminating re-usable sampling equipment, or handling quality control samples (Section 3.7).

Food shall not be eaten within 10 meters of any sampling area. Before eating or drinking, sampling personnel shall remove their gloves and any outer garments (e.g., coveralls) and leave the work area. When finished, sampling personnel shall wash their hands, remove any visible residue, and put new gloves and any outer garments back on prior to returning to the work area.

PFAS-containing stain resistant products are often applied to vehicle seats that have fabric upholstery. Therefore, if no outer garments (e.g., coveralls) will be worn, or if the outer garments will be worn in the field vehicle then, if feasible, the seats of the vehicle should be covered in a well-laundered cotton blanket to avoid contact between clothing and the seats.

Visitors to the sampling area shall remain at least 10 meters at a distance.

As indicated in Table 1, sampling personnel shall not use the personal care products or cosmetics (other than bar soap) prior to or during sample collection on any day. Additionally, clothes worn during sampling should be well-washed natural fibers.

Other personnel who come within 2-3 meters of the sample collection area should follow the guidelines above and in Table 1.

Fluids used during laboratory- or fieldwork (e.g., drilling for monitoring well installation or for deep soil sampling) should be confirmed PFAS-free.

When sampling on a surface water body, associated gear (e.g., waders, life preservers) should be confirmed PFAS-free.

3.2 EQUIPMENT DECONTAMINATION

Wherever possible, dedicated or disposable equipment shall be used to avoid the need for decontamination, which introduces additional potential for cross-contamination.

Large field equipment (e.g., drill rigs) should be decontaminated with potable water using steam or high-pressure water. Laboratory-certified "PFAS-free" water should be used to perform a final rinse of portions of the sampling equipment that will be in direct contact with samples, wherever practical.

Hand-held, non-dedicated sampling equipment, which is used at multiple field sampling locations, shall be decontaminated using the following procedure:

- Rinse with a non-PFAS-containing detergent (e.g., Alconox, Liquinox, or Citranox)
- Rinse with laboratory-provided, "PFAS-free" water (Grade 3 distilled, Millipore deionized)
- Rinse with methanol
- Rinse with laboratory-provided, "PFAS-free" deionized water.

The Safety Data Sheet for the selected detergent should be reviewed to ensure that it does not contain fluoro-surfactant ingredients.

Wherever possible, equipment should be rinsed with "PFAS-free" water immediately prior to use at each sampling location.

3.3 SAMPLE COLLECTION AND PRESERVATION

The sampling team shall coordinate with the analyzing laboratory regarding requirements for sample bottle, volume, and preservation requirements for samples for PFAS analysis, and the laboratory should provide certified "PFAS-free" containers. HDPE bottles with unlined caps are typically used for collection of samples for PFAS analyses. Polypropylene may also be used for specific applications (e.g., collection of drinking water samples to be analyzed for the short list of PFASs by Method 537) (Department of Defense Environmental Data Quality Workgroup 2017).

Containers for collection of PFAS samples shall never be left uncapped, either before or after sample collection, and the lid/cap shall be kept in a gloved hand and not be set down while removed from the container.

Sampling personnel shall put on a clean pair of nitrile gloves immediately prior to collection of each sample for PFAS analyses, prior to removing the lid from the sampling container. After the sample is collected and the container is closed, pens or pencils, but not markers, shall be used in completing sample labels or in the vicinity of samples during collection.

Following sample collection and addition of preservative (if required), sample containers for PFAS analyses shall be placed in coolers with new, double-bagged ice and not re-usable chemical ice packs unless confirmed PFAS-free and regulatorily accepted, such that meltwater does not contact sample containers during transport.

3.4 SOIL/SEDIMENT SAMPLING CONSIDERATIONS

Surface soil and sediment samples for PFAS analyses should be collected using a clean, stainless-steel tool (e.g., a trowel or Ponar grab sampler).

For field collection of soil and sediment cores, single-use PVC, HDPE, or acetate liners shall be used, and samples for PFAS analysis should be collected from the cores directly or using a stainless-steel tool.

3.5 GROUNDWATER SAMPLING CONSIDERATIONS

It is recommended that, where feasible, measurements of monitoring well water levels and well depths be performed after sampling for PFAS to avoid possible cross-contamination.

HDPE or silicone tubing shall be used for purging and sample collection, where applicable. Teflon and LDPE shall NOT be used. During sampling, sampling personnel shall ensure that no tubing or other equipment contacts the inside or rim of the sample bottle. Any foaming observed in the sample during collection should be noted on the chain-of-custody form that accompanies the samples to the analytical laboratory.

If analyses to be performed by the laboratory include less common PFAS chemicals that have relatively high volatility (including fluorotelomers and sulfonamide/alcohols such as fluorotelomer alcohols, fluorotelomer acrylates, and methyl/ethyl fluorosulfonamides and sulfonamidoethanols), then precautions should be taken during sample collection to minimize loss of volatiles (e.g., minimizing turbulence in water as it flows into the sample container).

If use of passive/no-purge sample collection technology is to be utilized, it is critical to confirm that the sampling device does not contain LDPE (e.g., HydraSleeves made of HDPE rather than LDPE may be requested for PFAS sampling).

Filtration is not recommended because the filter may sorb PFAS or be a source of PFAS contamination.

3.6 SURFACE WATER AND POREWATER SAMPLING CONSIDERATIONS

Capped surface water sample containers shall be rinsed multiple times with site surface water prior to sampling.

Because PFAS tend to accumulate at the air/water interface, specific procedures for surface water sampling shall be followed. After rinsing, the capped container shall be lowered into the surface water, with the top pointed down. The container shall then be reoriented with the top pointed upward and opened under water at the depth targeted for sampling, ideally at least 10 centimeters from both the sediment surface and the water surface. During sample collection, the sample collection point shall be positioned upstream of the sampler, gloves, etc. If an extension rod must be used due to the depth of sampling, the rod shall be made of clean, PFAS-free material.

For porewater sampling, the common stainless-steel and PVC samplers, with HDPE and silicone tubing, are acceptable. The samplers should not be reused at multiple sampling locations.

As for groundwater samples, filtration is not recommended.

3.7 FIELD QUALITY CONTROL SAMPLES

It is recommended that field blanks and equipment (i.e., rinsate) blanks be collected at least daily, using laboratory supplied “PFAS-free” water, to detect any cross-contamination that occurred despite precautions taken during sampling. If a peristaltic pump is used for sample collection, then at least one equipment blank should be collected by pumping “PFAS-free” water through the pump with clean HDPE tubing.

Field duplicates should also be collected to assess the precision of the results.

Analysis of trip blanks may be advisable on a project-specific basis, particularly if relatively volatile PFAS chemicals will be analyzed.

The same precautions taken during collection of specified samples should be taken during the collection of quality control samples (Section 3.7).

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

See detailed precautions noted above.

6. REFERENCES

Department of Defense Environmental Data Quality Workgroup. 2017. *Bottle Selection and other Sampling Considerations When Sampling for Per-and Poly-Fluoroalkyl Substances (PFAS)*. Revision 1.2. July.

Interstate Technology Regulatory Council (ITRC). 2018. *Fact Sheet: Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS).* March.

U.S. Army Corps of Engineers. 2016. *Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling*. March.

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Appendix C

Field Forms

BORING/WELL LOG

Client

HOLE NUMBER AND PERMIT NUMBER

1. COMPANY NAME
EA Engineering, Science, and Technology, Inc., PBC

2. DRILL SUBCONTRACTOR

SHEET 1 OF SHEETS

3. PROJECT

4. GEOLOGIST

5. COMPONENT

6. AREA

7. GRID LOC./BIASED POINT

8. NAME OF DRILLER

9. MANUFACTURER'S DESIGNATION OF DRILL

10. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT

TYPE OF LINER USED, IF APPLICABLE

11. SURFACE ELEVATION AND CONDITIONS

12. DIRECT READING PARAMETERS: PID (ppm)

13. DATE STARTED

14. DATE COMPLETED

15. OVERBURDEN THICKNESS

16. DEPTH GROUNDWATER ENCOUNTERED

17. DEPTH DRILLED INTO ROCK

18. DEPTH TO WATER AND ELAPSED TIME ATFER DRILLING COMPLETED

19. TOTAL DEPTH OF HOLE

20. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

21. WELL INSTALLED? IF SO COMPLETE CONSTRUCTION DIAGRAM

22. SAMPLE TYPE:

23. SAMPLE INTERVAL AND DESIGNATION FOR LAB ANALYSIS

24. SAMPLE INTERVAL AND DESIGNATION FOR FIELD SCREENING ANALYSIS
COD (if applicable)=
Hexavalent Chromium (if applicable)=

25. SCREENING ANALYSIS
COD=
Heavalent Chromium=

27. DISPOSITION OF HOLE

28. IF NOT A WELL, BACKFILLED WITH:

USCS LOG	DEPTH (FT)	DESCRIPTION OF MATERIALS	DIRECT READING VOC (ppm)	DIRECT READING	ANALYTICAL SAMPLE DESIGNATION AND INTERVAL	DEPTH (FT)	RECOVERY (IN.)	REMARKS

PROJECT:

HOLE NO.:

EA Engineering, Science,
and Technology, Inc., PBC

LOG OF SOIL/ROCK BORING

GPS Coordinates:
GPS Projection/Datum:
Surveyed Coordinates:
Survey Projection/Datum:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc:

Job. No.	Client:	Location:
Drilling Method:		Boring No.
Sampling Method:		Sheet 1 of

Water Level			
Time	-		
Date			
Reference			

Drilling	
Start	Finish

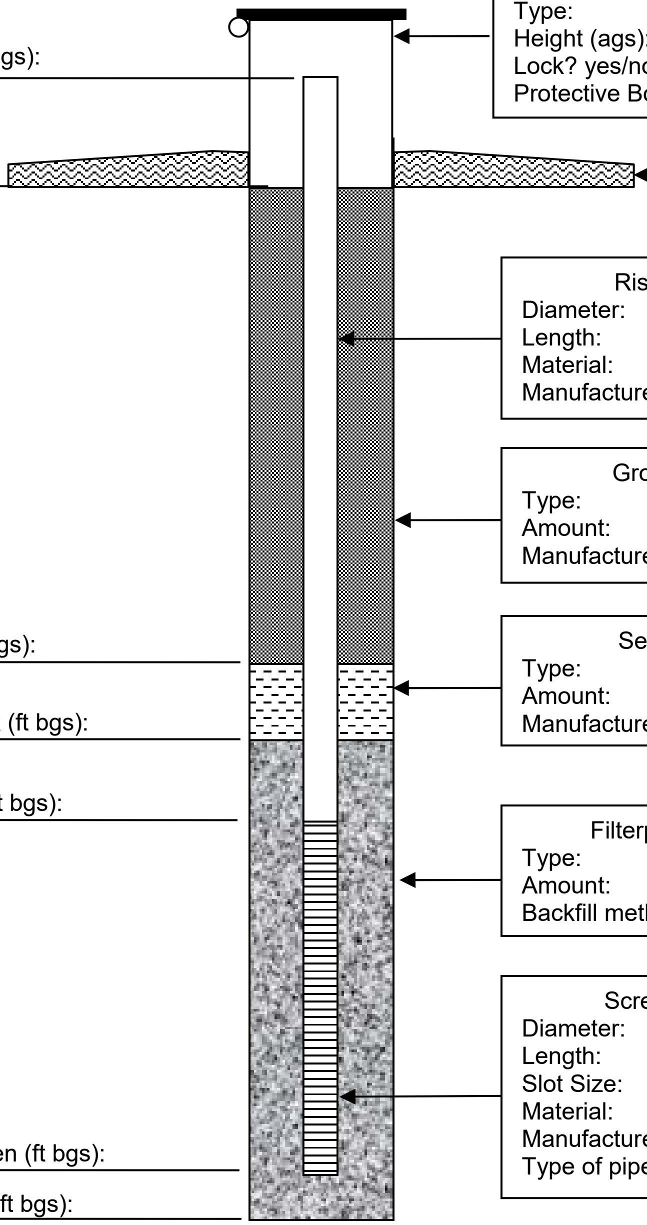
Sample Type	Inches Drvn/In. Recvrd	SC	pH	PID ppm	Blows per 6 in.	Depth in Feet		USCS Log	Surface Conditions:
						21			
						22			
						23			
						24			
						25			
						26			
						27			
						28			
						29			
						30			
						31			
						32			
						33			
						34			
						35			
						36			
						37			
						38			
						39			
						40			
						41			

Logged by: Date:

Drilling Contractor: Driller:

RECORD OF WELL CONSTRUCTION
(STICK-UP)

EA Engineering, Science, and Technology, Inc., PBC	Well/Soil Boring ID No.:
Project Title/ Project No.:	Date/Time Installed: Time Finished:
Location:	Depth to Water:
Site Geologist:	Drilling Method:



Top of riser (ft ags):

Ground surface

Top of seal (ft bgs):

Top of filterpack (ft bgs):

Top of screen (ft bgs):

Bottom of screen (ft bgs):

Bottom of well (ft bgs):

Protective Casing
Type:
Height (ags):
Lock? yes/no
Protective Bollards:

Sloped pad
Material:
Slope:

Riser Information
Diameter:
Length:
Material:
Manufacturer:

Grout Information
Type:
Amount:
Manufacturer:

Seal Information
Type:
Amount:
Manufacturer:

Filterpack Information
Type:
Amount:
Backfill method:

Screen Information
Diameter:
Length:
Slot Size:
Material:
Manufacturer:
Type of pipe joints:

Note: All features not to scale

ags – Above Ground Surface
bgs – Below Ground Surface

EA Engineering, Science,
and Technology, Inc., PBC

FIELD RECORD OF MONITORING WELL DEVELOPMENT (Page 1 of 3)

Well Designation: ______________________
Project Name: ______________________
Project Location: ______________________
Weather: ______________________
Developer Initials: ______________________

Well Development Date: ______________________ Development Time: ______________________
Gauge Date: ______________________ Gauge Time: ______________________
Static Water Level: ______________________ Measurement Reference: TOC
Well Grout Date: ______________________ Well Installation Date: ______________________
Well Diameter (inches): ______________________ Screen Length (ft): ______________________
Stick up/down (ft): ______________________ Sounding Method: ______________________
Condition: ______________________
Surge device and surge technique:____
Start/Stop times of surging intervals: ____
Pump device (type, size, capacity) and pump technique:____
Start/Stop times of pumping intervals:____
Quantity of water lost during drilling, removed prior to well installation, and other loss (list gallons and explain):____
____
Quantity of water added during granular filter placement, other additions (list gallons and explain):_______________
____

Well Volume Calculation (prior to development):
A. Depth to bottom: ________ ft [from top of casing (TOC)]
B. Depth to water ________ft from TOC
C. Liquid depth (A-B) (ft) ________ft
D. Well volume/ft ________gallons/ft (2" – 0.1667 gallons/ft)

	Beginning	1	2	3	4	5
Time (min):						
Pump rate (well yield) (gpm):						
Volume purged (gal):						
pH:						
Temperature (ºC):						
Specific Conductivity (µS/cm):						
Dissolved oxygen (mg/L):						
ORP (mV):						
Turbidity (NTU):						

FIELD RECORD OF MONITORING WELL DEVELOPMENT (Page 2 of 3)

	6	7	8	9	10	11
Time (min):						
Pump rate (well yield) (gpm):						
Volume purged (gal):						
pH:						
Temperature (ºC):						
Specific Conductivity (µS/cm):						
Dissolved oxygen (mg/L):						
ORP (mV):						
Turbidity (NTU):						

	12	13	14	15	16	17
Time (min):						
Pump rate (well yield) (gpm):						
Volume purged (gal):						
pH:						
Temperature (ºC):						
Specific Conductivity (µS/cm):						
Dissolved oxygen (mg/L):						
ORP (mV):						
Turbidity (NTU):						

FIELD RECORD OF MONITORING WELL DEVELOPMENT (Page 3 of 3)

Total volume of water removed (gal): ____________

Physical characteristics of water removed (including changes in clarity, color, particulates, and any odor noted during development):____

Estimated recharge rate:__________gpm

Depth to water 24 hours after development:________ft

Depth to sediment before development_____ft Depth to sediment after development: _____ft

Total surging time: _____hours

____

____

____

PLEASE NOTE

- **A 1-quart (2-pint) sample of the final water removed during development should be placed in a clear glass jar and labeled with well number and date. Each sample should be individually agitated and immediately photographed (close-up). Photograph No.: ________________________**
- **A minimum removal of three times the volume of standing water in the well and further volumetric removal should include**:

  (a) For those wells where the boring was advanced without the use of drilling fluid (mud and/or water) but water was added during well installation, then three times the volume of any water unrecovered from the well during installation should be removed (in addition to three volumes of standing water in the well).

  (b) For those wells where the boring was advanced or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), then three times the measured (or estimated) volume of total fluids lost while drilling plus three times the volume used for well installation should be removed (in addition to three volumes of standing water in the well).
- Monitoring well development is complete when the discharge from the well at the maximum pumping rate has a **turbidity of 50 NTU or less and temperature, pH, specific conductivity, dissolved oxygen, Eh, and turbidity are within 10 percent during three successive readings at 10 minute intervals.**
- **READ APPENDIX A OF WORK PLAN FOR MONITORING WELL DEVELOPMENT DETAILS**

Source: USACE SOW and USACE EM 1110-1-4000

Well Purging and Sampling Record

Well ID: ____________ **Sample ID:** ____________ **Sample Date/Time:** ____________

Casing diameter/type: Well location: Weather:

Screened interval(s): Sampling personnel:

Total depth: Sampling method:

Initial depth to water (w/o pump): Water level indicator:

Final depth to water (w/o pump): Water quality meter:

Measuring point: **North side of casing** Pump depth setting: Pump type/model:

	Δ < 1º C	Δ < 10%	Δ <10%	Δ <10%	Δ < 0.1 pH	Δ < 10 mV	Δ < 0.3 ft	< 1L/min	Δ < 10 NTU		
Time	**Temp (^{o}C)**	**Conductivity (mS/cm)** or **(µS/cm)**	**DO (%)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Water Level (feet btoc)**	**Flow Rate (L/min)** or **(mL/min)**	**Turbidity (NTU)**	**Purge Volume (L)** or **(mL)**	**Additional Comments**

Note:

Parameter Stabilization Limits:
(3 consecutive readings) for percent difference type parameters
Percent difference formula =
ABS[((first reading - second reading)/first reading) x 100]
Ex: Readings 12, 16, 15, 13
((12-16)/12)*100 = 33% ((16-15)/16)*100 = 6%
((15-13)/15)*100 = 13% In example, stabilization has not occurred.

# of Bottles / Analysis:

____
____
____
____
____
____
____

EA Engineering, Science, and Technology, Inc., PBC

Log of Sediment Sample Collection

Job. No.	**Client:** **Project:**	**Location**
Sampling Location Description:		**Sample Location ID:**
		Sheet 1 of 1
Sample Method:		
Depth of Water Body:		Sampling Date/Time
Width of Water Body:	**Start**	**Finish**
Water Body Location	DATE	DATE
	TIME	TIME

Coordinates: Northing: Easting:

Surface Water Elevation:

Reference Elevation:

Reference Description:

Surface Conditions:

Weather:

	Water Quality Parameters							
	Time **(hrs)**	**pH** **(pH units)**	**Cond.** **(mS/cm)**	**Turb.** **(ntu)**	**DO** **(mg/L)**	**Temp** **(^{o}C)**	**ORP** **(mV)**	**Description of Sample**

Samplers:

Sampling Date:

Sampling Time:

Split Sample With:

Sample Type:

EA Engineering, Science,
and Technology, Inc., PBC

Site Name	**Project No.**
Site Location	**Date/Time**
Page of	**Field Technician**

Surface Conditions:

Weather / Temperature:

Drilling Equipment

Sample Collection Equipment/Method

Analyses

Sample Interval (in.)	PID (ppm)	Sample Date	Sample Time	Sample ID	QA/QC Collected	Sample Appearance / Description

Logged by: ______________________ Signature ______________________

PHOTOIONIZATION DETECTORFIELD CALIBRATION FORM

Site Name:

INSTRUMENT:	INSTRUMENT ID No:
OPERATOR:	WEATHER:
SPAN GAS TYPE:	DATE:
CALIBRATION NOTES:	
COMMENTS:	
SIGNATURE:	DATE:

WATER QUALITY METER FIELD CALIBRATION FORM

Model:
Parameters for Measurement:

CALIBRATION
DATE:
TIME:
METER ID:

pH CALIBRATION

pH STANDARD	INITIAL READING	FINAL READING
4.0		
7.0		
10.0		

CONDUCTIVITY CALIBARATION

CONDUCTIVITY STANDARD	STANDARD READING	FINAL READING
1.413		

TURBIDITY CALIBRATION

STANDARD	INITIAL READING	FINAL READING
0 NTU		
126 NTU		

ORP CALIBRATION

STANDARD	FINAL READING
240 millivolts	

DISSOLVED OXYGEN CALIBRATION

STANDARD	INTITIAL READING	FINAL READING
100% AIR SATURATION		

COMMENTS

SIGNATURE

NOTE: The manufacturer's acceptable range for calibrated readings will be notated on the form if available.
If the final reading is +/- 20% of the standard; Recalibrate or replace unit (if necessary).

Well Assessment Checklist

Facility Information

Site Name:
Site Address:
Site County:
Site State:
Site ID Number:
Site Owner:
Project Manager:

Well Locational Information

State Well ID:
Well Tag ID:
Well Installation date:

	From Log	*By GPS*
Ground Surface		
TOC Elevation		
Latitude (WGS84)		
Longitude (WGS84)		
Northing (State Plane) NAD27		
Easting (State Plane) NAD27		

Cross streets (if applicable):

GPS Instrument used:
Datum:
Accuracy/Precision:

Well Construction Details

Type of well (Circle one) Flush Mount Stick up Multilevel Well*
Well lock\security type:
Elevation (top of inner casing):
Surface casing material:
Well casing material:
Surface Casing diameter: *inches*
Well Diameter: *inches*
Well Depth (as installed): *ftbgs*
Well Depth (as measured): *fttoc*
Screened interval: *ft*
Open hole interval: *ft*
Depth to water: *ftbtoc*
Date: ____________________ *Time:*

* If multilevel well please see attached worksheet.

Well Assessment Checklist

Well Headspace Readings

PID/FID Reading taken inside top of casing (if applicable): *ppm*

Multi-gas/CGI meter Readings taken (if applicable):

LEL: ________________ *% LEL*
O_2: ________________ *40% Vol.*
CO: ________________ *ppm*
H_2S: ________________ *ppm*

Do readings indicate unsafe conditions exist?	Yes	No

Well Condition

Is the concrete pad in good condition?	Yes	No
Is the well surface casing in good condition?	Yes	No
Is the surface casing vertical?	Yes	No
Is there an internal well seal?	Yes	No
Has there been physical damage to the well?	Yes	No
Does sounding depth match completed depth?	Yes	No
Is measuring point marked?	Yes	No
Is the well clearly labeled?	Yes	No
Flush mount - Is it secure from runoff?	Yes	No

Other Comments:

Recommendations

Well needs to be redeveloped	**Yes**	**No**
Well needs to be re-surveyed.	**Yes**	**No**
Well needs to be repaired.	**Yes**	**No**
Well needs to be replaced.	**Yes**	**No**
Well needs to be properly abandoned.	**Yes**	**No**
No action necessary.	**Yes**	**No**

Comments

Inspected by: ____________________
Date of Inspection: ____________________
Reviewed by: ____________________ **(Print)**
____________________ **(Sign)**

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Appendix D

Accident Prevention Plan

APPENDIX D
ACCIDENT PREVENTION PLAN

UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN FOR PHASE I REMEDIAL INVESTIGATION OF PER- AND POLYFLUOROALKYL SUBSTANCES, NIAGARA FALLS AIR RESERVE STATION NIAGARA FALLS, NEW YORK

PREPARED FOR:

UNITED STATES ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
2 Hopkins Plaza
Baltimore, Maryland 21201

PREPARED BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
EA Engineering, P.C. and Its Affiliate
EA Science and Technology*
269 W. Jefferson Street
Syracuse, New York 13202

DoD Contract Number: W912DR19D0005/Delivery Order: W912DR22F0247

December 2022

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*EA Engineering, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC who does business as EA Science and Technology in the State of New York

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
ABIH	American Board of Industrial Hygiene
ACGIH	American Conference of Governmental Industrial Hygienists
AFCEC	Air Force Civil Engineering Center
AFFF	Aqueous film-forming foam
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
ASP	Associate Safety Professional
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COVID-19	Coronavirus Disease 2019
CPR	Cardiopulmonary resuscitation
CSP	Certified Safety Professional
dBA	Decibels on the A-weighted scale
DPT	Direct-push technology
DR	Designated Representative
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
EDT	Eastern Daylight Time
EM	Engineer manual
EMR	Experience modification rate
GFCI	Ground fault current interrupter
GIT	Geologist in Training
HAZWOPER	Hazardous Waste Operations and Emergency Response
HECP	Hazardous Energy Control Plan
IAW	In accordance with
IDW	Investigation derived waste
MW	Monitoring well(s)
NA	Not applicable
NAICS	North American Industry Classification System
NFARS	Niagara Falls Air Reserve Station
NFPA	National Fire Protection Association
NIOSH	National Institute for Safety and Health
No.	Number

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

OSHA	Occupational Safety and Health Administration
PFAS	Per- and Polyfluoroalkyl Substances
PE	Professional Engineer
PG	Professional Geologist
PMP	Project Management Professional
PPE	Personal protective equipment
PWS	Principal Work Statement
QA	Quality assurance
QC	Quality control
RAC	Risk assessment codes
RI	Remedial Investigation
RPM	Remedial Project Manager
SDS	Safety Data Sheets
SHM	Safety and Health Manager
SOW	Statement of Work
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
TBD	To be determined
TO	Task order
TRIR	Total Recordable Incident Rate
USACE	U.S. Army Corps of Engineers

1. INTRODUCTION

This Accident Prevention Plan (APP) has been prepared by EA Engineering, P.C. and its affiliate EA Science and Technology (EA)[1] to provide services for Phase I Remedial Investigation (RI) of Per- and Polyfluoroalkyl Substances (PFAS) at the Niagara Falls Air Reserve Station (NFARS) was prepared to support RI activities designed to delineate the impact of PFAS in identified aqueous film-forming foam (AFFF) release areas at NFARS in Niagara Falls, New York. Work conducted under Contract Number (No.) W912DR19D0005 with the U.S. Army Corps of Engineers (USACE) Baltimore District, Task Order (TO) No. W912DR22F0247 for the Air Force Civil Engineering Center (AFCEC). This contract will be performed in accordance with applicable federal, state, and local safety and occupational health laws and regulations, including Occupational Safety and Health Administration (OSHA) standards (e.g., 29 Code of Federal Regulations [CFR] 1910 and 29 CFR 1926) and the USACE Safety and Health Requirements Manual (Engineer Manual [EM] 385-1-1, 30 November 2014). The contents of the APP are subject to review and revision as new information becomes available.

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[1] EA Engineering, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC who does business as EA Science and Technology in State of New York.

1.1 SIGNATURE SHEET

Plan Preparer:
This APP has been prepared by a Qualified Person:

Adrian Hughes, II 23 December 2022

Name: Adrian Hughes, Certified Safety Professional (CSP), Associate Safety Professional (ASP), Professional Geologist (PG) Date
Title: Safety and Health Manager (SHM)
Company: EA Telephone: 410-584-7000

Plan Approvals:

An American Board of Industrial Hygiene (ABIH) – Certified Industrial Hygienist (CIH) and a CSP has supervised the preparation of, and reviewed and approved this APP.
Company: EA Telephone: 410-329-5192

23 December 2022

Name: Robert Marcase, CIH (ABIH No. 3118), CSP (Board of CSP No. 20560) Date
Title: Director of Safety and Health
Company: EA Telephone: 410-329-5192

Certification/Concurrence:

Project and program management has concurred with the elements of this APP. Site worker concurrence will be documented through signature on an APP/Site Safety and Health Plan (SSHP) review form.

Frank J Barranco Jr. Ph.D., P.G. 23 December 2022

Name: Frank Barranco, Jr., Doctor of Philosophy (PhD), Professional Engineer (PE), PG Date
Title: Director of Quality Control (QC)
Company: EA Telephone: 410-329-5137

Robert Casey 23 December 2022

Name: Robert Casey, PMP Date
Title: Project Manager
Company: EA Telephone: 315-565-6550

1.2 REVISIONS

Changes in the Performance Work Statement (PWS), field changes, or unanticipated site conditions may require APP modification and approval to retain field safety. Changes will be made by the Plan Preparer with input from other qualified personnel familiar with the types of work involved and current site safety issues. The revisions and/or APP addenda will also be submitted to USACE and AFCEC for acceptance. Revisions will be tracked and presented in a tracking table that follows the cover page. Qualifications of personnel are described in Chapter 4.

Personnel qualifications and resumes will be submitted under separate cover for government review as an entire project field and management team.

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2. BACKGROUND INFORMATION

This section presents a brief description of the project, Statement of Work (SOW), key personnel, and phases of work.

2.1 CONTRACTOR INFORMATION

EA Engineering, P.C. and its affiliate EA Science and Technology
269 W. Jefferson Street
Syracuse, New York 13202

2.2 CONTRACT NUMBER

EA is the prime contractor under contract with the USACE Baltimore District, Contract No. W912DR19D0005; TO No. W912DR22F0247.

2.3 PROJECT DESCRIPTION

The USACE Baltimore District has contracted EA to perform RIs for PFAS contamination resulting from AFFF, non-AFFF, and secondary PFAS releases at NFARS. NFARS is located in Niagara Falls, New York, approximately 15 miles north of the city of Buffalo. The installation, which adjoins the Niagara Falls International Airport, encompasses approximately 550 acres. The installation is fenced with controlled access. NFARS was established in November 1942 and operated by the Aerospace Defense Command, with numerous groups active on the installation between 1946 and 1971. In 1971, the installation was transferred to the Air Force Reserves command, and the 914th Tactical Airlift Group (later called the 914th Tactical Airlift Wing) became the installation host.

The historical use of PFAS containing AFFF have resulted in the environmental release of PFAS compounds (specifically perfluorooctanoic acid, perfluorooctane sulfonate, and perfluorobutane sulfonate) based on preliminary assessments and site investigations completed in 2018. The 2018 site investigation (Aerostar 2018) defined seven sites for additional RI activities based on observed PFAS concentrations.

This Phase I RI (site characterization, conceptual site model, and Phase I Report) is being performed to delineate the vertical and lateral extent of PFAS contamination in soil, groundwater, sediment, and surface water resulting from previous AFFF releases. Information gleaned from the Phase I RI sampling efforts will be used to develop a comprehensive and installation-wide conceptual site model to identify migration and exposure pathways from the identified PFAS source areas.

The seven sites being investigated under this TO (**Figure 2-1**) include:

- FT007P – AFFF Area 1: Former Fire Training Area (Site 9) and Outfall 7
- SS850P – AFFF Area 2: Hanger 850
- SS706P – AFFF Area 3: Building 706
- SS700P – AFFF Area 4: Building 700 and Outfall 4
- SS015P – AFFF Area 5: Blue Angels Crash Site
- SS101P – AFFF Area 6: Fox Row/Taxiway Alpha and Outfalls 5 and 9
- SS316P – AFFF Area 8: Hulby Street

2.4 SCOPE OF WORK

Brief descriptions of the work associated with the PFAS RI at NFARS are presented in the following sections. Detailed descriptions of the work are presented in the Uniform Federal Policy-Quality Assurance Project Plan developed for this project. Any significant changes or additional tasks that may be identified in the future will be submitted as addenda to this APP for review and approval by USACE and AFCEC.

The Activity Hazard Analyses (AHAs) and Coronavirus Disease 2019 (COVID-19) are listed in **Table 2-1** for tasks associated with the RI activities and are presented in further detail in **Attachment A**. Task-specific required equipment is listed in each AHA. Risk Assessment Codes (RACs) for the AHAs required to complete this task order do not indicate that high risk activities are to be completed.

General SOW includes the following:

- Mobilization and demobilization
- Synoptic groundwater level measurement with a water level indicator
- Complete direct-push technology (DPT) investigation
- Install new monitoring wells (MWs) and geotechnical analysis with DPT technology
- Collect soil, groundwater, sediment, and surface water samples. Soil samples will be collected during direct push investigations, groundwater and surface water samples will be collected with peristaltic pumps, and sediment samples will be collected with dedicated spoons

- Investigation-derived waste (IDW) disposal
- Porewater sampling with lysimeters
- Survey Sample locations

Table 2-1. Scope of Work and Site-Specific Activity Hazard Analyses

Work Phase	Site Mobilization	Groundwater Sampling	Well Installation	Soil Sampling	Sediment Sampling	Surface Water Sampling	IDW Handling	Site Demobilization
Mobilization/Demobilization	✓							✓
COVID-19 Hazard Mitigation	✓	✓	✓	✓	✓	✓	✓	✓
Drilling and Well Installation	✓		✓				✓	✓
Groundwater Sampling		✓					✓	✓
Sediment Sampling					✓		✓	✓
Soil Sampling				✓			✓	✓
Surface Water Sampling						✓	✓	✓

2.5 CONTRACTOR SAFETY INFORMATION

OSHA-recordable incident rate and lost-workday rates are comparable with the industry average. In addition, the insurance industry has developed an experience-rating system as an equitable means of determining premiums for Workers' Compensation Insurance (the experience modification rate [EMR]). This rating is based on a comparison of firms doing similar types of work, with the employer rated against the average expected performance in each work classification. For over 10 years, EA has been below the industry average. EA's EMR and recordable incident rate for the past 6 years are summarized in **Table 2-2**. The current OSHA Form 300 and 300A are included in **Attachment B**.

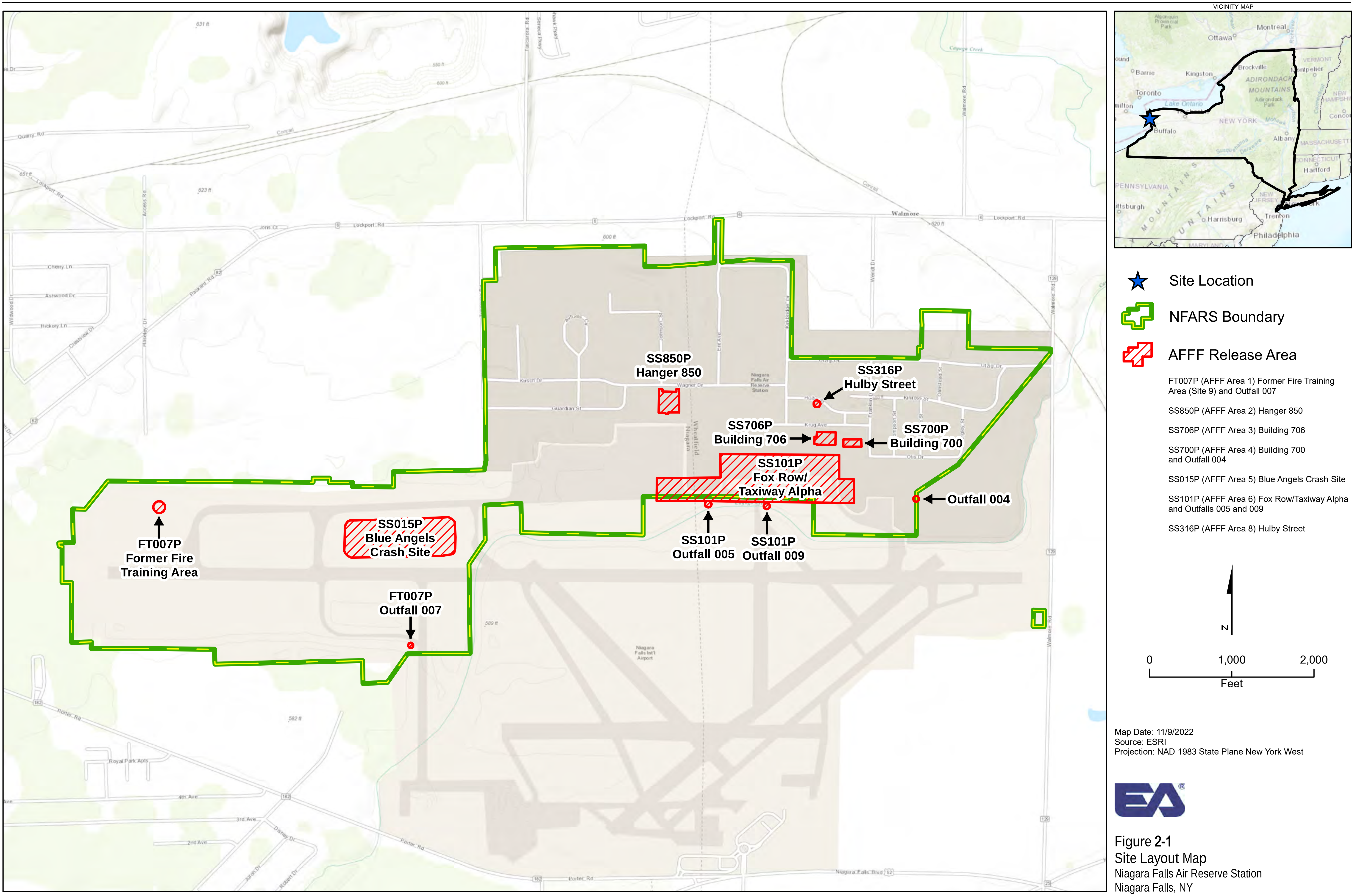
Table 2-2. Summary of EA Safety Information[1]

Metrics	2021	2020	2019	2018	2017	2016
Experience Modification Rate[2]	0.65	0.66	0.67	0.78	0.74	0.78
Number of Recordable Cases[3]	5	4	2	7	5	4
Total Recordable Incident Rate[4]	0.98	0.71	0.38	1.31	0.95	0.79
Total Hours Worked	1,231,888	1,123,596	1,062,015	1,072,638	1,055,170	1,008,144

Notes:

1. http://inside.ea/hands/Lists/Safety%20Statistics/AllItems.aspx
2. EMR: Proprietary insurance industry standard which normalizes average to 1.0; therefore, an EMR less than 1 indicates a risk level less than the industry average.
3. Total Recordable Incident Rate (TRIR): Number of recordable incidents per 100 full-time employees per unit time (1year).
4. Industry average for remediation services (North American Industry Classification System [NAICS] Code 562910) is 2 cases per 100 employees and for engineering services (NAICS Code 541330) is 0.7 cases per 100 employees. The average TRIR of these numbers is 1.35; therefore, EA has maintained a TRIR of less than industry average during this timeframe.

Safety and health information will be maintained onsite by the Installation Specific Site Safety and Health Officer (SSHO). It is not anticipated that a work trailer will be necessary for the site work. Therefore, the information will be contained in a mobile file located in the SSHO's vehicle and available to all workers and oversight personnel. The information will include a map illustrating the route to the nearest hospital, emergency phone numbers, a copy of the APP that includes copies of AHAs, OSHA Form 300A, Safety and Occupational Health Deficiency Tracking Log, and field logbooks, documenting daily health and safety meetings.



★ Site Location

🟩 NFARS Boundary

🟥 AFFF Release Area

FT007P (AFFF Area 1) Former Fire Training Area (Site 9) and Outfall 007

SS850P (AFFF Area 2) Hanger 850

SS706P (AFFF Area 3) Building 706

SS700P (AFFF Area 4) Building 700 and Outfall 004

SS015P (AFFF Area 5) Blue Angels Crash Site

SS101P (AFFF Area 6) Fox Row/Taxiway Alpha and Outfalls 005 and 009

SS316P (AFFF Area 8) Hulby Street

Map Date: 11/9/2022
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 2-1
Site Layout Map
Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\Figure 1-2 Site Layout Map.mxd

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3. STATEMENT OF SAFETY AND HEALTH POLICY

3.1 EA'S CORPORATE SAFETY AND HEALTH POLICY

EA considers the safety and health of its employees, clients, and visitors and the prevention of work-related accidents and illnesses and property loss to be of the highest priority. Proactively implemented, a comprehensive and systematic safety and health program will result in more efficient and profitable operations by improving employee health and morale, and by reducing Worker's Compensation costs, lost time, fire and liability insurance premiums, and property damage.

The objectives of EA's Safety and Health Program for this contract are to ensure:

- Sound safety and health practices and conditions necessary for the protection of the health and welfare of employees, subcontractors, clients, and visitors.

- Compliance with this APP and federal and state safety and health regulations and standards.

- Effective safety and fire prevention practices necessary for protection of company-owned or operated and site property.

EA is committed to the overall goal of having no workplace injuries or safety incidents. A summary of EA's safety statics over the last several years are presented and discussed as part of our annual safety training program; which are detailed in Section 2.5 and **Table 2-2**.

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4. RESPONSIBILITY AND LINES OF AUTHORITY

EA is responsible for implementing a safety and occupational health program for protection of employees in the workplace and, as addressed in this APP and the Installation Specific Addenda APP, on project sites. As such, EA has established roles and responsibilities for implementing the safety program at the corporate, project management, and field/task levels. This APP presents the site-specific requirements that will ensure compliance with EA's corporate program while maintaining compliance with federal and client requirements. EA retains full responsibility for the implementation of this APP. Site personnel are responsible for adherence to this APP during the performance of their work. No person may work in a manner that conflicts with the intent of, or the inherent safety and environmental precautions expressed in, these procedures. Furthermore, employees working on-site have the authority to stop work if unsafe conditions exist.

4.1 CORPORATE AND PROJECT LEVEL IDENTIFICATION AND ACCOUNTABILITY OF PERSONNEL FOR SAFETY

Personnel required for completion of the PWS to be performed under this APP include corporate, management, technical, and safety personnel. The key roles and respective personnel filling those roles for the proposed work are presented in the sections below. As demonstrated in the responsibilities required of each role, and as discussed in subsequent subchapters, EA maintains separate lines-of-authority for technical task management and safety to limit conflicts of interest between the need to maintain project deliverables, budget and schedule, and safety. Contact information for key personnel is presented in Chapter 9 and addenda. Competency in performing several of the roles listed below is detailed on resumes and certifications provided in **Attachment C** and meets or exceeds requirements presented in EM 385-1-1 01.A.17. **Table 4-1** presents project personnel, their involvement on the project, responsibilities, and the organization these individuals represent.

4.1.1 Program Manager

The Program Manager will provide program management communication and the point-of-contact for the delivery order and will review safety plans, ensure client-specific safety and health requirements are followed, periodically monitor field operations, and communicate with safety personnel.

4.1.2 Business Unit Director

The Business Unit Director is accountable for implementation of the safety and health program; may contractually obligate the company; ensures time and budget are applied to training; conducts periodic reviews of safety and health procedures; ensures employees follow safety and health procedures; and requires Project Managers to implement corrective actions, if necessary.

4.1.3 Project Manager

The Project Manager is accountable for allocating resources to the project to develop and implement this APP; direct corrective actions, if required; review/investigate work-related injuries and illnesses; and report accidents/incidents in accordance with requirements presented in Chapter 9. The Project Manager will assist in submission of safety-related documents for acceptance.

4.1.4 Safety and Health Manager

The SHM is accountable for development and enforcement of this APP/SSHP through oversight and implementation, audits and inspections, remaining available for project emergencies, modifications, evaluation of exposure monitoring, and approval of safety documents. The SHM is also accountable for providing expertise, opinion, and resolution to safety issues from employees; arranging and providing required safety and health training for workers within their region(s) of responsibility; assisting with investigation of accidents and near-misses; ensuring medical surveillance program requirements are followed; ensuring monitoring programs are properly designed; and conducting hazard assessments documented through the generation of site-specific AHAs.

4.1.5 Site Safety and Health Officer

The SSHO is accountable for ensuring on-site adherence to the APP/SSHP by EA employees and subcontractors; mitigating unsafe work conditions; proper application of monitoring equipment; leading initial on-site investigations of accidents, near misses, and occupational illnesses; providing incident reports to project management; confirming qualifications and training of on-site personnel; performing on-site safety-related briefings; coordinating health and safety monitoring and APP compliance with subcontractors; inspections; and investigating on-site hazardous conditions. The SSHO may designated a supporting collateral duty Designated Representative (DR) from each individual subcontractor for appropriate communication of safety-related hazards, controls, and process revisions. The resume and certifications for the SSHO are provided in **Attachment C**.

4.1.6 Designated Representative

A collateral duty DR will support the SSHO as requested by the SSHO and may perform temporary and collateral safety duties when the SSHO is offsite for short durations. The DR will assist specifically with heat stress monitoring performance and documentation, quality assurance (QA) checks for personal monitoring, assistance with calibration of equipment, and general support of the SSHO during site activities.

4.1.7 Supervisors and Employees

Supervisors are accountable for ensuring employees receive training in hazard recognition and safe work practices, periodically monitoring activities to ensure conformance with training, investigating/reporting incidents, investigating employee reports of hazardous conditions, and mitigating hazardous conditions. Employees, including subcontractors, are accountable for following the training, following safe work practices, notifying the SSHO and supervisors of new hazardous conditions, reporting incidents, and participating in pre-task/pre-entry/on-site training. Specific safety responsibilities of subcontractors are addressed in Chapter 5.

4.2 TRAINING REQUIREMENTS AND EQUIVALENCIES

Training and competency requirements for site personnel are presented in Chapter 6. This includes the applicability of the OSHA 30-hour classes, requirements stated in EM 385-1-1 Chapter 01.A.17, and ensuring that training includes the following topics or equivalent topics: OSHA Act/General Duty Clause; (b) 29 CFR 1904, Recordkeeping; (c) Subparts C, CC, D, E, F, K, and M of OSHA; and (d) rigging, load handling equipment, welding and cutting, scaffolding, excavations, concrete and masonry, demolition, health hazards in construction, materials handling, storage and disposal, hand and power tools, motor vehicles, mechanized equipment, marine operations, steel erection, stairways and ladders, and confined spaces or any others that are applicable to the work being performed.

No work will occur beyond those topics presented above. The Chapter 9 sub-plans and the hazard analysis process evaluate each of the Chapter 2 tasks and have determined the applicability of the training and proof-of-competency required. Training requirements are presented in Chapter 6 and proofs-of-competency are presented in **Attachment C**.

4.3 COMPETENT AND/OR QUALIFIED PERSONS

The following personnel are designated as Competent and/or Qualified Persons to complete the scope of services. Proof-of-competency is provided using resumes and certifications provided in **Attachment C** and required trainings and certifications are presented in Chapter 6. The designated Competent/Qualified Persons are included in the AHAs provided in **Attachment A**. The SSHO will maintain copies of personnel certifications on the project site and supplement **Attachment C**. The personnel, roles, and their competencies are presented in **Table 4-2**.

Competent or Qualified Persons provided by subcontractors will be identified prior to the initiation of that task and will be presented in the AHAs. All personnel will need to satisfy the training, certification, and inspection requirements highlighted in Chapters 5, 6, and 7, respectively. Any additional Competent or Qualified Persons identified prior to initiation of a task will be provided in subsequent addenda.

4.4 REQUIREMENTS FOR PRE-TASK SAFETY AND HEALTH ANALYSIS

The SHM has evaluated the activities associated with implementation of the site work and have determined potential hazards associated with the activities. The results of the hazard analysis and hazards are documented using AHAs (**Attachment A**). As part of the three-phase control process, AHAs will be submitted and accepted at or before the pre-mobilization preparatory meeting. In addition, site personnel will be required to review this APP and associated supplemental plans and will be given a pre-entry/pre-construction briefing on the contents of the APP and associated supplemental plans. The SSHO will provide the pre-entry/pre-construction briefing, which will include discussion of site description; site control measures; Emergency Response Plan and procedures; general and task-specific hazards and hazard controls including AHAs; task-specific personal protective equipment (PPE) requirements; task-specific environmental monitoring requirements and action levels; lines- of-authority and communication; stop work authority in cases of safety non-compliance; Hazard Communication Program; location of hazardous materials; identification and recognition of hazardous materials; physical and health hazards of hazardous materials; and protective measures when working with hazardous materials.

4.5 REQUIREMENTS FOR INITIAL ACTIVITY HAZARD ANALYSIS SUBMISSION AND ACCEPTANCE

AHAs are not required to be submitted concurrently with the APP or associated required attachments; however, all AHAs will be submitted and accepted at or prior to the preparatory meetings. All AHAs will be resubmitted if the field methodology changes require an increase in the RAC score and/or if the increase in the RAC score results in a high-risk task or activity.

4.6 REQUIREMENT FOR WORK STOPPAGE WITHOUT COMPETENT PERSON

No work shall be performed by the contractor unless a designated competent person and/or SSHO is present on the job site. All site personnel have stop-work authority. Competent persons required to complete sitework are listed in **Table 4-2**.

4.7 NON-COMPLIANCE WITH SAFETY REQUIREMENTS

EA requires that employees and its subcontractors shall adhere to this APP and associated supplemental plans. All personnel maintain stop work authority.

Progressive disciplinary action is used to deal with non-compliance issues. For EA employees, this includes the following:

- First offense will warrant a verbal warning, explanation of why the activity was non-compliant, and reference the section of the APP the activity lacking compliance was presented.
- A second offense, if it is of the same nature, will warrant a written warning and may lead to removal from the job site. If the second offense is not the same non-compliance issue as the first, additional explanation of why the activity was non-compliant will be discussed and the employee will be required to re-review the APP.
- A third offense will lead to removal from the job site.
- If additional offenses are perpetrated on other project sites, the employee may be suspended or terminated.

If subcontractors are non-compliant with safety requirements, they will be given verbal and written warnings for the first two offenses. If additional offenses occur, the subcontractor may be removed from the project site.

4.8 LINES-OF-AUTHORITY

EA maintains separate lines of reporting for technical task management and safety in order to limit conflicts of interest between the need to maintain safety and maintain project deliverables, budget, and schedule. Safety personnel have the authority to require and implement changes with regard to site safety and all site personnel maintain stop work authority. The Corporate QA/QC Officer, in addition to the SSHO, can request changes to the APP. The Corporate QA/QC Officer will inform the Program Manager and Project Manager of the required changes.

If there is disagreement between safety and management at the SSHO and Project Management level, the disagreement will be elevated to the Corporate QA/QC Officer, SHM, and the Program Manager for resolution. The Corporate QA/QC Officer, SHM, and the Program Manager have the ability to elevate safety issues to EA's President/Chief Executive Officer, if required, for resolution. Work related to the identified safety issue or hazard will not resume until a safe resolution is agreed upon. The USACE Project Manager and the AFCEC Remedial Project Manager (RPM) will be notified by the Project Manager of safety issues that result in a work stoppage or required change to the APP. **Table 4-1** and **Figure 4-1** present project personnel, their involvement on the project, the organization these individuals represent, and contact information.

4.9 COMPANY PROCEDURES FOR MANAGER AND SUPERVISOR ACCOUNTABILITY FOR SAFETY

EA's commitment to safety and health is documented, and requirements addressed, from the time an offer of employment is made to a job applicant. Managers and supervisors are made responsible for enforcing safety and health as part of their job descriptions. They are ultimately responsible for protecting the health and welfare of the employees, as well as minimizing the potential liability associated with on the job or work-related accidents.

A manager or supervisor has the authority to assign and direct personnel on project tasks. As such, the Project Manager and SSHO will possess knowledge of the correct safe procedures for tasks that will be performed under their supervision. If there is question as to the appropriate safety measures, the SSHO or Project Manager will seek assistance from the SHM. If any task cannot be accomplished safely, it will not be attempted.

In addition, at a minimum of once per year, each employee's performance is formally evaluated in the following areas: personal commitment to safe work practices, adherence to established health and safety plans and programs, ability to recognize safety hazards, communication skills, acquisition and proper use of PPE and monitoring equipment, and proper budgeting for safety and health aspects in projects.

Unsatisfactory performance in any of the above areas by supervisors or managers is addressed through implementation of performance improvement plans; mandatory additional training; lower overall compensation; and, if appropriate, termination.

4.10 REQUIREMENTS FOR PRE-TASK SAFETY AND HEALTH ANALYSIS

The SHM has evaluated the activities associated with implementation of the site work and has determined potential hazards associated with the activities. The results of the hazard analysis and hazards are documented using AHAs (**Attachment A**). In addition, site personnel will be required to review this APP, review associated supplemental plans, and will be given a pre-entry/pre-construction briefing on the contents of the APP and associated supplemental plans. The SSHO will provide the pre-entry/pre-construction briefing, which will include discussion of the following items:

- Site description
- Site control measures
- Emergency Response Plan and procedures
- General and task-specific hazards and hazard controls including AHAs
- Task-specific PPE requirements
- Task-specific environmental monitoring requirements and action levels
- Lines-of-authority and communication
- Stop work authority in cases of safety non-compliance
- Hazard Communication Program
- Location of hazardous materials
- Identification and recognition of hazardous materials
- Physical and health hazards of hazardous materials
- Protective measures when working with hazardous materials.

Table 4-1. Contact Information of Key Personnel

Project Personnel	Role	Primary Location/ Time Zone	Email Address	Phone Number
Lindsay Mairs	AFCEC Base RPM	Niagara Falls/EDT	Lindsay.mairs@us.af.mil	716-236-3125
Tom Heins	USACE Project Manager	Niagara Falls/EDT	Thomas.r.heins@usace.army.mil	716-236-2049
Brenda Herman	EA Program Manager	Hunt Valley/EDT	bherman@eaest.com	410-913-1681
Barbara Roeper	EA Deputy Program Manager	Hunt Valley/EDT	broeper@eaest.com	410-746-0147
Gordy Porter	EA Business Unit Director	Hunt Valley/EDT	gporter@eaest.com	410-329-5113
Robert Casey	EA Project Manager	Syracuse/EDT	rcasey@eaest.com	315-565-6550
Robert Marcase	EA Director of Health and Safety	Hunt Valley/EDT	rmarcase@eaest.com	410-329-5192
Adrian Hughes, V	EA SHM	Hunt Valley/EDT	ahughes@eaest.com	410-527-2059
Joseph Von Uderitz	Project Geologist	Syracuse/EDT	jvonuderitz@eaest.com	315-382-9534
Samantha Saalfield	Project Chemist	Hunt Valley/EDT	ssaalfield@eaest.com	410-527-2491
Michael Wright	EA Site Safety and Health Officer	Syracuse/EDT	mwright@eaest.com	315-565-6572
Amanda Kohn	EA Field Manager	Syracuse/EDT	akohn@eaest.com	315-565-5648
Jeremy Fontaine	EA Field Geologist	Syracuse/EDT	jfontaine@eaest.com	315-849-4194

Notes:
EDT = Eastern Daylight Time
TBD = To be determined

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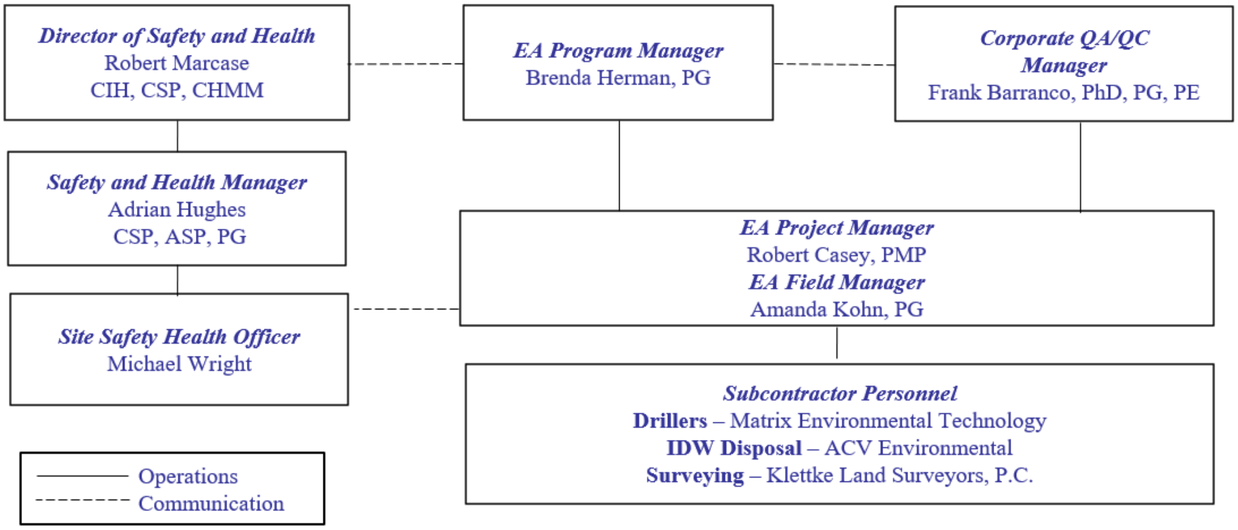
Table 4-2. Competent and/or Qualified Persons

Role	Name(s)	Activities
Director of Health and Safety	Robert Marcase, CIH, CSP	Director of Safety and Health. Review and approval of the APP/SSHP, hazard identification, resolution of unanticipated safety issues, and forwarding safety documents and/or resolutions to the USACE and AFCEC for acceptance.
SHM	Adrian Hughes, CSP, ASP, PG	Program SHM. Review and approval of the APP/SSHP, hazard identification, resolution of unanticipated safety issues, and forwarding safety documents and/or resolutions to the USACE and AFCEC for acceptance.
Field Manager	Amanda Kohn, PG	Site management; subcontractor oversight; residential cover activities, support SSHO.
SSHO	Michael Wright, GIT	Overall safety for EA and subcontractor personnel; all site work. For the work, Exception 3 of 01.A.17 of EM 385-1-1 allows a collateral duty SSHO with 12+ months of collateral duty Safety and Occupational Health experience with monitoring skills.
DR	Jeremey Fontaine, GIT	Personal monitoring (air and temperature-related stress); support SSHO with documentation.

Notes:
Competent persons are presented on AHAs (**Attachment A**).
No qualified persons, as described in EM 385-1-1, are required to complete work described in the PWS.
Subcontractors and suppliers are presented in Chapter 5.
GIT = Geologist in training

Figure 4-1. Lines-of-Authority for EA Corporate and Site Activities (Safety)



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5. SUBCONTRACTORS AND SUPPLIERS

5.1 IDENTIFICATION OF SUBCONTRACTORS AND SUPPLIERS

The following subcontractors have been identified to support the PFAS RI for NFARS:

- **Klettke Land Surveyors, P.C.** Surveyor to perform surveying of MWs and locations of environmental samples.

- **Matrix Environmental Technology:** DPT for soil sampling. Drilling services for MW installation. DPT groundwater samples.

- **Pace Analytical (Baton Rouge, Louisiana)** Laboratory for analyses of environmental samples.

- **Environmental Data Services:** Data validation of laboratory analytical results.

- **ACV Environmental** Disposal of IDW generated during RI.

Additional subcontractors and associated competent/qualified persons (if necessary) will be identified prior to the start of the activity being performed and will follow the requirements of this document. Coordination and safety responsibilities of subcontractors are presented below. Off-site work conducted by subcontractors is not covered by this APP.

5.2 SAFETY RESPONSIBILITIES OF SUBCONTRACTORS

Subcontractors providing onsite services will be required to review and abide by this APP. Specific responsibilities of subcontractors include:

- Complying with the requirements of their SOW

- Maintaining a safe and healthy work environment

- Complying with contract requirements, laws, regulations, and EM 385-1-1

- Reviewing this APP to ensure that the safety and health requirements of their specific tasks are satisfied

- Performing work in accordance with the APP requirements

- Providing trained and experienced workers for the specific work activities

- Providing documentation of training to EA

- Participating in the Daily Safety Tailgate meetings

- Identifying additional training needs for unique tasks

- Participating in, and documenting, routine equipment and site inspection activities

- Ensuring equipment brought to the site is in good condition, routinely inspected, and maintained in safe working order

- Ensuring the SSHO, or designee, is aware of materials and equipment brought to the site and that the equipment is in good condition, routinely inspected, and maintained in safe working order.

6. TRAINING

EA will ensure site personnel and supervisors have received the required training to complete the pertinent phases of work in a manner that is consistent with the Safety and Health Policy goals and objectives highlighted in Chapter 3, and state and federal standards. All employees and supervisors working on this project receive safety and occupational health training upon hire and annually thereafter.

The SSHO will ensure that all employees engaged in site operations are informed regarding the nature and degree of exposure to chemical, physical, and biological hazards likely to result from participation in site operations. EA will accomplish this by ensuring that all personnel entering the site have received the appropriate training required to safely complete site-specific work prior to participation in site activities. OSHA-required training will be conducted prior to site mobilization and is documented through the certificates presented in **Attachment C**.

EA will conduct daily safety briefings summarizing site-specific activities and the training required to complete the on-site work. Site workers will have received the required training prior to the start of involvement in site activities and are required to attend daily safety briefings. Documentation of training, update frequency of training, time of initial training, training types, and personnel receiving the training are presented in **Table 6-1**.

The SSHO will brief all visitors to the site on the site hazards and controls. All visitors will be required to sign a visitor log and will always be escorted by the SSHO or Field Manager when work is occurring, or hazards are present.

Table 6-1. Mandatory Training and Certifications

Personnel	Training	When	Update Frequency (1)	Documentation
No Chemical Hazards Exposure	Pre-Entry Site Briefing Site Indoctrination	Initially	Newly Identified Hazards	APP Indoctrination
Visitors and Authorized Entrants	Visitor Briefing (by SSHO) (Escort by SSHO, or Site supervisor)	Prior to observing on-site work	Daily	Visitor's Log
Workers Exposed to COCs	Safety and Occupational Health Training (29 CFR 1910.120 I-compliant 40-Hour HAZWOPER)	Upon Hire	See 8-Hour Refresher	Corporate files
40-Hour Trained Personnel	Annual Health and Safety Refresher (29 CFR 1910.120 (e)-compliant 8-Hour HAZWOPER Refresher training)	Initially	Annually	Corporate files
	Medical Surveillance	Initially	Annually	Corporate Files
>2 Personnel	First Aid/CPR (in person, not online)	Initially	Bi-annually	Corporate files **Attachment C**
First Aid/CPR Providers	OSHA 1910.1030-Compliant Bloodborne Pathogen Training	Initially	Annually	Corporate files
SSHO	8^+ hours of annual/formal safety training over 4-year period	Rolling Aggregate	4-Year Total	Corporate files
	8-Hour Supervisor Training (Includes 8-Hour HAZWOPER Supervisor Training)	Initially	Does not expire	Corporate files **Attachment C**
	OSHA 30-Hour Construction Safety Course or equivalent in addition to 40-Hour HAZWOPER	Initially	Does not expire	Corporate files **Attachment C**
DR and/or SSHO	Personal air sampling/monitoring (Methods Presented in SSHP)	Initially	NA	Corporate files
	Dust Monitoring (total dust)	Initially	NA	Corporate files
	Operating photoionization detector	Initially	NA	Corporate files
	OSHA Heat Stress Application or Wet-Bulb Globe/Physiological Monitoring	Initially	NA	Corporate files
All On-site Personnel	Pre-Entry Site Briefing/ Site Indoctrination ("General Training")	Initially	NA	APP Review Form
	3^+ Days – on-the-job training	Initially	NA	Corporate files
	Emergency Response Training (Requirements in Section 9.2)	Initially	Prior to on-site work	APP Review Form
	Use of fire extinguishers (Annual and Emergency Response)	Initially	Annually	Corporate files
	Annual Health and Safety Refresher (29 CFR 1910.120 (e)-compliant 8-Hour HAZWOPER Refresher training)	Annually	Annually	Corporate files **Attachment C**
	PPE	Initially	Annually/ if retraining required (2)	PPE Training Form
	Daily Tailgate Safety Meeting (*Topics Exceed Monthly/Weekly Meeting*)	Daily	Not applicable	Daily Tailgate Safety Form
	Hot Environments Training	Initially	Annually	Corporate Files/ Tailgate Safety

Personnel	Training	When	Update Frequency [(1)]	Documentation
	Cold Environments Training	Initially	Annually	Corporate Files/ Tailgate Safety
	Novel Coronavirus Awareness	Initially	Annually	APP Review Form
Authorized Persons	Hazardous Energy Control Program	Initially	Annually	Corporate Files
EA and USACE	Safety Pre-Work Conference	Initially	NA	Meeting Minutes
Supervisors	Monthly Safety and Health Training and Planning Meeting [(3)]	Initially	Monthly	Annotation on Daily Form
	8-Hour Supervisor Training	Initially	Annually	Corporate Files
	Medical Monitoring – must show Compliance with 29 CFR 1926.62	Initially	Annually	Corporate Files **Attachment C**
Equipment Operators	Valid driver's license – operational experience	NA	Varies by Individual	Driver's License Corporate Files
	Equipment Inspection Protocols	Initially	Annually	Corporate Files/ Daily Tailgate
Heavy Equipment Operators (DPT Operator)	Valid driver's license	Not applicable	Varies by individual (on license)	Driver's license
	Cumulative training and operations experience (employer-provided)	Prior to onsite work	Not applicable	Subcontractor files

Notes:

1. Currently, EA utilizes an automated system to notify the Director of Safety and Health/SHM and the employee when a training or certification is about to expire. Employees are required to communicate their plan to update the training/certification with the Director of Safety and Health and will be provided with resources to meet training/certification requirements. Subcontractor safety documentation will be reviewed prior to on-site work and periodically to ensure continued compliance.
2. Retraining requirements are at the discretion of health and safety personnel based on accuracy and compliance.
3. In the event any field events last longer than 1 month.
4. "Initially" indicates either upon hire or prior to on-site work.

COC = Contaminant of concern
CPR = Cardiopulmonary resuscitation
HAZWOPER = Hazardous Waste Operations and Emergency Response
NA = Not applicable

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7. SAFETY AND HEALTH INSPECTIONS

Periodic safety and health-related inspections are required at the NFARS site. **Table 7-1** summarizes inspectors, frequency of the inspection, and documentation. The qualifications of the inspectors stated below are presented in **Attachment C**. If a deficiency is found during the inspection process, the SSHO will note the date the deficiency was identified, a description, name of the person responsible for correcting the deficiency, the projected date of correction, and once corrected, the date the deficiency is actually resolved. This information will also be recorded in chronological order on a deficiency log posted in the site work area. The SSHO will perform a follow-up inspection and note the corrective measures taken and the date the correction was completed. The deficiency, follow-up actions, and statuses will be noted on the Daily Safety Inspection Checklist and the deficiency will be discussed during subsequent daily tailgate safety briefings. No external inspections or certifications are required to complete the work in this PWS.

A summary of inspections is presented in **Table 7-1**, and the forms to document the inspections are presented in **Attachment D**.

Table 7-1. General Safety and Health Inspection Requirements

Personnel [1]	Inspection	Timing	Documentation [3]
SSHO (Assisted by DR)	General Site Conditions (e.g., vehicles, documents, etc.)	Initial and Daily	Initial and Daily Safety and Health Inspection Checklist Health and Safety Activity Report
	PPE	Initial and Daily	Initial and Daily Safety and Health & Health and Safety Activity Report Dispose of PPE, if faulty
	Emergency Equipment: - Fire extinguisher - First aid kit - Portable eyewash containers	Initial and Monthly	Initial Safety and Health Inspection Monthly Safety and Health Inspection
	Exposure hours	Daily (Monthly)	Site Entry and Exit Log (Logged daily and reported monthly)
	Physiological monitoring (heat stress prevention) (Employees in Level D)	**Tables 9-5 and 9-6**	Daily Environmental Monitoring Record
	Physiological monitoring (heat stress prevention)	**Tables 9-5 and 9-6**	Daily Environmental Monitoring Record
	Air temperature, wind speed, inclement weather risk	≥2x Daily	Daily Environmental Monitoring Record
	Personal Sampling Pumps	≥2x Daily	Daily Environmental Monitoring Record
	Respirators and cartridges	Daily	Respirator Logs and Cartridge Logs
	Deficiency tracking and associated Inspection(s)	Daily	Deficiency Tracking Log Deficiency Tracking Safety Inspection
	Excavations	Daily/ Changes	Daily Safety and Health Inspection
	Refueling tank/spill kit	Daily	Daily Safety and Health Inspection
	Refueling tank certification	30 Months	Initial Safety and Health Inspection
	General safety and health	Daily	Daily Safety and Health Inspection
Authorized Persons	HECP Inspections	Daily	**Attachment D** Field Forms
All Employees	PPE	Before use	None; dispose of PPE, if faulty
	Hand tools and equipment	Before use	None; dispose of faulty equipment/supplies.
Project QC Manager	QC Officer review of safety	Daily	Daily Safety and Health QC Form
Licensed Driller	Well installation and completion equipment	Daily	USACE Drilling Checklist USACE Rigging and Wire Rope Checklist
SHM	Fire Prevention Plan Survey	Annual	Fire Prevention Plan Audit
	Safety and Health Audits	Random	EA Corporate Audit Forms
	Fire prevention	Annual	EA Corporate Audit Forms

Notes:

1. Personnel associated with titles are presented in Chapter 4.
2. Monitoring frequency is weather-dependent and presented in the SSHP (**Attachment E**).
3. Any deficiencies and related information will also be recorded in chronological order on a deficiency log posted in the site work area in accordance with Chapter 7.
4. USACE Drilling Checklist and USACE Rigging and Wire Rope Checklist are included in Attachment D.

HECP = Hazardous Energy Control Plan

8. MISHAP REPORTING AND INVESTIGATION

EA will track exposure hours, mishap notifications and reporting, and accident investigations at NFARS. EA will monitor employee exposure hours using the Site Entry and Exit Log (**Attachment D**). Site personnel are required to sign-in and sign-out each time they enter and exit the site. These hours will be compiled monthly by the SSHO and will be provided to the EA Program Manager on the first workday of the month. The EA Program Manager will provide these data to the USACE by the 10th day of the subsequent month.

8.1 FIELD EXPOSURE DATA REPORTING

EA will report contractor field exposure hours (total hours on-site including unpaid hours and individual subcontractor hours) monthly to USACE. Reporting will be completed by the EA Project Manager or their designee.

8.2 MISHAP REPORTING AND INVESTIGATION

A mishap is defined as any unplanned, undesired event that occurs during the course of work being performed. Mishaps include accidents, incidents, and near misses. Employees will immediately report all mishaps to the SSHO who will report the accident to the Project Manager, Supervisors, Program Manager, Director of Safety and Health/SHM, Corporate QA/QC Officer, and Human Resources. The SSHO will complete the EA Accident/Loss Report[2] and submit it immediately to the Director of Safety and Health and the Project Manager. The Project Manager will report to the USACE Project Manager and the AFCEC RPM. All recordable mishaps must be communicated to the USACE Project Manager and the AFCEC RPM as soon as possible and within 24 hours of the accident with the exception of the following events, which must be reported immediately: fatality, permanent partial or total disability, hospitalization of one or more people from a single incident, or property damage of $500,000 or more.

EA is also responsible for reporting property damage (exceeding $5,000 is recordable), days away injuries, days away illnesses, and restricted/transfer injuries to the USACE Project Manager and the AFCEC RPM. In addition, EA is responsible for reporting any fatality to the State Occupational Health and Safety Bureau within 8 hours and any inpatient hospitalization, amputation, or eye loss within 24 hours.

Any mishap occurring in any of the following high hazard areas will be immediately reported to the USACE:

- Electrical (e.g., arc flash, electrical shock, etc.)
- Uncontrolled release of hazardous energy (electrical and non-electrical)
- Load handing equipment or rigging
- Fall-from-height (any level than the same surface).

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[2] Available on the EA intranet site.

The above mishaps will be investigated in depth to identify all causes and to recommend hazard control measures.

An accident investigation will be conducted for all mishaps. Reportable accidents will be investigated by the SHM including occupational injuries and illnesses; accidents resulting in significant loss or damage to property; accidents involving vehicles whether or not they result in damage to property or personnel; and accidents in which there may have been no injury or property damage, but which have a high probability of recurring with at least a moderate risk to personnel or property (near miss). Minor accidents will be investigated by the SSHO. An accident investigation will be used to determine and implement corrective actions, identify the causal factors contributing to the accident, identify deficiencies to the APP, provide information to identify trends or problem areas, and follow requirements for Workers' Compensation and/or OSHA recordkeeping and reporting. Results of the accident investigation along with the appropriate corrective actions will be sent to the USACE Project Manager and the AFCEC RPM as soon as possible.

The SSHO will provide the Director of Safety and Health/SHM, Corporate QA/QC Officer, and the Project Manager with an update once the corrective action has been implemented. The EA Project Manager will notify the USACE Project Manager and the AFCEC RPM of the status of the corrective action. Contact information for individuals involved in accident reporting procedures is presented in Section 9.2.2.

9. SUPPLEMENTAL PLANS

Supplemental plans are presented in the order described in Appendix A of EM 385-1-1 and Checklist A-02; however, the order, name, and some descriptions of plans differ from Data Item Description HNC-002 for APPs.

9.1 FATIGUE MANAGEMENT PLAN

A Fatigue Management Plan has been completed for the NFARS site, because it is anticipated that during the life of the project, the following triggers for a Fatigue Management Plan will be met:

- Exceed 10 hours a day for more than 4 consecutive days
- Exceed 50 hours in a 7-day work week
- Exceed 12 hours a day for more than 3 consecutive days
- Exceed 58 hours a week for sedentary (to include office) work.

Fatigue can be defined as a state of impairment that can include physical and/or mental elements. This is associated with lower alertness and ultimately reduced performance. Fatigue is the result of insufficient rest and sleep between activities and symptoms are not easily recognized. Rest is defined as a period of time during which the person concerned is off duty; is not performing work, including administrative tasks; and is afforded the opportunity for uninterrupted sleep. This does not include time for breaks, meals, or travel time to/from work.

9.1.1 Scope

All work tasks have been noted that would require fatigue management control.

9.1.2 Application

All employees are subject to fatigue; however, equipment operators and motor vehicle operators are the primary focus because of the use of equipment or vehicles that can put others in harm's way. A minimum of 8 consecutive hours of rest between shifts in a 24-hour period is required for equipment and motor vehicle operators.

Equipment operators are defined as operators of equipment, including but not limited to, the following that may be found on-site hoisting equipment and draglines, mobile construction equipment, electrical power systems, and hydraulically operated equipment. These operators are not permitted to exceed 12 hours of duty time in any 24-hour period, including time worked at another occupation.

Motor vehicle operators are defined as operators of motor vehicles while on duty. These operators shall not operate vehicles for a continuous period of more than 10 hours in any 24-hour period; no employee, while on duty, may operate a motor vehicle after being in a duty status for more than 12 hours during any 24-hour period.

9.1.3 Evaluation of Risk

Generally, activities will not consistently exceed the hours above; therefore, the level of risk is determined to be low. If site hours or site conditions change, then the risk evaluation will be updated and submitted as an addendum.

9.1.4 Controls

Controls for fatigue may include work scheduling (limit number of consecutive night shifts), rotating jobs to prevent repetitive work, breaks at critical times in the work cycle, control of environmental factors (heat, cold, and use of PPE), buddy check-in for individuals working alone, and alternate transportation for long commutes. Extensive commute times are prevalent between EA offices and the work site.

Two types of fatigue controls can be used: administrative controls and workplace controls.

Administrative Controls:

- Alternate work tasks
- Allow for more frequent or longer breaks
- Alternative commutes
- Healthy food (lower sugar)
- Administrative employees take a walk
- Alternating, limit, or eliminating night shifts
- Schedule high risk tasks when most alert

Workplace Controls:

- New fatigue mats
- Adequate lighting
- Lifting devices
- Work assistance in lifting and holding
- Good ventilation, either cool or heat depending
- Ability to move around every hour or so
- Use of PPE
- Alarms or monitors

9.1.5 Training

Training shall include symptoms of fatigue, habits, and actions the worker may take to avoid fatigue, actions workers should take if they observe fatigue in a co-worker, and controls in place to prevent fatigue. This training will be integrated into the safety kickoff and periodically throughout the life of the project in Daily Tailgate Safety Meetings.

9.1.6 Procedures

The following procedures will be utilized for work tasks identified as having a risk of fatigue:

- Work tasks will be planned to eliminate or minimize fatigue, including utilizing the controls discussed in Section 9.1.4.
- Workers will be provided with adequate breaks.
- Workers will be encouraged to arrive to work in a rested state (ideally 8 hours of sleep, at least 5 hours of interrupted sleep).
- Symptoms of fatigue and work hours for equipment and vehicle operators will be monitored by employees and the SSHO. Symptoms include excessive yawning, reduced alertness, and reduced reaction time.

If a fatigued employee is identified, their task will be re-assigned to a non-fatigued employee. The fatigued employee will be safely transported (vehicle operated by other) to an area for rest.

9.2 EMERGENCY PLANS

An emergency is defined as a situation that requires calling outside help onto a job site. Depending on the phase of work, field personnel will immediately stop work and report to the SS/SSHO under the following situations: medical emergency, fire emergency, spill emergency, discovery of unanticipated hazards (e.g., heavily contaminated materials), heavy equipment accident, overexposure of personnel to on-site contaminants requiring Emergency Medical Services, or heat/cold-related injury or stress requiring Emergency Medical Services support.

Personnel are prohibited from working alone and will always abide by the buddy system and continue work within similar zones of work. No Civil Disaster Emergency Operations will occur as part of this SOW.

9.2.1 Procedures and Tests

Prior to work start-up, personnel will be familiar with this Emergency Response Plan. A test of cellular phone coverage will be made across the entire work area and will be conducted prior to mobilization to ensure that emergency services can be alerted in the event of an emergency.

Prior to the start of work at the site, field personnel will conduct a drill to mobilize to the rally point as determined by the SSHO prior to the start of work. Alternate rally point locations will be communicated to field personnel. Additionally, the SSHO will review the provisions of this plan during the pre-entry site briefing. The SS/SSHO will make this plan available for review and photocopying. Emergency contact numbers are provided in **Table 9-1**. Directions to the nearest hospitals (**Figure 9-1**) will be posted in the work area and maintained in work vehicles.

In the event of an emergency, the information available at that time will be properly evaluated and the appropriate steps taken to implement the Emergency Response Procedures. The SSHO will assume command of the situation and will call the appropriate emergency services and evacuate personnel to the rally point (as indicated by SSHO) where attendance will be taken. On-site emergencies will ultimately be handled by off-site emergency support personnel (i.e., the local fire department, ambulance squad, or police, depending on the nature of the emergency) who will have authority once they arrive. Information garnered on-site will not be released to parties other than those listed in this section and emergency responders. Once emergency response agencies have been notified, the Project Manager will then be notified immediately.

Site personnel will retreat to the Support Zone rally point (where the daily tailgate meeting occurs daily) or evacuate at the discretion of the SSHO.

No rescue activities will occur beyond traditional first aid/CPR procedures at this site. Contact personnel for emergencies is discussed above and in Chapter 9.2.2.

9.2.2 Posting of Emergency Telephone Numbers

Emergency telephone numbers will be posted in the support zone at the job site and kept in support vehicles. Additional copies will be distributed to site personnel by the SSHO. The SSHO will have the phone numbers readily available on his/her person or in their vehicle. Emergency contact information is presented in **Table 9-1**.

Table 9-1. Emergency Contact Numbers

Contacts	Name	Office/Work	Mobile
Ambulance, Fire, and/or Police	Emergency Services	911	NA
Hospitals (24-Hour Emergency Rooms)	Mt. St. Mary's Hospital	716-297-4800	NA
EA Program Manager	Brenda Herman	NA	410-913-1681
EA Corporate Safety and Health Director	Robert Marcase	410-584-7000	410-329-5192
EA SHM	Adrian Hughes	410-527-2059	410-913-1531
EA Project Manager	Robert Casey	315-565-6550	315 430-7429
EA Field Manager	Amanda Kohn	315 565-6548	315 506-2556
EA SSHO	Michael Wright	315-565-6572	315 565-6572
AFCEC RMP	Lindsay Mairs	716-236-3125	NA
USACE PM	Tom Heins	716-236-2049	917-275-3373
Poison Control	NA	800-222-1222	NA
One-Call	NA	811	NA
EPA National Response Center	NA	800-424-8802	NA
AllOne Medical Services (Physician – On Call)	All One Health Resources	800-350-4511	NA
Federal OSHA Hotline	NA	800-321-6742	NA

Figure 9-1. Hospital Map and Directions from Niagara Falls Air Reserve Station to Mt. St. Mary's Hospital (24-Hours)

6.1 miles and 12 minutes

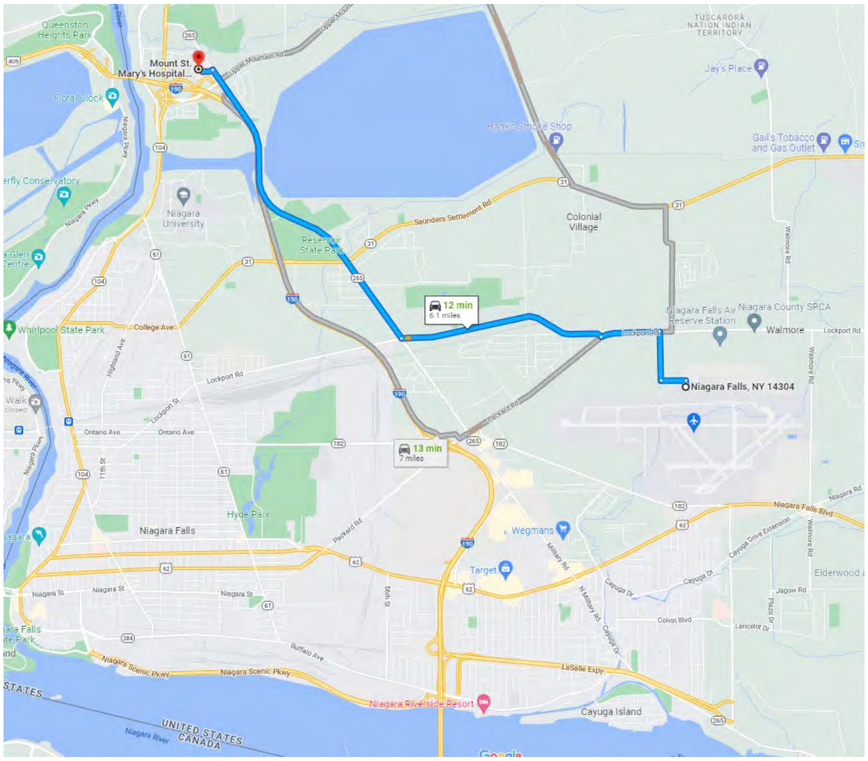
Phone: 716-297-4800

Hospital Address:

5300 Military Road,
Lewiston, New York
14092

Route to Hospital:

1. Head north on Blewett Avenue.
2. Turn right onto Tuscarora Road (0.2 miles)
3. Turn left onto Lockport Road (0.4 miles)
4. Turn right onto Joris Ct/Lockport Road (0.5 miles
5. Turn right onto NY-265 N (1.8 miles)
6. Turn left into Mt St. Mary's Hospital Emergency Room (3.0 miles)



Record of Communication with Hospital		
Person Calling Hospital	**Date**	**Result of Call**
Patrick Gannon	20221104@ 1038 EDT	Hospital will accept personnel from the site. Personnel did not state desire to visit location. Personnel reiterated COVID-19 may affect availability of beds within the Intensive Care Unit.

Note:
The Hospital will be contacted prior to mobilization to ensure that patients are being accepted and space is available for care.

9.2.3 Spill Emergency Response Plan

The scope of services included in this Contract does not include shipping or receiving liquid hazardous materials, nor the storage of significant quantities of fuels or petroleum products. All vehicles fueling and lubrication shall only be conducted off site at commercial fuel stations. The contractor will perform containment and cleanup immediately in the event of mobile equipment hydraulic system leaks or fuel release to prevent soil and groundwater contamination. The contractor will provide spill kits at the project site, which can be utilized immediately in cases of small spills resulting from mobile equipment. Spill containment material (spill kits) will be staged in an easily accessible area on-site to facilitate immediate spill response. Storm drains shall be identified and protected appropriately in the event of a spill.

If hazardous or unknown potentially hazardous materials are unexpectedly spilled during project work activities; evacuate and secure the area (to keep out all personnel). Call for assistance and be careful not to become exposed to the material. The SSHO, and depending on the size of the spill, the Project Manager shall be contacted. For large spills of hazardous materials, a Hazardous Materials Response Team may need to be contacted to limit exposures to site personnel and/or the community. Emergency numbers are listed on **Table 9-1**. Construction equipment available on-site will be used to contain spills, as necessary.

9.2.4 Firefighting Plan/Fire Emergency Response Plan

Site personnel will not attempt to handle a fire/explosion emergency. The SSHO will take measures to reduce injury and illness, primarily by evacuating personnel as quickly as possible. The SSHO will then notify the Project Manager. Site personnel will evacuate the area and gather/meet at the rally point (as indicated by the SSHO). The SSHO will be responsible for identifying if any site personnel did not gather at the rally point.

The Firefighting Plan will be presented by SSHO and reviewed by site workers as part of the pre-entry site briefing (Chapter 6). In addition, the Director of Safety and Health, EA's designated authority for fire prevention and emergency response, prepares the fire hazard evaluation program, which is reviewed by EA employees during annual employee safety and occupational health training.

As part of this plan, the SHM has evaluated the operations and type(s) of equipment/materials to determine potential fire or explosion hazards and will convey this information to site personnel through the SSHO. Training requirements are listed in **Table 6-1**. A fire and/or explosion will be immediately recognized as an emergency. Emergency services (fire, police, and ambulance) will immediately be notified by the SSHO (emergency numbers are provided in **Table 9-1**). A copy of the emergency numbers will be included in the site support vehicle.

Cleanup after such events may require specialized services and are not covered by this APP/SSHP. The Project Manager will establish proper cleanup actions through coordination with emergency services personnel, with input from the USACE Project Manager or AFCEC RPM. Emergency contact information is presented in **Table 9-1**.

9.2.5 Posting of Emergency Telephone Numbers

Emergency telephone numbers will be posted in the support zone at the job site and additional copies will be kept in site support vehicles. Emergency contact information is presented in **Table 9-1**.

9.2.6 Plan for Prevention of Alcohol and Drug Abuse

Employees are strictly prohibited from any activity related to using, possessing, manufacturing, selling, transporting, distributing, storing, concealing, and/or dispensing any controlled or illegal substances, as defined by federal or state law, on the premises of EA, while conducting EA business (including travel), during EA-sponsored activities, or in off-the-job activities. This includes places of public accommodation or recreation, restaurants, and common carriers. Violation of this policy will result in immediate removal from the site and appropriate disciplinary action, up to and including termination of employment. If the employee is observed by another employee as not “fit-for-work” for any reason, contact the employee’s immediate supervisor or Corporate Human Resources as the situation will be managed as any other performance problem. EA may drug test/screen employees at any time. Drug testing procedures are part of corporate policy and are not covered within this plan. Additionally, EA employees are to have no expectation of privacy with respect to any property brought onto site premises or carried during travel, including air travel. Specific information can be obtained from Corporate Human Resources. No part of this plan grants employees contract rights or changes their status as “at-will” employees.

9.3 SITE SANITATION/HOUSEKEEPING PLAN

Housekeeping**—**The work area will be kept as clean as possible including frequent trash removal and efforts to keep pathways clear of materials and debris. Efforts will be made to move all equipment and supplies daily and to prevent equipment and personnel from traversing the site form contacting materials and/or debris.

Drinking Water**—**Adequate bottle drinking water will be provided to all site workers and will be stored in coolers within dedicated site vehicles and in the support zone of each work area. Sufficient quantities will be provided to ensure a minimum of 4 ounces per worker per working hour on-site. Drinking water will be supplemented with electrolyte beverages.

Non-Potable Water**—**No non-potable water will be utilized for dust suppression activities and will not be consumed by site personnel.

Toilets**—**At least two portable toilets will be brought on-site and will be within 10 minutes of the work area. Fewer than 16 employees will be on-site; therefore, only one toilet is required. If more than one sex is present on-site, one additional portable toilet will be provided. A portable hand washing station will be present.

Washing Facilities**—** Each vehicle, the portable restroom, and the support zone will also be furnished with a bottle of hand sanitizer and eyewash container in addition to the hand washing facilities.

Showers and Food Service**—**No showers or food service area is necessary for the completion of site activities.

Waste Disposal**—**All municipal wastes (trash, dunnage, etc.) will be removed from the site in a timely manner from adequately located waste receptacles to prevent a health hazard.

9.4 MEDICAL SUPPORT AGREEMENT

Less than 100 personnel will be required on-site to complete this job; therefore, on-site medical support is not required for this project. At least two people currently trained in first aid/CPR will be present on-site. Training requirements are presented in Chapter 6. Off-site medical support will be provided by professional medical services presented in **Table 9-1** and **Figure 9-1**. Medical facilities identified in **Table 9-1** have been contacted to confirm that injured employees will be able to receive prompt treatment. No work tasks with a high or extremely high RAC on the AHAs have been identified; therefore, arrangements do not need to be confirmed in writing.

9.5 BLOOD-BORNE PATHOGEN PROGRAM AND EXPOSURE CONTROL PLAN

This site-specific plan will be applied in conjunction with the EA Corporate Bloodborne Pathogen Exposure Control Plan and OSHA 29 CFR 1910.1030, which will be available for consultation by site employees. This plan applies to personnel who will potentially be providing first aid/CPR as the completion of the work required in the PWS will not expose site personnel to bloodborne pathogens. OSHA definitions relating to bloodborne pathogens are covered during training.

Based on a review of the work required, only site personnel providing first aid/CPR will potentially be exposed to bloodborne pathogens. Universal precautions and PPE will be used by providers of first aid/CPR to prevent contact with blood or other potentially infectious materials when working with employees who have an injury or in areas where the injury may have contaminated surfaces. PPE required for the program is presented in Chapter 5 of the SSHP (**Attachment E**). No decontamination of PPE will occur; all PPE will be disposed. Work areas will be kept clean and sanitary and will be decontaminated after contact with blood/potentially infectious materials with a dilute bleach solution. Information pertaining to the Hepatitis B vaccination series; post-exposure reporting, evaluation, and follow-up procedures; and recordkeeping practices and requirements are presented in the EA Corporate Bloodborne Pathogen Exposure Control Plan, which is present on EA's intranet. Training requirements are presented in Chapter 6.

9.6 EXPOSURE CONTROL PLAN

Based on a review of the work required in the PWS the NFARS site, only site personnel providing first aid/CPR will potentially be exposed to bloodborne pathogens. Universal precautions and PPE will be used by providers of first aid/CPR to prevent contact with blood or other potentially infectious materials when working with employees who have an injury or in areas where the injury may have contaminated surfaces. PPE required for the program is presented in Chapter 5 of the SSHP (**Attachment E**). No decontamination of PPE will occur; all PPE will be disposed. Work areas will be kept clean and sanitary and will be decontaminated after contact with blood/potentially infectious materials with a dilute bleach solution. Information pertaining to the Hepatitis B Vaccination series; post-exposure reporting, evaluation, and follow-up procedures; and recordkeeping practices and requirements are presented in the EA Corporate Bloodborne Pathogen Exposure Control Plan, which is present on the EA intranet at all times.

COVID-19 is addressed in Section 2.3.9 of the SSHP (**Attachment E**). Training requirements are presented in Chapter 6.

9.7 AUTOMATIC EXTERNAL DEFIBRILLATOR PROGRAM

No automatic external defibrillators will be located on-site.

9.8 SITE LAYOUT PLANS

The scope of services does not include any construction activities, establishing access routes, temporary facilities, etc. **Figure 9-2** contains the features of the layout plan descriptions below as well as equipment laydown areas. Placement of these structures will occur during the mobilization phase of work and the site layout map will be updated prior to the start of site work. A site layout map will be utilized by the SSHO during the Tailgate Safety Briefing to inform the workers of the location of hazardous areas on the site, restroom facilities (including hand wash facility), assembly areas to be used in the event of site evacuation, and any other information relevant to the day's activities.

At this time, the support zone remains a general area surrounding Site 4. This area and the Warm Zone (descriptions provided in the SSHP, **Attachment E**) have imperfect boundaries pending the results of the vegetation and biological surveys. Following the results of these surveys, vegetation clearance will allow increased resolution of the site layout.

The layout will ensure that equipment and vehicles have full ingress and egress, room is ensured for backing-in of vehicles, placement of portable restrooms and hygiene stations, and general site work.

9.8.1 Temporary Construction Buildings

No temporary construction buildings will be placed.

9.8.2 Facilities

A portable restroom/hand washing facility will be placed adjacent to the Treatment System if need be. Locations are illustrated on **Figure 9-2**.

9.8.3 Fencing

No fencing will be used.

9.8.4 Access Routes

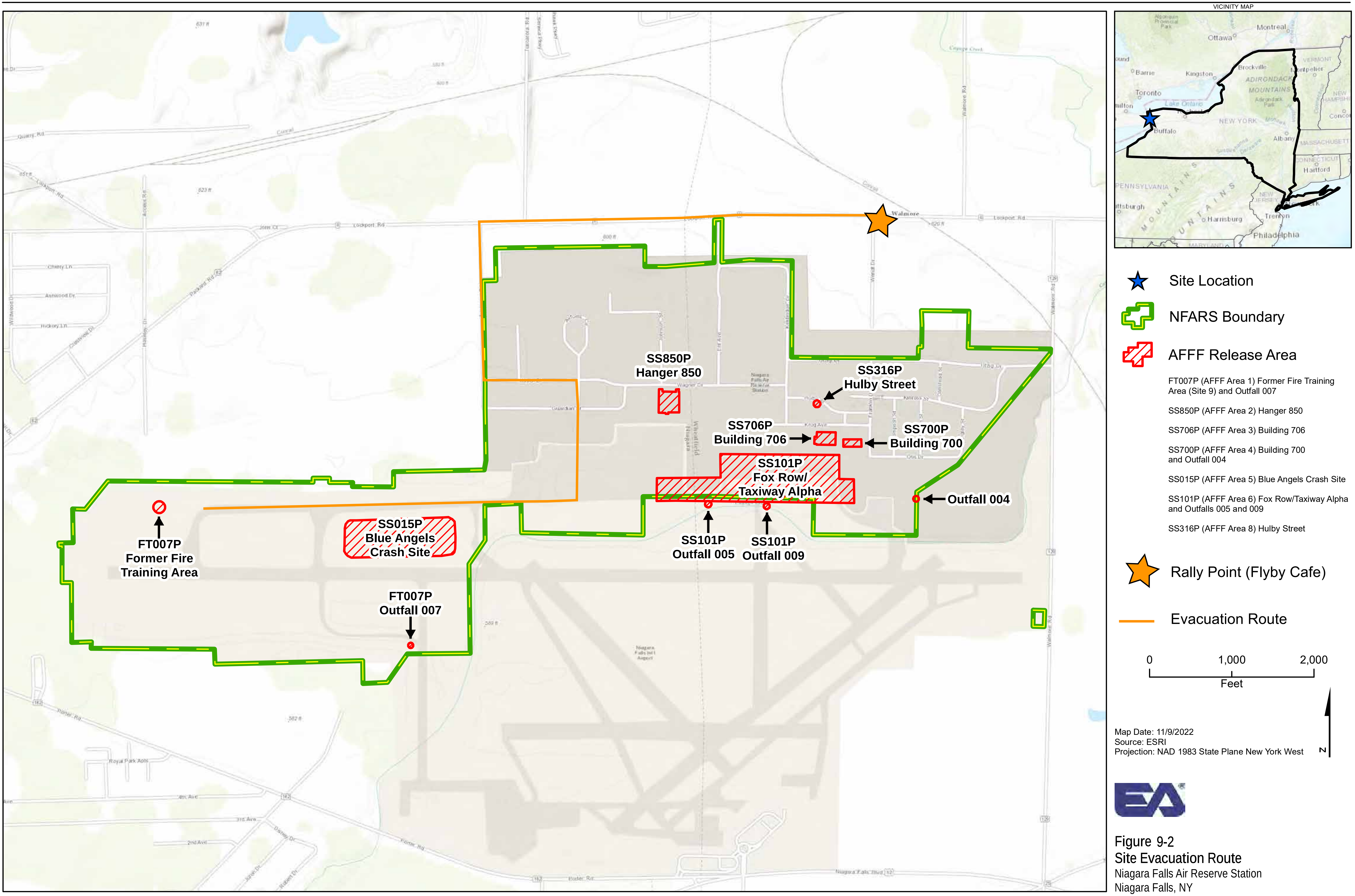
Access to the work site is from various municipal roads, and access to the site will be through Tuscarora Road. Access during emergency situations is identical to the access described above. Access to the work areas will be restricted to authorized personnel. The routes will allow equipment and vehicles to have full ingress and egress, room is ensured for backing-in of vehicles, placement of portable restrooms and hygiene stations, and general site work. Site vehicles will be organized to ensure a bottleneck, close-proximity turns, or head-in facing vehicles during site work.

9.8.5 Anchor Systems for Temporary Structures

No temporary construction buildings will be placed.

9.8.6 Temporary Facility Spacing

No other temporary facilities will be placed.



Map Date: 11/9/2022
Source: ESRI
Projection: NAD 1983 State Plane New York West

Figure 9-2
Site Evacuation Route

Niagara Falls Air Reserve Station
Niagara Falls, NY

\eafp\Departments\Federal\MAES_2019\Projects\12_W912DR22F0247_Niagara Falls PFAS RI\05_GIS\Planning Documents\Figure 1-2 Site Layout Map.mxd

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9.8.7 Temporary Power Distribution Approval

No temporary power distribution is needed for the completion of the PWS.

9.8.8 Temporary Ramp, Trestle, Scaffold, and Platform Approval

No ramps, trestles, scaffolds, or platforms will be used to complete the PWS.

9.9 ACCESS AND HAUL ROAD PLAN

An access or haul road plan will not be required for the completion of the PWS.

9.10 HEARING CONSERVATION PROGRAM

EA will evaluate the workplace for noise hazards initially and regularly during the course of work. The hearing conservation program applies to all employees who are exposed to hazardous noise or ototoxic chemicals during Chapter 2 tasks. None of the following ototoxic chemicals (including arsenic, carbon disulfide, carbon monoxide, cyanide, lead and derivatives, manganese, mercury and derivatives, n-hexane, Stoddard solvent, trichloroethylene, toluene, and xylenes) will be encountered during work tasks.

Trace concentrations of styrene were identified through sampling of the asphalt; however, it is not present in liquid or vapor form and personnel will be unlikely to have contact with styrene based on the controls presented in previous and following chapters.

Workers will be made aware of potential noise hazards prior to the start of tasks with noise hazards. Medical surveillance (Chapter 6 of the SSHP [**Attachment E**]) includes pre-employment and end-of-employment testing for all employees.

9.10.1 Noise Hazard Identification

Completion of the Chapter 2 tasks are anticipated to expose employees to instantaneous noise levels greater than the National Institute for Occupational Safety and Health (NIOSH) recommend exposure limit; however, noise concentrations are not anticipated to be continuous. The SHM has screened the on-site equipment versus the Federal Highway Administration Construction Noise Handbook.[3] Based on this screening, personnel outside of 50 feet of the following equipment will experience: a pickup truck (55 decibels on the A-weighted scale [dBA]), an operating backhoe (80 dBA), a front-end loader as the telehandler proxy (80 dBA), and a skid steer (80 dBA). Conversely, operators[4] will be exposed to noise concentrations that frequently exceed the NIOSH Recommended Exposure Limit though often not the OSHA Probable Effects Level. Based on these data and the exposures observed historically, hearing protection (subsequently discussed) will be sufficient to protect workers during the initial exposure assessment. When the hammer is in use on

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[3] https://www.fhwa.dot.gov/Environment/noise/construction_noise/handbook/handbook09.cfm
[4] https://www.cdc.gov/Niosh/mining/UserFiles/works/pdfs/hcensu.pdf

the DPT Rig, personnel within 25 feet will be exposed to sound pressure levels near 120 dBA and exposed to levels near 85 dBA during general operation.

Noise measurements shall be made whenever there is difficulty in communicating at distances greater than 2 feet (0.6 meters), upon worker complaint of excessive noise, or whenever hazardous noise levels are suspected. Noise assessments and/or measurements shall be performed and documented when any new facility or new equipment is placed in service and when areas that in the past were not noise hazards become noise hazardous for any reason.

9.10.2 Assessment of Noise Hazards

Workplaces known or suspected to include hazardous noise will be surveyed initially, annually, and whenever site conditions change impacting noise generation. The following will be followed for the assessment of noise hazards:

For continuous (steady state) noise and impact (impulse) noise, the instrument settings shall be in accordance with **Table 9-2**.

Dosimeters shall measure the employee's full work shift to be considered full-shift sampling.

Calibration of noise measuring equipment shall be in accordance with (IAW) manufacturer's instructions (USACE refer to Engineer Regulation 385-1-89).

The anticipated unit for use will be a Lutron Personal Noise Dosimeter (DS-92005). If this unit is unavailable near the time of mobilization, the updated unit(s) chosen will be submitted to the USACE and AFCEC for acceptance.

Table 9-2. Settings for Noise Measuring Equipment

Feature	**Dosimeter (ACGIH)**	**Dosimeter (Department of Defense and USACE) ***	**Type 2 (or better) Sound Level Meter for Continuous Noise (USACE)***	**Type 1 Sound Level Meter for Impulse Noise (USACE)***
Criterion Time	8 hours	8 hours	8 hours	8 hours
Criterion Level	85 dBA	85 dBA	85 dBA	85 dBA
Weighting	A	A	A	Unweighted, linear, or Z
Peak Weighting	Unweighted	Unweighted, linear, or Z	Unweighted, linear, or Z	Unweighted, linear, or Z
Threshold Level	80 dBA	80 dBA	80 dBA	140 dBA
Upper bound on integration	130 dBA	None	None	None
Time Weighting	Slow	Slow	Slow	Impulse
Exchange Rate	5 dBA	3 dBA	3 dBA	3 dBA

Notes:
* When used for the purposes of delineating noise hazardous areas or evaluating noise exposures to personnel.
ACGIH = American Conference of Governmental Industrial Hygienists

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[5] https://inspectusa.com/lutron/database/pdf/ds-9200.pdf

9.10.3 Exposure Standards

Work using heavy equipment often creates excessive noise. Noise can cause workers to be startled, annoyed, or distracted; it can cause physical damage to the ear, pain, and temporary and/or permanent hearing loss; and it can interfere with communication. For impact (impulse) noise, personnel exposures may not exceed 140 dBA (unweighted) without effective hearing protection devices.

No impact or impulse noise is anticipated to be encountered based on the SOW. The Demolition Plan is pending and if the anticipated methodology changes and will increase the risk of noise exposure, then an addendum will be submitted for review.

If workers are subjected to noise exceeding an 8-hour time-weighted average sound level of 85 dBA, hearing protection will be provided with an appropriate noise reduction rating to comply with 29 CFR 1910.95 and reduce noise levels to or below 85 dBA. Workers involved near heavy machinery operation activities are likely to be subjected to noise exceeding sound levels of 85 dBA peak sound pressure. At this level, hearing protection will be selected by the SSHO with an appropriate Noise Reduction Rating to reduce noise levels to or below these values (**Table 9-3**).

Table 9-3. Non-Department of Defense Continuous Noise Exposures (OSHA Standard)

Duration per day (hours)	**Permissible Sound Pressure Level (dBA)**
8	85
4	88
2	91
1	94
0.5 = 30 minutes	97
0.25 = 15 minutes	100

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, the combined effects must be considered. Exposure to different levels for various periods of time shall be computed according to the following formula:

$$Cn = T1 / L1 + T2 / L2 + . . . + Tx / Lx$$

where

Cn = Combined noise exposure factor.
T = Total time of exposure at a specified sound-pressure level (in hours).
L = Total time of exposure permitted at that level (in hours), from **Tables 9-2 or 9-3**, as appropriate. If the sum exceeds 1, the mixture of exposure periods exceeds the threshold limit value.

9.10.4 Noise Controls

Hearing protection will be worn when working within 50 feet of heavy equipment (e.g., skid steer) that is in operation. Adequacy of the hearing protection will be verified by utilizing a sound level meter application with a 5 dBA safety factor to take noise level measurements. The action level will be 85 dBA for all sitework, as stated above.

Elimination of noise through engineering controls is not viable on-site. Administrative controls are viable; however, they will not be used as the noise hazard may be adequately controlled using PPE and the greater physical hazard is an incident pertaining to equipment operator change outs.

The necessary controls will include hearing protection comprised of formable earplugs with a 32 dBA or greater noise reduction rating or muffs with a 30 dBA or greater noise reduction rating. Based on the NIOSH-recommended effective reduction factors, this will provide combined protection of 16 dBA and 23 dBA, respectively.

Personnel within 25 feet of active hammer use require double hearing protection, personnel within 50 feet of equipment and outside of 25 feet will require single hearing protection, and all other personnel are required to remain greater than 50 feet away from the site.

9.11 RESPIRATORY PROTECTION PLAN

No respiratory hazards are identified during Chapter 2 tasks. Wells are of small scale and dust suppression will be used when visible dust is observed; however, the levels fall below nuisance dust level for all activities and the potential exposure to silica is compliant with the OSHA silica standard.

No EA personnel are anticipated to be donning respirators; however, the EA SSHO will ensure training and compliance requirements have been met prior to allowing personnel to don respiratory protection. The SHM is the Respiratory Program Administrator for EA and will support an addendum if EA personnel will don respiratory protection. Voluntary use of respirators will be managed under the OSHA Appendix.

EA will monitor potential respiratory hazards, will implement feasible engineering, and work practice controls to reduce the hazard, and will evaluate action levels for upgrading or downgrading respiratory protection, and personnel authorized to perform each task requiring respiratory protection. If it determined that a Respiratory Protection Plan is required for EA personnel as work progresses a site-specific respiratory protection program, in accordance with EA’s Corporate Respiratory Protection Program will be developed as an addendum to this APP and submitted to the USACE and AFCEC for review.

Improper use of respirators can be hazardous to the employee’s safety and health. Selection of the wrong equipment may result in the employee being unknowingly exposed to the hazard; and thus, inhaling harmful concentrations. Respirators that are not properly maintained, inspected, and cleaned can reduce the protection afforded, as well as cause skin irritation and place a greater strain on the respiratory system. An improper respiratory protection program may give the employee a false sense of security that could lead to harmful exposures. The purpose of this plan is to ensure that employees who must wear respirators are adequately protected, and that respirator usage complies with the requirements of the OSHA Respiratory Protection Standard (29 CFR 1910.134). **Note**: Fit testing on the exact respirator that meets respiratory protection requirements is required prior to donning respiratory protection. Site personnel have not been finalized at the time of publication of this APP; therefore, prior to site work requiring a respirator, the full resume and certification package, and fit testing completion will be submitted to the USACE and AFCEC. No work will occur with respirators as PPE without fit testing using respirators that meet or exceed the minimum respiratory protections. Also note that no respiratory protection is anticipated if no spillage of the caustic materials occurs.

9.12 HEALTH HAZARD CONTROL PROGRAM

The presence of hazards will be assessed through identifying work phases and potential physical, chemical, biological, and radiological hazards associated with those work phases. Work phases for this site are listed in Chapter 2. The hazards and related controls, including engineering controls and PPE, for activities performed during these work phases were assessed by the SHM during development of this APP and are described in AHAs included in **Attachment A** and the SSHP (**Attachment E**). To understand potential hazards associated with each required activity, AHAs are reviewed with on-site personnel prior to performing site tasks.

9.13 HAZARD COMMUNICATION PROGRAM

The purpose of this Hazard Communication Program is to ensure that important information regarding hazardous chemicals used, handled, or stored during the conduct of business is transmitted to employees and other affected persons as appropriate. A hazardous chemical as defined by OSHA means any chemical that is either a physical hazard or health hazard and includes hazardous chemicals generated during work operations. Chemical hazard information will be made available to employees and other affected persons, as appropriate, through the implementation of this comprehensive program, which includes container labeling and other forms of warning, collection, and compilation of safety data sheets (SDSs), and training. A summary of the hazard communication program, as it pertains to this PWS, is presented below.

Chemicals that are used in non-commercial quantities for the purpose, duration, and composition for which it was intended for commercial usages (e.g., Windex® used as intended in the home), are excluded from the HAZCOM requirements.

9.13.1 Chemicals Included in the Hazard Communication Program

The program applies to hazardous chemicals that are known to be present in the workplace and used or stored in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency. It is the responsibility of the SHM with support of the SSHO to ensure that chemical materials meet the provisions of this Hazard Communication Program. If there are any questions regarding the applicability of these program requirements to a particular material or situation, the SHM will be consulted.

9.13.2 Lists of Hazardous Chemicals

No hazardous chemicals will be used, brought on-site, or manufactured. Non-hazardous chemicals brought on-site are presented by the SDSs in **Attachment F** and includes the name of each chemical, type of compound (e.g., flammable, corrosive, poison), date of the inventory, and location of the compound. The SSHO will maintain the list for the duration of the project, update the list appropriately, notify site personnel and the SHM of the addition of new compounds, and inform the site personnel of the associated hazards of those compounds. Small amounts of chemicals will be required for sample preservation. SDSs for all on-site chemicals, even non-hazardous chemicals, will be updated in a manner consistent with the above paragraph as new chemicals are brought on-site.

9.13.3 Labels and Other Forms of Warning

Site personnel will rely upon the original product labels to the extent practical. When labels must be applied to a temporary container, they will be printed in English and contain the following information:

- Identity of the hazardous chemical(s)
- Appropriate hazard warnings (i.e., any words, pictures, symbols, or combination thereof), which provide employees with specific information regarding the physical or health hazard(s) including primary target organ effect(s)
- Name of the chemical manufacturer, importer, or other responsible party, if appropriate.
- Labels and other forms of warning will be legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. If existing labels already contain the required information, new labels are not required.

9.13.4 Alternatives to Labeling, Tagging, or Marking Requirements

Alternatives to the above-referenced labeling, tagging, or marking requirements are described below:

- Signs, placards, process sheets, batch tickets, operating procedures, or other such written materials may be used in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the marking information required above. The written materials will be readily accessible to employees in their work area throughout each work shift. If this alternative system is utilized, it will be done only with approval of the SHM or the SSHO.

- Portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer, are not required to be labeled (e.g., fueling vehicles with gasoline).

9.13.5 Shipping Hazardous Chemicals

No shipping of hazardous chemicals is required for completion of this PWS. Decontamination methods (presented in the SSHP [**Attachment E**)] will not generate hazardous chemicals.

9.13.6 Safety Data Sheets

The SSHO will maintain a copy of the SDS for each new chemical brought on-site and will ensure that they are readily accessible during each work shift to employees when they are in their work area(s). While conducting site-specific field operations, the list of chemicals and the SDSs must be readily available on-site. SDSs are presented in **Attachment F** and will be kept on-site.

9.13.7 Employee Information and Training

At a minimum, training will be conducted at the Pre-Entry Briefing and whenever a new physical or health hazard (e.g., new material brought on-site) the employees have not previously been trained in is introduced into their work scope.

9.14 PROCESS SAFETY MANAGEMENT PLAN

A Process Safety Management Plan is not required to complete Chapter 2 tasks because it does not include the use or storage of any highly hazardous chemicals.

9.15 LEAD COMPLIANCE PLAN

A Lead Compliance Plan is not required to complete Chapter 2 tasks because it does not include lead hazard control activities.

9.16 ASBESTOS ABATEMENT PLAN

An Asbestos Abatement Plan is not required to complete Chapter 2 tasks because it does not include asbestos abatement activities.

9.17 RADIATION SAFETY PLAN/RADIATION PROTECTION PLAN

A Radiation Safety Plan/Radiation Protection Plan is not required to complete Chapter 2 tasks because it does not include the handling of radioactive material or the use of radiation generating devices.

9.18 ABRASIVE BLASTING PROCEDURES

An Abrasive Blasting Plan is not required to complete Chapter 2 tasks because it does not include abrasive blasting.

9.19 HEAT STRESS MONITORING PLAN

It is the responsibility of the SSHO, with support from the DR, and each employee to ensure that temperature stress controls are adequate for the site conditions and tasks. All employees are empowered and expected to stop or modify work and take any precautionary measures to prevent temperature-related illnesses. Temperatures are very stable and are approximately 30/32 degrees Celsius (°C) (86/90 degrees Fahrenheit [°F]) during the day and 24/25 °C (75/77°F) at night, with little annual variations.[6]

Heat stress hazards can occur even in temperatures not commonly considered “hot” due to the level of physical activity, the level of PPE the worker is wearing, or the physical condition of the worker. Site training will include symptoms of heat-related illnesses and prevention techniques. Personnel will be familiar with the signs and symptoms of heat stress, including the following:

- **Heat Cramps**—Muscle spasms in the abdomen or limbs. Frequent rest periods and fluid intake are appropriate measures to prevent or reduce heat cramps.

- **Heat Exhaustion**—Severe dehydration; pale, clammy skin; profuse sweating; dizziness, light-headedness; slurred speech; rapid pulse; confusion; fainting; fatigue; cool skin; nausea. Affected personnel will be escorted from the site, set in a cool, shaded area, and given fluids slowly.

- **Heat Stroke**—Life-threatening condition occurring when the body’s temperature-regulating system improperly functions. Hot dry skin; rapid, deep breathing; lack of perspiration; delirium; high fever (often 106°F or more), nausea; unconsciousness. Brain damage and/or death may occur if body temperature is not reduced. Provide fluids, use cooling devices (hose-down or shower), call emergency medical services or transport to hospital immediately.

Heat stress prevention techniques include:

- Resting frequently in a shaded or air-conditioned area (site support vehicles).

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[6] https://www.weather-us.com/en/newjersey-usa-climate

- Allowing workers who are not acclimatized to take additional breaks. Note that all presumed workers are local personnel.

- Drink at least 8 ounces of water or diluted electrolyte drink mix every 15–20 minutes.

- Monitoring workers on a periodic basis as described below.

Heat stress monitoring will be conducted in a manner that anticipates and prevents the onset of heat stress symptoms (i.e., work-rest regimens). The radial pulse of each worker will be counted by the SSHO or DR during a 30-second period as early as possible during the rest period immediately following work activities. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will be maintained. If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be shortened by another one-third. When ambient temperatures are expected to exceed 75°F, the resting heart rate of each worker will be measured by the workers and reported to the DR or SSHO prior to the start of on-site activities.

All work will occur in Level D or Modified Level D PPE excluding asbestos-related work and unless a spill of liquid occurs on-site. The PPE suites are presented in the SSHP (**Attachment E,** Chapter 5) and reinforced in the AHAs (**Attachment A**).

The buddy system will be applied to assist in compliance with radial pulse measurement and to ensure that observations of site personnel are maintained continually within each work-rest cycle. This system will also be in place to ensure a compliant rate of fluid consumption. A Wet-Globe Bulb will be used to calculate the adjusted temperature. The frequency for physiological monitoring is provided in **Table 9-4**.

Table 9-4. Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Adjusted Temperature (°F)		**Monitoring Interval (Minutes of Work)**
90	Above 90	45
87.5	90	60
82.5	87.5	90
77.5	82.5	120
72.5	77.5	150

Notes:

1. Assumes work levels of 250 kilocalories/hour (e.g., a moderate work level). Consider increasing the frequency for heavier work rates.
2. Adjusted Air Temperature: Calculate the adjusted air temperature by using this equation:

. *Adjusted Temperature*(°F) = *Air Temperature*(°F) + ([*13*] × [*% sunshine*]).

4. Measure the air temperature with a standard thermometer, with the bulb shielded from radiant heat. Estimate the percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow.
5. 100% sunshine = no cloud cover and a sharp, distinct shadow/0% sunshine = cloud cover and no shadows.

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6. Adapted from: NIOSH/OSHA/U.S. Coast Guard/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Chapter 8 (1985).
7. Only local personnel will be used to perform the work to ensure full acclimatization.

The suggested and work-rest regimen is provided in **Table 9-5**.

Table 9-5. Suggested Work-Rest Regimen[1]

Ambient Temperature (°F)	Work Period (Hours)	Rest Period (Minutes)
70	3.0	15
75	2.5	15
80	2.0	15
85	1.5	15
90	1.0	15
95	0.5	15

Notes:

[1] https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html#screening

$WBGT_{eff} = WBGT_{out}$ + Clothing Adjustment Factor (CAF) (Use Celsius)

Other factors, such as a worker's level of acclimation, level of physical fitness, and age, may increase or decrease his/her susceptibility to heat stress. Before assigning a task to an individual worker, these factors will be taken into account to ensure that the task will not endanger the worker's health. Sunscreen lotions will be provided and used per manufacturer's recommendations.

If a heat-related illness is suspected or observed, the affected person will be moved to a cool or shaded area and given plenty of liquids to consume. If symptoms of a heat stroke are observed, the victim will be cooled, and site personnel will immediately call 911.

9.20 COLD STRESS MONITORING PLAN

Cold stress hazards are most likely to occur at low temperatures or low wind chill factors, with wet, windy conditions contributing to risk. As temperatures could fluctuate during these events, workers will be trained in signs and symptoms of cold stress and controls. If unexpected cold weather occurs, workers will be trained in signs and symptoms of cold stress and controls. Workers will be familiar with the signs and symptoms of cold stress, which include:

- ***Hypothermia***—Cold-induced decreasing of the core body temperature that produces shivering, numbness, drowsiness, and muscular weakness. If severe enough, it can lead to unconsciousness and death.

- ***Frostbite***—Constriction of blood vessels in the extremities, decreasing the supply of warming blood may result in formation of ice crystals in the tissues, causing tissue damage. Condition may range from frostnip, which is a numbing of extremities, to deep-freezing tissue beneath the skin. Symptoms include white or grayish skin, blisters, numbness, mental confusion, failing eyesight, fainting, shock, and cessation of breathing. Death may occur from heart failure.

Pain in the extremities may be the first warning of cold stress and precautions will be taken to reduce exposure. Maximum severe shivering will be taken as a sign of immediate danger to the worker and exposure to cold will be immediately terminated. Personnel exhibiting signs and symptoms of cold stress will be removed from the site and given appropriate first aid. Emergency medical services will be contacted if symptoms are severe (e.g., more than numbness of the extremities or shivering). Employees will not be immersed in water.

As a precautionary measure, employees will wear layers of loose-fitting clothing including insulated coveralls, head cover, gloves, and boots when temperatures fall below 40°F. Protection of the hands, feet, and head is particularly important because these are likely to be injured first by cold. However, actual injury to hands, feet, and head is not likely to occur without prior development of early signs of hypothermia such as numbing and shivering. Bare skin-contact with cold surfaces (below 32°F) will be avoided. No continuous exposure to cold is permitted when the air speed and temperature results in an equivalent chill temperature of 26ºF or less. The equivalent chill temperature will be determined by the using the wind chill temperature shown in **Table 9-6**. Warm rest areas (support vehicles) will be provided. Air temperature and wind speed will be monitored at least every 4 hours at air temperatures below 45ºF.

Table 9-6. Wind Chill Temperature

		Wind Speed (miles per hour)										
		0	5	10	15	20	25	30	35	40	45	50
Air Temperature (ºF)	40	40	36	34	32	30	29	28	28	27	26	26
	35	35	31	27	25	24	23	22	21	20	19	19
	30	30	25	21	19	17	16	15	14	13	12	12
	25	25	19	15	13	11	9	8	7	6	5	4
	20	20	13	9	6	4	3	1	0	-1	-2	-3
	15	15	7	3	0	-2	-4	-5	-7	-8	-9	-10
	10	10	1	-4	-7	-9	-11	-12	-14	-15	-16	-17
	5	5	-5	-10	-13	-15	-17	-19	-21	-22	-23	-24
	0	0	-11	-16	-19	-22	-24	-26	-27	-29	-30	-31
	-5	-5	-16	-22	-26	-29	-31	-33	-34	-36	-37	-38
	-10	-10	-22	-28	-32	-35	-37	-39	-41	-43	-44	-45
	-15	-15	-28	-35	-39	-42	-44	-46	-48	-50	-51	-52
	-20	-20	-34	-41	-45	-48	-51	-53	-55	-57	-58	-60
	-25	-25	-40	-47	-51	-55	-58	-60	-62	-64	-65	-67
	-30	-30	-46	-53	-58	-61	-64	-67	-69	-71	-72	-74
	-35	-35	-52	-59	-64	-68	-71	-73	-76	-78	-79	-81
	-40	-40	-57	-66	-71	-74	-78	-80	-82	-84	-86	-88
	-45	-45	-63	-72	-77	-81	-84	-87	-89	-91	-93	-95

Green:	**LITTLE DANGER** (frostbite occurs in >2 hours in dry, exposed skin)
Yellow:	**INCREASED DANGER** (frostbite could occur in 45 minutes or less in dry, exposed skin)
Red:	**GREAT DANGER** (frostbite could occur in 5 minutes or less in dry, exposed skin)
Adapted from: Sustaining Health and Performance in Cold Weather Operations: U.S. Army Research Institute of Environmental Medicine. October 2001.	

9.21 INDOOR AIR QUALITY MANAGEMENT PLAN

All work will be conducted primarily outdoors; however, employee health will be protected. Employees will be protected from involuntary exposure to environmental tobacco smoke in working areas. Smoking, including smokeless (vape), will be prohibited inside vehicles and work zones. Designated smoking areas that are not commonly used or accessed by nonsmokers will be a work minimum of 25 feet from work zones.

9.22 MOLD REMEDIATION PLAN

A Mold Remediation Plan is not required to complete Chapter 2 tasks because it does not include the remediation of mold.

9.23 CHROMIUM (VI) EXPOSURE EVALUATION

A Chromium (VI) Evaluation is not required to complete Chapter 2 tasks because it does not include the cutting or breaking up of cement surfaces made from Portland cement with a high chromium content, painting or paint removal operations, welding using rods or wire with a chromium coating, heading or welding on stainless steel, and handing or applying anti-corrosive substances or coatings.

9.24 CRYSTALLINE SILICA MONITORING PLAN AND ASSESSMENT

A Crystalline Silica Monitoring Plan is not required under the current scopes of work because exposures are anticipated to be below the action limit, no grinding or abrading will occur, work shall occur outdoors, and the duration of pouring low-silica concrete and/or filter sand shall be less than 15 minutes of total duration in a day.

9.25 LIGHTING PLAN FOR NIGHT OPERATIONS

A Lighting Plan for Night Operations is not required to complete Chapter 2 tasks because all work will be scheduled during daylight hours. Work is prohibited when lighting conditions are insufficient.

9.26 TRAFFIC CONTROL PLAN

A Traffic Control Plan is not required to complete Chapter 2 tasks because site activities will not occur within public roadways.

9.27 FIRE PREVENTION AND PROTECTION PLAN AND PROGRAM

9.27.1 Introduction and Applicability

This plan focuses on the prevention and control of incidental incipient-stage fires caused from site vehicles and potential violation of smoking protocol and assesses the safeguarding of demolition operations (National Fire Protection Association [NFPA] 2019). The effectiveness will be documented through surveys and inspections (Chapter 7) to identify potential compliance issues and evaluate effectiveness. Based on a review of the Chapter 2 tasks to federal, USACE, AFCEC, and New York standards, a site-specific fire prevention and protection plan will be required; however, several elements are inapplicable at this time.

A critical heat flux evaluation has occurred for the potential on-site ignition sources and the results are presented below. No temporary offices or sheds, hot work, temporary heating equipment, temporary wiring, explosive materials, cooking, temporary lighting, fuel gas and/or associated piping, underground work, marine operations, or similar standard elements are present for the investigation.[7]

Similarly, no unusual fire hazards, hot work, required fire or open flames, risk of underground fire, gas cylinders, facility-related vegetation management (separate from general vegetation clearance), paint-soiled clothing or paint-soiled drop cloths, combustible waste disposal, burning operations, installation of low-density fiberboard/insulation/vapor barrier, temporary enclosure usage or installation, temporary buildings, fire lane control, fire hydrant access control, hazardous locations, heating unit siting, torch use (cut/sweat pipe), formwork or scaffolding protections, construction of buildings or structures, or existing water supply are either present and/or required for the investigation.[8]

The anticipated SOW will take less than one year; therefore, only one audit will be required and at least two are likely. If hot work of any kind is deemed necessary, an addendum and commensurate AHA will be provided. Inspection/audit frequency are provided in **Table 7-1**.

9.27.2 Site-Specific Assessment of General Hazards and Controls

Based on the anticipated Chapter 2 tasks, the primary on-site fire hazards include the ignition of dried vegetation, poorly managed general refuse, and ignition of poorly managed diesel refueling operations. Ignition sources are limited but include poorly managed smoking-related materials (e.g., lighters, matches, cigarettes, pipes, cigars, and vaping), hot surfaces from running engines, and a statistically remote lightning strike.

The on-site personnel are not responsible for firefighting activities as a primary job duty. Personnel may voluntarily fight an incipient-stage fire using the properly rated fire extinguishers, utilize the on-site water truck, and/or notify personnel on-site of an incipient-stage fire. No alarms or other

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[7] Checklist presented in NFPA 241: Standard for Safeguarding Construction, Alternation, and Demolition Operations. September 2018.

[8] Checklist presented in Chapter 9 of EM 385-1-1 (2014).

warning system is required as the site size is sufficiently small for verbal communications. The SSHO and DR will be the points-of-contact for notification procedures if the fire is not immediately contained. All personnel on-site are responsible for following the controls presented below.

9.27.3 Site-Specific Controls and Procedures

Smoking is prohibited in all areas other than designated smoking areas. This process is to manage smoking as both an ignition source and health-related issue (Indoor Air Quality; Chapter 9.2.1). Combustible waste materials will be removed from the work area at least daily to ensure that these materials do not contact the ignition sources presented above. The purposeful ignition of materials on-site is prohibited. Fire extinguishers will be placed around the site in accordance with **Table 7-1** once site measurements may be fully completed by the SSHO or DR.

9.27.4 Flammable and Combustible Liquids and Flammable Gasses

No flammable liquids or gases are present on-site except for gasoline-powered vehicles. No gasoline-powered vehicles or equipment is anticipated.

9.27.5 First Response Fire Protection

First response, as stated above, will be for incipient-stage fires that may be handled with properly rated fire extinguisher. They will be inspected annually, and records will be maintained in writing. Only those fire extinguishers that are approved by a listed company, properly marked, contain approved (e.g., no CCl4 or other) agents, and are properly constructed are suitable for use on-site.

The SSHO and DR will ensure that the inventory of fire extinguishers is inspected prior to beginning each definable feature of work **AND** that personnel have received fire extinguisher training. Currently, each support vehicle will have a minimum 2A:5B:C-rated extinguisher, each piece of equipment will have a minimum 2A:10B:C-rated extinguisher, and a minimum 4A:40 B:C-rated extinguisher will be located within 100 feet of the pickup-mounted transfer tank.

No explosives will be brought on-site nor are they present on-site, and no fixed fire suppression system is present on-site, no on-site firefighting organizations will be staffed on-site, and no fire watches are present on-site as no hot work is required at this time.

9.28 WILD LAND FIRE MANAGEMENT PLAN

A Wild Land Fire Management Plan IAW USACE Engineer Pamphlet 1130-2-540 is not required to complete Chapter 2 tasks; however, general fire prevention measures are discussed in the Fire Prevention and Protection Plan.

9.29 ARC FLASH HAZARD ANALYSIS

An Arc Flash Hazard Analysis is not required as no work will occur on energized equipment. Additionally, workers are prohibited from working on energized equipment.

Personnel are prohibited from opening any panels within the operational system without an arc flash hazard analysis. All work shall occur IAW the HECP below.

9.30 HAZARDOUS ENERGY CONTROL PLAN (LOCK-OUT/TAG-OUT)

An HECP is not required to complete Chapter 2 tasks; however, permit control measures (e.g., Utility One Call) will occur to ensure striking of underground utilities. For on-site equipment, no equipment maintenance is allowed on energized equipment by any personnel. Equipment will be towed off-site for repair by qualified personnel outside of the scope of this APP.

9.31 STANDARD PRE-LIFT PLAN

A Standard Pre-Lift Plan is not required to complete Chapter 2 tasks, because there are no tasks that include lifts or rigging.

9.32 CRITICAL LIFT PLAN

A Critical Lift Plan is not required to complete Chapter 2 tasks, as no critical lifts are anticipated to complete the PWS.

9.33 NAVAL ARCHITECTURAL ANALYSIS

A Naval Architectural Analysis is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.34 FLOATING PLANT INSPECTION AND CERTIFICATION

A Floating Plant Inspection and Certification Program is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.35 SEVERE WEATHER FOR MARINE ACTIVITIES

A Severe Weather Plan for Marine Activities is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.36 EMERGENCY PLAN FOR MARINE ACTIVITIES

An Emergency Plan for Marine Activities is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.37 MAN OVERBOARD/ABANDON SHIP ACTIVITIES

A Man Overboard/Abandon Ship Activities Plan is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.38 ASSURED EQUIPMENT GROUNDING CONTROL PROGRAM

No Assured Equipment Grounding Control Program is required for the Chapter 2 tasks at this time. The following information is to provide the SSHO with information that may trigger the needs of the program. Ground fault current interrupter (GFCI) protection shall be provided on all circuits serving portable electric hand tools, semi-portable electric power tools, sampling pumps, or equipment charging stations.

As part of the Assured Equipment Grounding Control Program, the following will be considered in all stages and implementation of tasks that involve the use of electrical receptacle outlets. All receptacle outlets (125-volt, 15-, 20-, 30-amperage, and greater) that provide temporary electrical power during operation and maintenance GFCI protection shall be provided on all circuits serving portable electric hand tools or semi-portable electric power tools (such as block/brick saws, table saws, air compressors, welding machines, and drill presses). The GFCI device shall be calibrated to trip within the threshold values of 5 milliampere +/-1 milliampere as specified in UL Standard 943. GFCI devices shall be tested before initial use and before use after modification. Receptacle outlets that are not part of the permanent wiring of the building or structure shall be GFCI protected by one of the following means: a receptacle outlet with integral GFCI protection; a standard receptacle outlet connected downstream of a receptacle outlet with integral GFCI protection; and/or receptacles protected by a GFCI-type circuit breaker.

Receptacle outlets that are part of the permanent wiring of the building or structure and are used for temporary electric power, (including portable generators) shall use a portable GFCI if the receptacle outlets are not already GFCI protected. The portable GFCI shall be as near as practicable to the receptacle outlet. EA does not anticipate the use of any electric power tools or machines.

9.39 FLOAT PLAN FOR LAUNCHES, MOTORBOATS, AND SKIFFS

A Float Plan is not required to complete Chapter 2 tasks, as no marine activities will be conducted.

9.40 SEVERE WEATHER CONTINGENCY PLAN

The SSHO will monitor local weather conditions and advise the Project Manager when severe weather is forecasted. Based on the SOW associated with this Contract, it is likely that work tasks can be postponed until the severe weather passes. In the event of severe weather occurring while personnel are on-site, the following procedures will be followed:

- All personnel shall shut down field operations and take shelter.
- If lightning is occurring, stop outdoor work and move indoors, or stay inside a moving vehicle (do not continue to linger outdoors). Shut down and move away from heavy equipment.
- In case of tornado conditions, seek out low ground (i.e., ditch or basement), shield yourself from falling objects, and stay away from windows.

- The SSHO will take a head count.
- Any visitors should remain with the group, if feasible.
- All personnel will stay assembled until further instructions are received. However, it is important to note that in some emergencies, employees must deviate from these instructions. Use common sense. For example, if smoke is present, employees need to begin evacuating even if the alarm has not been sounded. If smoke is present, stay below smoke while evacuating.

Note that not all emergencies are the same. In some cases, employees will have to follow a procedure that is different from the facility evacuation plan. Be certain to train and drill employees in this need to exercise common sense above all in emergency situations.

9.41 SITE-SPECIFIC FALL PROTECTION AND PREVENTION PLAN

A Site-Specific Fall Protection and Prevention Plan is not required to complete Chapter 2 tasks, because no elevated work will be conducted. Personnel are prohibited from working at elevations greater than 4 feet. No ladders are anticipated to complete this SOW.

9.42 DEMOLITION/RENOVATION PLAN

A Demolition/Renovation Plan is not required to complete Chapter 2 tasks because no demolition activities will occur.

9.43 ROPE ACCESS WORK PLAN

A Rope Access Work Plan is not required to complete Chapter 2 tasks, as no climbing activities will occur.

9.44 EXCAVATION AND TRENCHING PLAN

An Excavation and Trenching Plan is not required to complete Chapter 2 tasks.

9.45 COMPRESSED AIR WORK PLAN FOR UNDERGROUND CONSTRUCTION

A Compressed Air Work Plan for Underground Construction is not required to complete Chapter 2 tasks, as no underground construction activities will occur.

9.46 EMERGENCY RESCUE (TUNNELING) PLAN

An Emergency Rescue (Tunneling) Plan is not required to complete Chapter 2 tasks, as no underground construction activities will occur.

9.47 ERECTION AND REMOVAL PLAN FOR FORMWORK AND SHORING

An Erection and Removal Plan for Formwork and Shoring is not required to complete Chapter 2 tasks, as no forms or shoring will be constructed.

9.48 PRECAST CONCRETE PLAN

A Precast Concrete Plan is not required to complete Chapter 2 tasks, as no such operations will occur.

9.49 LIFT SLAB PLAN

A Lift Slab Plan is not required to complete Chapter 2 tasks, as no slab lifting activities will occur.

9.50 MASONRY BRACING PLAN

A Masonry Bracing Plan is not required, as no masonry activities will occur.

9.51 STEEL ERECTION PLAN

A Steel Erection Plan is not required to complete Chapter 2 tasks, as no erection activities will occur.

9.52 EXPLOSIVE SAFETY SITE PLAN

An Explosives Safety Site Plan is not required as only munitions and explosives of concern avoidance or construction support is required for portions of the Chapter 2 tasks.

9.53 BLASTING PLAN

A Blasting Plan is not required to complete Chapter 2 tasks, as no blasting activities will occur.

9.54 DIVING OPERATIONS PLAN

A Diving Operations Plan is not required to complete Chapter 2 tasks, as no diving activities will occur.

9.55 SAFE PRACTICES MANUAL FOR DIVING ACTIVITIES

A Safe Practices Manual for Diving Activities is not required to complete Chapter 2 tasks, as no diving activities will occur.

9.56 EMERGENCY MANAGEMENT FOR DIVING

An Emergency Management for Diving Plan is not required to complete Chapter 2 tasks, as no diving activities will occur.

9.57 TREE FELLING/MAINTENANCE PROGRAM

A Tree Felling/Maintenance Program is not required to complete Chapter 2 tasks as no tree felling or tree maintenance is anticipated. Under this APP, land clearance activities will occur using mechanized equipment IAW 29 CFR 1926.604. During site clearance activities, personnel outside of the operating equipment must maintain distances greater than 50 feet from the operating equipment to eliminate the possibility of struck-by/exposure to hazards caused by removal of vegetation. No operations will occur within 10 feet of energized lines; thus, neither 29 CFR 1910.269 nor 1910.333 are applicable.

OSHA directive CPL 02-01-045 applies to the logging/felling standard (29 CFR 1910.266) and states that regulators and workers consider scale (removal of “one or a few trees” renders inapplicability); complexity (…”a few hours to a few days” renders inapplicability); number of trees removed (“…the removal of one or several trees from a lot would not be considered a logging operation.”). No tree felling operations that are sufficient to trigger either OSHA (29 CFR 1910.266) or EM 385-1-1 (Chapter 31) will occur.

9.58 AIRCRAFT/AIRFIELD CONSTRUCTION SAFETY AND PHASING PLAN

An Aircraft/Airfield Construction Safety and Phasing Plan is not required to complete Chapter 2 tasks, as no aircraft/or airfield construction is being completed. All work shall occur off of runways and site personnel will make an effort to approach the site without crossing active runways.

9.59 AIRCRAFT/AIRFIELD SAFETY PLAN COMPLIANCE DOCUMENT

An Aircraft/Airfield Safety Compliance Document is not required to complete Chapter 2 tasks, construction work IAW Chapter 9.58 is not occurring. EA personnel shall coordinate directly with the Tower or designated representative to operate RI related tasks without impacting airport function. If additional information is required, then an addendum should be submitted.

9.60 SITE SAFETY AND HEALTH PLAN

The SSHP is presented in **Attachment E**.

9.61 CONFINED SPACE ENTRY PROCEDURES

Confined space entry procedures are not required as no confined spaces will be entered nor exist.

9.62 CONFINED SPACE PROGRAM

The Confined Space Program is not required as no confined spaces will be encountered.

9.63 PERSONAL HYGIENE AND PERSONNEL DECONTAMINATION PLAN

Fieldwork will be conducted in Level D for general operations. Fieldwork will be conducted in Level D or Modified Level D when handling groundwater, and/or when sampling for soil directly.

Site personnel will wash their hands, face, and exposed skin surfaces prior to ingestion of food, liquids or any other hand-to-mouth activities and when leaving the site. Hand washing with potable water, soap, and paper towels will be available at the portable restroom facilities. The site vehicle will also be furnished with hand sanitizer.

Additional details are presented within **Attachment E**.

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10. RISK MANAGEMENT PROCESSES

An assessment of the hazards, training, and equipment required to perform the tasks were completed as part of a risk analysis by corporate health and safety management with input from personnel who have previously performed the tasks. As stated in EM 385-1-1 01.A.13, major activities and SOW to be performed will be covered in an AHA. AHAs will be reviewed with all personnel involved in a task prior to each work activity or phase presenting hazards not experienced in previous project operations.

Upon commencement and throughout the activity, the AHA will be used to verify compliance with the prescribed hazard controls and to note any potential changes in process. The AHAs provide detailed project-specific hazards and controls for each major phase/activity of work. The primary activities and SOW required to complete the SOW are presented in Section 2. AHAs are included in **Attachment A**.

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11. PERSONAL PROTECTIVE EQUIPMENT

Required personal protective equipment is presented in the SSHP (**Attachment E**).

12. REFERENCES

Department of Transportation Federal Highway Administration. 2009. Manual on Uniform Traffic Control Devices. 3 May.

Occupational Safety and Health Administration (OSHA). 2017. *OSHA Technical Manual – Fifth Edition.* https://www.osha.gov/dts/osta/otm/index.html. 9 September.

U.S. Army Corps of Engineers (USACE). 2014. *Engineer Manual 385-1-1 Safety and Health Requirements Manual*. 30 November.

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Attachment A

Activity Hazard Analyses

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ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**COVID-19 Hazard Mitigation**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each “hazard” and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
All Tasks	Inhalation of virus from infected individual (symptomatic or asymptomatic) by other individuals	• Remain more than 6 feet from each other, unless necessary to perform job function. • Daily safety tailgate meetings will continue to be held in the warehouse but will be limited to no more than 10 people at a time (breaking up groups and staggering meeting times accordingly). • Maintain social spacing of 6 feet for meetings, with preference for tele-meetings. • Stay outside of individual offices (at doorways) when talking. • Use phones to communicate. • Maintain diligent use of personal protective equipment (PPE) including safety glasses to limit contact with eyes and nitrile gloves. Face shields may be worn for work that cannot be completed without maintaining a distance of 6 feet between individuals.	2/4/M

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
All Tasks	Inhalation of virus from infected individual (symptomatic or asymptomatic) by other individuals	• Staff are discouraged from taking breaks and eating lunch in communal settings where it is difficult to maintain a distance of 6 feet from co-workers. Breaks and lunches should be taken in offices, cubicles or personal vehicles. • Staff are encouraged to practice social distancing when not on the jobsite. • Staff are required to comply with all Federal, State, and local requirements and recommendations.	2/4/M
All Tasks	Dermal Contact with contaminated surfaces by individual personnel	• Wash hands often with soap and water for at least 20 seconds especially if in a public place, or after blowing your nose, coughing, or sneezing. • If soap and water are not readily available, use a hand sanitizer that contains at least 60% alcohol. Cover all surfaces of hands and rub them together until they feel dry. • Avoid touching your eyes, nose, and mouth with unwashed hands.	2/4/M
All Tasks	Dermal Contact - Contamination on Surfaces	• Clean AND disinfect frequently touched surfaces daily. This includes field equipment, personal mobile phones, vehicle surfaces (steering wheel, door handles, shift stick), tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, toilets, faucets, and sinks. If surfaces are dirty, clean them: Use detergent or soap and water prior to disinfection. Use disinfectant capable of killing the virus on surfaces including: o Bleach – mix 5 tablespoons (1/3 cup) bleach per gallon of water or 4 teaspoons bleach per quart of water o Alcohol solutions with at least 70% alcohol o Other approved disinfectants listed at https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2 • The field office will be professionally cleaned twice weekly, with a focus on sanitizing/disinfecting all commonly touched surfaces such as doors, doorknobs and hardware, handrails, tabletops, windowsills, light switches, toilets, sinks, etc.	2/4/M

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
All Tasks	Infected individual(s)/ personnel at work	• The following questions below will be asked of each employee/subcontract employee and any potential site/office visitors to help identify people that should be excluded from office/job site. If an employee or subcontractor answers yes to any of the questions below, he/she will be asked to leave the job site immediately and contact their Supervisor and/or appropriate Human Resources Department for further instruction. o Do you currently have fever, chills, a cough, sore throat, or shortness of breath? o Have you been in contact with someone who has been medically diagnosed with COVID-19? o Have you been in contact with anyone, including family members, who have traveled to any of the known COVID-19 “hotspots” within the last 14 days? • The field office will be professionally cleaned if an infected individual is identified onsite, with a focus on sanitizing/disinfecting all commonly touched surfaces such as doors, doorknobs and hardware, handrails, tabletops, windowsills, light switches, toilets, sinks, etc.	2/4/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Emergency equipment including first aid kit, eye wash, fire extinguishers • Safety glasses, nitrile gloves, face shields • Hand soap or hand sanitizer • Disinfectant	• Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher) • Confirm disinfectant is approved to kill COVID-19	All Personnel: • COVID-19 awareness training covering symptoms, routes of transmission, mitigation efforts required

NOTES: AHA = Activity hazard analysis.
PPE = Personal protective equipment.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Drilling and Well Installation**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each “hazard” and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	**Hazards**	**Controls**	**RAC Severity / Probability / RAC**
Drilling/Well Installation	Physical Hazard: Slips, Trips, Falls	• Keep work area free of excess material and debris. • Remove all trip hazards by keeping materials/objects organized and out of walkways. • Be aware of uneven surfaces while walking around drilling and well installation locations. • Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces. • Stay aware of footing, and do not run.	3/3/M

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Drilling/Well Installation	Physical Hazard: Injury from heavy equipment (drill rig and support vehicles).	• Be aware of the location of equipment, wear high visibility safety colors (fluorescent yellow-green, fluorescent orange-red, or fluorescent red), and establish eye contact with operator. • If exposed to traffic up to 45 miles per hour, high visibility apparel meeting at minimum ANSI/ISEA Class 2 requirements (e.g., fluorescent shirt or vest with retro reflective material) will be worn. • Use spotters when moving in/out of nominal clearance areas. • Heavy equipment should be equipped with back-up alarm or use horn when backing. • Be aware of pinch points, swinging chains, augers, etc. • Wear hard hat, steel or composite toed footwear, and safety glasses with side shields when working in proximity of drill rig.	2/4/M
Drilling/Well Installation	Physical Hazard: Faulty or Inappropriate Equipment	• Qualified driller must inspect drill rig and all associated equipment prior to use; if faulty or inappropriate, do not proceed until repaired or replaced. • Inspect all hand tools prior to use; if faulty or inappropriate, do not proceed until repaired or replaced.	2/4/M
Drilling/Well Installation	Physical Hazard: Moving Equipment/Air Rotary Drilling	• Clear area of obstructions and communicate with all workers involved that drilling is beginning. • Do not exceed manufacturer's recommended speed, force, torque, etc. and penetrate the ground slowly with hands on the controls for at least the first foot of soil to minimize chance of auger kick-out. • Stay clear of rotating auger. • Use long-handled shovel to clear away cuttings when auger has stopped. • Secure loose clothing. • Do not walk under suspended loads. • When possible, remove overhead hazards promptly. • Wear appropriate PPE including hard hats, safety glasses with side shields, and steel/composite-toed footwear.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Drilling/Well Installation	Physical Hazard: Pressure Washing	• Keep work area clear of debris and organize site to minimize walking distance. • Avoid creating wet walking surfaces that may become slippery. Ensure equipment is not leaking. • Wear appropriate PPE including PVC-dipped gloves, hard hats, face shield in addition to safety glasses with side shields, and steel/composite-toed footwear. • Keep hands and clothing arm’s length away from the discharge opening of the nozzle. • Use in accordance with manufacturer guidelines and ensure all manufacturer safety devices are in place. • Work so that high pressure spray is directed away from the body and other personnel. Keep face clear of heater exhaust. • Do not hold equipment that is being cleaned.	3/4/L
Drilling/Well Installation	Physical Hazard: Hearing loss	• Wear appropriate PPE (ear plugs capable of reducing worker noise exposure below an 8-hour TWA of 85 dBA) when working in proximity to drill rig.	3/4/L
Drilling/Well Installation	Physical Hazard: Material Handling, Moving, Lifting	• Follow proper lifting techniques. • Wear work gloves for materials handling. • Use two or more persons for heavy bulk lifting. • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • One person will not lift more than 60 pounds.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Drilling/Well Installation	Physical Hazard: Vehicular	• Utilize cones, signs, flags, and/or other traffic control devices as outlined in the Traffic Control Plan; wherever appropriate, use work truck as a safety shield to protect against traffic risk. • Wear high-visibility apparel (fluorescent yellow-green, fluorescent orange-red, or fluorescent red). Select color to provide highest contrast to the work environment. • If exposed to traffic up to 45 miles per hour, high visibility apparel meeting at minimum ANSI/ISEA Class 2 requirements (e.g. fluorescent shirt or vest with retro reflective material) will be worn. • If exposed to traffic above 45 miles per hour, the SSHO will make a determination as to whether high visibility apparel meeting ANSI/ISEA Class 3 requirements (i.e., fluorescent shirt or vest with retro reflective material and similar shorts, pants, coveralls etc.) will be worn.	2/4/M
Drilling/Well Installation	Physical Hazard: Heat Stress	• Determine appropriate work schedule (resulting from WBGT readings); take regular breaks. • Have adequate water and electrolyte drinks available. • Designate shaded break areas. • Be aware of symptoms of heat-related illness.	3/4/L
Drilling/Well Installation	Physical Hazard: Cold Stress	• Wear appropriate clothing to protect skin from wind and cold temperatures. Avoid working in extreme conditions. • Designate warm rest areas. • Be aware of symptoms of cold-related illness.	3/4/L
Drilling/Well Installation	Physical Hazard: Fire/Explosion	• Ensure type ABC, fully charged fire extinguisher is onsite. • Perform utility clearance to avoid possible gas or utility lines. • Stop work if hazardous conditions are identified.	1/5/M
Drilling/Well Installation	Physical Hazard: Electrical	• Inspect work areas for spark sources, maintain safe distances, and provide barriers to prevent inadvertent contact. • Maintain minimum clearance distances for overhead energized electrical lines. Use a spotter to confirm clearance of overhead lines and other obstructions. • Perform utility clearance to avoid possible buried electrical lines. Interview property owners on location of possible private utilities.	1/5/M

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Drilling/Well Installation	Physical Hazard: Weather	• Monitor weather conditions online or on the radio using a weather station that is part of the National Oceanic and Atmospheric Administration weather radio network or similar notification system. • If unfavorable weather conditions arise, SSHO and Investigation Manager will evaluate the safety hazards and activities will be halted by the Investigation Manager at the discretion of the SSHO. • Approach from and stay upwind of potential sources of vapors.	2/4/M
Drilling/Well Installation	Chemical Hazard: Exposure to Contaminants of Concern	• Wear safety glasses with side shields and nitrile gloves. • Perform environmental monitoring as per APP/SSHP. • Calibrate instruments prior to use. • Ensure personnel using equipment have been trained on instrument use and site-specific action levels/upgrades. • Position personnel and equipment upwind of sampling activities. • Decontaminate tools and PPE after use. • Wash hands and face.	3/4/L
Drilling/Well Installation	Chemical Hazard: Decontamination Material Handling and Contaminated Media Residue Exposure	• Only those personnel with HAZWOPER training will be allowed to perform equipment decontamination. • Safety data sheets will be maintained onsite for decontamination materials/fluids (e.g., detergents, etc.). • Proper PPE will be required, including nitrile gloves and safety glasses with side shields. If vigorous scrubbing is required (creating a splash hazard) a face shield and/or disposable coverall may be required at the discretion of the SSHO.	3/4/L
Drilling/Well Installation	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	• Use insect repellant as necessary. • Stay alert and safe distance away from biological hazards. • Inspect work areas when arriving onsite to identify hazards. • Workers with allergies should carry antidote kits, if necessary. • Wash hands, face, and other exposed areas at the beginning of each break and at the end of the workday. If dermal contact occurs, wash the affected area with soap and water immediately. • Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, or poison ivy is likely. Remove gloves prior to touching exposed areas of the body.	3/3/M

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Drill Rig / Direct Push Relocation / Setup	Physical Hazard: Rig Roll Over	• Do not move rig with mast raised. • Cross all hills and obstructions head on. • Set riggers prior to raising mast.	2/5/L
Drill Rig / Direct Push Relocation / Setup	Physical Hazard: Collision with property or personnel	• Heavy equipment should be equipped with back-up alarm or use horn when backing. • Use spotters when moving in/out of nominal clearance areas.	2/5/L

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Level of PPE (initial/upgrade): D/C • Monitoring equipment • Heavy equipment and drill rig • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • Pressure washing equipment • Decontamination pad • WBGT monitor	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use • Use appropriate PPE • Underground hazards require clearance • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • APP and AHA review • Valid driver's license • Operation of equipment • Use of monitoring equipment • Proper lifting • First aid/CPR—at least 2 people onsite • Hazardous waste sites require 40 hour HAZWOPER training, annual updates. • SSHO will require 30-hour OSHA Construction Safety Course. • Site Manager will require 8-hour HAZWOPER Supervisor Course • Drill rig operator (and any other large equipment operator) will be trained in equipment use and maintenance

NOTES:
AHA = Activity hazard analysis.
ANSI = American National Standards Institute.
APP = Accident Prevention Plan.
CPR = Cardiopulmonary resuscitation.
dBA = Decibels.
HAZWOPER = Hazardous Waste Operations and Emergency Response.
ISEA = International Safety Equipment Association.
OSHA = Occupational Safety and Health Administration.
PPE = Personal protective equipment.
PVC = Polyvinyl chloride.
RAC = Risk assessment code.
SSHO = Site Safety and Health Officer.
SSHP = Site Safety and Health Plan.
TWA = Time weighted average.
WBGT = Wet-bulb globe temperature.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Groundwater Sampling and Well Purging**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each “hazard” and determine RAC.

Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.

Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.

Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Groundwater Sampling	Physical Hazard: Slips, Trips, Falls	• Keep work area free of excess material and debris. • Remove all trip hazards by keeping materials/objects organized and out of walkways. • Be aware of uneven surfaces while walking around drilling and well installation locations. • Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces. • Stay aware of footing, and do not run.	3/3/M
Groundwater Sampling	Physical Hazard: Heat Stress	• Determine appropriate work schedule (resulting from WBGT readings); take regular breaks. • Have adequate water and electrolyte drinks available. • Designate shaded break areas. • Be aware of symptoms of heat-related illness.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Groundwater Sampling	Physical Hazard: Cold Stress	• Wear appropriate clothing to protect skin from wind and cold temperatures. Avoid working in extreme conditions. • Designate warm rest areas. • Be aware of symptoms of cold-related illness.	3/4/L
Groundwater Sampling	Physical Hazard: Weather	• Monitor weather conditions online or on the radio using a weather station that is part of the National Oceanic and Atmospheric Administration weather radio network or similar notification system. • If unfavorable weather conditions arise, SSHO and Investigation Manager will evaluate the safety hazards and activities will be halted by the Investigation Manager at the discretion of the SSHO. • Approach from and stay upwind of potential sources of vapors.	2/4/M
Groundwater Sampling	Chemical Hazards – Exposure to Organic Vapors from Well, Contaminants in Groundwater	• Perform environmental monitoring as required in APP. Where appropriate PPE (including nitrile gloves) as indicated in the site-specific addendum. • Ensure personnel using have been trained on instrument use and site-specific action levels/upgrades. • Calibrate instrument prior to use. • Position personnel and equipment up wind of well.	2/4/M
Groundwater Sampling	Physical Hazard: Hearing loss	• Wear appropriate PPE (ear plugs capable of reducing worker noise exposure below an 8-hour TWA of 85 dBA) when working in proximity to drill rig.	3/4/L
Groundwater Sampling	Physical Hazard: Material Handling, Moving, Lifting	• Follow proper lifting techniques. • Wear work gloves for materials handling. • Use two or more persons for heavy bulk lifting. • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • One person will not lift more than 60 pounds.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Groundwater Sampling	Physical Hazard: Vehicular	• Utilize cones, signs, flags, and/or other traffic control devices as outlined in the Traffic Control Plan; wherever appropriate, use work truck as a safety shield to protect against traffic risk. • Wear high-visibility apparel (fluorescent yellow-green, fluorescent orange-red, or fluorescent red). Select color to provide highest contrast to the work environment. • If exposed to traffic up to 45 miles per hour, high visibility apparel meeting at minimum ANSI/ISEA Class 2 requirements (e.g. fluorescent shirt or vest with retro reflective material) will be worn. • If exposed to traffic above 45 miles per hour, the SSHO will make a determination as to whether high visibility apparel meeting ANSI/ISEA Class 3 requirements (i.e., fluorescent shirt or vest with retro reflective material and similar shorts, pants, coveralls etc.) will be worn.	2/4/M
Groundwater Sampling	Chemical Hazard: Exposure to Contaminants of Concern	• Wear safety glasses with side shields and nitrile gloves. • Perform environmental monitoring as per APP/SSHP. • Calibrate instruments prior to use. • Ensure personnel using equipment have been trained on instrument use and site-specific action levels/upgrades. • Position personnel and equipment upwind of sampling activities. • Decontaminate tools and PPE after use. • Wash hands and face.	3/4/L
Groundwater Sampling	Chemical Hazard: Decontamination Material Handling and Contaminated Media Residue Exposure	• Only those personnel with HAZWOPER training will be allowed to perform equipment decontamination. • Safety data sheets will be maintained onsite for decontamination materials/fluids (e.g., detergents, etc.). • Proper PPE will be required, including nitrile gloves and safety glasses with side shields. If vigorous scrubbing is required (creating a splash hazard) a face shield and/or disposable coverall may be required at the discretion of the SSHO.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Groundwater Sampling	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	• Inspect work areas when arriving at a sampling site to identify hazard(s). Specifically, inspect well casing immediately upon opening for stinging insects. • Use insect repellant as necessary. • Stay alert and safe distance away from biological hazards. • Inspect work areas when arriving onsite to identify hazards. • Workers with allergies should carry antidote kits, if necessary. • Wash hands, face, and other exposed areas at the beginning of each break and at the end of the workday. If dermal contact occurs, wash the affected area with soap and water immediately. • Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, or poison ivy is likely. Remove gloves prior to touching exposed areas of the body.	3/3/M
Well Purging	Physical, Chemical, and Biological Hazards Listed Above, In Addition To Those Listed Below	• Controls as listed above, as well as those listed below.	2/4/M
	Physical Hazard: Hearing loss	• Where appropriate PPE (ear plugs) when working in proximity to air compressor.	3/4/L
	Physical Hazard: Material Handling, Moving, Lifting Accident	• Observe proper lifting techniques. Obey sensible lifting limits (60 lb maximum per person manual lifting). • Use two or more persons for heavy bulk lifting. • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads.	3/4/L
	Physical Hazard: Fire	• Ensure type ABC, fully charged fire extinguisher on-site. • Stop work if hazardous conditions are identified.	1/5/M
	Chemical Hazard: Uncontrolled Release of Groundwater	• Ensure tubing discharge pressure is controlled and contained in bucket or drum.	2/4/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Level of PPE (initial/upgrade): D/C • Monitoring equipment • Heavy equipment and drill rig • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • Pressure washing equipment • Decontamination pad • WBGT monitor	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use • Use appropriate PPE • Underground hazards require clearance • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher) • Inspect air compressor • Inspect gas cylinders	• Use and limitations of PPE • APP and AHA review • Valid driver's license • Operation of equipment • Use of monitoring equipment • Proper lifting • First aid/CPR—at least 2 people onsite • Hazardous waste sites require 40 hour HAZWOPER training, annual updates. • SSHO will require 30-hour OSHA Construction Safety Course. • Site Manager will require 8-hour HAZWOPER Supervisor Course

NOTES:
AHA = Activity hazard analysis.
ANSI = American National Standards Institute.
APP = Accident Prevention Plan.
CPR = Cardiopulmonary resuscitation.
dBA = Decibels.
HAZWOPER = Hazardous Waste Operations and Emergency Response.
OSHA = Occupational Safety and Health Administration.
PPE = Personal protective equipment.
PVC = Polyvinyl chloride.
RAC = Risk assessment code.
SSHO = Site Safety and Health Officer.
SSHP = Site Safety and Health Plan.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**IDW Handling**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Handling and Accumulation of IDW	Physical Hazard: Slips, Trips, Falls	• Keep work area free of excess material and debris. • Remove all trip hazards by keeping materials/objects organized and out of walkways. • Be aware of uneven surfaces while walking around sampling locations. • Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces. • Stay aware of footing, and do not run.	3/3/M
Handling and Accumulation of IDW	Physical Hazard: Waste Handling, Moving, Lifting	• Do not exceed recommended weight limits for container handling equipment. • Obey sensible lifting limits (60 pound maximum per person manual lifting).	3/4/L
Handling and Accumulation of IDW	Physical Hazard: Heat/Cold Stress	• Take breaks as needed. • Be aware of weather conditions and dress appropriately. • Consume adequate food/beverages. • If possible, adjust work schedule to avoid heat/cold stresses.	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Handling and Accumulation of IDW	Physical Hazard: Weather	• Monitor radio for up-to-date severe weather forecasts. • Discontinue work during thunderstorms and severe weather events. • Approach and stay upwind of potential sources of vapors.	3/4/L
Handling and Accumulation of IDW	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	• Use insect repellant as necessary. • Stay alert and safe distance away from biological hazards. • Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if there is a probability of encountering snakes, ticks, poison ivy, or poison oak.	3/3/M
Handling and Accumulation of IDW/Disposal of IDW	Chemical Hazard: Solid and Liquid IDW	• Only those personnel with HAZWOPER training will be allowed to perform IDW handling. • Perform environmental monitoring with properly calibrated equipment as required in APP. • Transfer of IDW will be performed with equipment that will limit direct contact with IDW (pumps, skid loaders, etc.) when possible. • Transfer of IDW into over pack drums will be performed with appropriate equipment to either lift the drums up and into the over pack containers or safely flip drums into the new over pack drums). • IDW will be properly containerized and/or covered and labeled. • Proper PPE will be required, including nitrile gloves and safety glasses. If open container pouring/transfer of liquid IDW is required (creating a splash hazard) a face shield and/or disposable coverall may be required at the discretion of the SSHO.	3/4/L
Handling and Accumulation of IDW/Disposal of IDW	Physical Hazard: Heavy Equipment/Collision with Property or Personnel	• Heavy equipment should be equipped with back-up alarm or use horn when backing. • Use spotters when moving in/out of nominal clearance areas.	2/5/L

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING:

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Monitoring equipment • PPE • Material/drum/overpack drum moving equipment (skid loader, dolly, drum lift, etc.) • Containers/containerization material (drums, overpack drums, polyethylene liners) • Power and hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • Water pumps • Respiratory Protection – not required	• Inspect PPE prior to each use • Inspect vehicle and IDW moving/lifting equipment daily • Calibrate environmental monitoring equipment daily prior to use. • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • APP and AHA review • Valid driver's license • Operation of equipment (e.g., skid loader) • Use of monitoring equipment • Use and limitations of PPE • Lifting • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40-hour HAZWOPER training, annual updates for any intrusive activities. • SSHO will require HAZWOPER 40-hour Worker Training and 30-hour OSHA Construction Safety Course.

NOTES:
AHA = Activity hazard analysis.
APP = Accident Prevention Plan.
CPR = Cardiopulmonary resuscitation.
HAZWPOER = Hazardous Waste Operations and Emergency Response.
IDW = Investigation-derived waste.
OSHA = Occupational Safety and Health Administration.
PPE = Personal protective equipment.
RAC = Risk assessment code.
SSHO = Site Safety and Health Officer.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Mobilization and Demobilization**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	**Hazards**	**Controls**	**RAC Severity/ Probability / RAC**
Mobilization and Demobilization	Physical Hazard: Slips, Trips, and Falls	• Keep work area free of excess material and debris. • Remove all trip hazards by keeping materials/objects organized and out of walkways. • Be aware of uneven surfaces while walking around work area. • Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces. • Stay aware of footing and do not run.	3/3/M
Mobilization and Demobilization	Physical Hazard: Material Handling, Moving, Lifting	• Follow proper lifting techniques. • Wear work gloves for materials handling. • Use two or more persons for heavy bulk lifting. • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • One person will not lift more than 60 pounds.	3/4/L

Work Task Steps	**Hazards**	**Controls**	**RAC**
			Severity/ Probability / RAC
Mobilization and Demobilization	Physical Hazard: Vehicular	• Utilize cones, signs, flags, and/or other traffic control devices as outlined in the Traffic Control Plan; wherever appropriate, use work truck as a safety shield to protect against traffic risk. • Wear high-visibility apparel (fluorescent yellow-green, fluorescent orange-red, or fluorescent red). Select color to provide highest contrast to the work environment. • If exposed to traffic up to 45 miles per hour, high visibility apparel meeting at minimum ANSI/ISEA Class 2 requirements (e.g. fluorescent shirt or vest with retro reflective material) will be worn. • If exposed to traffic above 45 miles per hour, the SSHO will make a determination as to whether high visibility apparel meeting ANSI/ISEA Class 3 requirements (i.e., fluorescent shirt or vest with retro reflective material and similar shorts, pants, coveralls etc.) will be worn.	2/4/M
Mobilization and Demobilization	Physical Hazard: Heat Stress	• Determine appropriate work schedule (resulting from WBGT readings); take regular breaks. • Have adequate water and electrolyte drinks available. • Designate shaded break areas. • Be aware of symptoms of heat-related illness.	3/4/L
Mobilization and Demobilization	Physical Hazard: Cold Stress	• Wear appropriate clothing to protect skin from wind and cold temperatures. Avoid working in extreme conditions. • Designate warm rest areas. • Be aware of symptoms of cold-related illness.	3/4/L
Mobilization and Demobilization	Physical Hazard: Weather	• Monitor weather conditions online or on the radio using a weather station that is part of the National Oceanic and Atmospheric Administration weather radio network or similar notification system. • If unfavorable weather conditions arise, SSHO and Investigation Manager will evaluate the safety hazards and activities will be halted by the Investigation Manager at the discretion of the SSHO. • Approach and stay upwind of potential sources of vapors.	2/4/M
Mobilization and Demobilization	Physical Hazard: Fire/Explosion	• Ensure type ABC, fully charged fire extinguisher is onsite. • Stop work if hazardous conditions are identified.	1/5/M

Work Task Steps	Hazards	Controls	RAC
			Severity/ Probability / RAC
Mobilization and Demobilization	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	• Use insect repellant as necessary. • Stay alert and safe distance away from biological hazards. • Inspect work areas when arriving onsite to identify hazards. • Workers with allergies should carry antidote kits, if necessary. • Wash hands, face, and other exposed areas at the beginning of each break and at the end of the workday. If dermal contact occurs, wash the affected area with soap and water immediately. • Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, or poison ivy is likely. Remove gloves prior to touching exposed areas of the body.	3/3/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING:

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Level of PPE (initial/upgrade): D • Emergency equipment including first aid kit, eye wash, fire extinguishers • WBGT monitor	• Inspect PPE prior to each use • Inspect vehicle daily • Use appropriate PPE • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • APP and AHA review • Valid driver’s license • Operation of equipment • Proper lifting • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40-hour HAZWOPER training, annual updates. • SSHO will require 30-hour OSHA Construction Safety Course. • Site Manager will require 8-hour HAZWOPER Supervisor Course

NOTES:
AHA = Activity hazard analysis.
APP = Accident Prevention Plan.
ANSI = American National Standards Institute.
CPR = Cardiopulmonary resuscitation.
HAZWPOER = Hazardous Waste Operations and Emergency Response.
ISEA = International Safety Equipment Association.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Sediment Sampling**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247	**Severity**	**Probability**				
Date Prepared:	11 November 2022		1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Sediment Sampling	Physical Hazard: Slips, Trips, Falls	Keep work area free of excess material and debris.	3/3/M
		Remove all trip hazards by keeping materials/objects organized and out of walkways.	
		Be aware of uneven surfaces while walking around drilling and well installation locations.	
		Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces.	
	Physical Hazard: Lifting and Handling of Equipment/Tools	Follow proper lifting techniques.	3/3/M
		One person will not lift more than 60 pounds.	
		Get assistance or use mechanical aids.	
		Wear leather gloves for materials handling.	
		Wear Kevlar gloves for cut resistance.	
	Chemical Hazard: Exposure to Contaminants of Concern	Wear safety glasses and nitrile gloves	3/4/L
		Decontaminate sampling tools and PPE after use	
		Wash hands and face after sampling events	

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Sediment Sampling	Physical Hazard: Working Near Water	No one will work alone when collecting surface soil or sediment samples	3/4/L
		If collecting samples from the shore, be alert to site conditions and proximity to water	
		If wading into water is required, one person will stay on shore	
		Wade only into shallow water; be alert for debris, obstructions	
	Physical Hazard: Heat Stress	Determine appropriate work schedule; take regular breaks	3/3/M
		Have adequate water and electrolyte drinks available	
		Designate shaded break areas	
		Be aware of symptoms of heat-related illness	
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation Exposures	Inspect work areas when arriving at a sampling site to identify hazard(s)	3/3/M
		Use insect repellant as necessary	
		Stay alert and safe distance away from biological hazards	
		Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, poison ivy or oak	
		Workers with allergies should carry antidote kits, if necessary	
	Biological Hazards: Microorganisims	Wear nitrile gloves, safety glasses, and waders	4/3/L
		Wash PPE after use	
		Wash hands and face prior to eating, drinking, or smoking	
	Drowning Hazard	Personnel will not enter water greater than 24 inches deep	1/5/M
		Personnel will don a USCG-Rated Class II PFD (or greater)	
		A life ring will be present within 90’ of any person in the water	
		Personnel will stop work and leave the water if conditions change	

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • PPE • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • USCG Type II Personal Floatation Device • USCG Rated Life Ring	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use. • Use appropriate PPE • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • Valid driver's license • Lifting • APP and AHA review • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40-hour HAZWOPER training, annual updates • SSHO will require HAZWOPER 40-hour Worker Training and 30-hour OSHA Construction Safety Course

NOTES:
AHA = Activity hazard analysis.
ANSI = American National Standards Institute.
APP = Accident Prevention Plan.
CPR = Cardiopulmonary resuscitation.
dBA = Decibels.
HAZWOPER = Hazardous Waste Operations and Emergency Response.
OSHA = Occupational Safety and Health Administration.
PPE = Personal protective equipment.
PVC = Polyvinyl chloride.
RAC = Risk assessment code.
SSHO = Site Safety and Health Officer.
SSHP = Site Safety and Health Plan.

ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Soil Sampling**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247		**Probability**				
Date Prepared:	11 November 2022	**Severity**	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each “hazard” and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Soil Sampling	Physical Hazard: Slips, Trips, Falls	Keep work area free of excess material and debris. Remove all trip hazards by keeping materials/objects organized and out of walkways. Be aware of uneven surfaces while walking around drilling and well installation locations. Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces. Stay aware of footing, and do not run.	3/3/M
	Physical Hazard: Lifting and Handling of Equipment/Tools	Follow proper lifting techniques. One person will not lift more than 60 pounds. Get assistance or use mechanical aids. Wear leather gloves for materials handling.	3/3/M
Soil Sampling	Chemical Hazard: Exposure to Contaminants of Concern	Wear safety glasses and nitrile gloves Perform environmental monitoring as per APP/SSHP Decontaminate sampling tools and PPE after use Wash hands and face after sampling events	3/4/L
Soil Sampling		No one will work alone when collecting surface soil or sediment samples	3/3/M

Work Task Steps	Hazards	Controls	RAC
			Severity / Probability / RAC
	Physical Hazard: Working Near Water	If collecting samples from the shore, be alert to site conditions and proximity to water	
		If wading into water is required, one person will stay on shore	
		Wade only into shallow water; be alert for debris, obstructions	
	Physical Hazard: Heat Stress	Determine appropriate work schedule; take regular breaks	3/3/M
		Have adequate water and electrolyte drinks available	
		Designate shaded break areas	
		Be aware of symptoms of heat-related illness	
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation Exposures	Inspect work areas when arriving at a sampling site to identify hazard(s)	3/3/M
		Use insect repellant as necessary	
		Stay alert and safe distance away from biological hazards	
		Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, poison ivy or oak	
		Workers with allergies should carry antidote kits, if necessary	

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • PPE • Monitoring equipment • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • Respiratory Protection – not required	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use. • Use appropriate PPE • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • Valid driver's license • Lifting • APP and AHA review • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40-hour HAZWOPER training, annual updates • SSHO will require HAZWOPER 40-hour Worker Training and 30-hour OSHA Construction Safety Course

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ACTIVITY HAZARD ANALYSIS

Activity/Work Task:	**Surface Water Sampling**	Overall Risk Assessment Code (RAC) (use highest code from all subtasks):					**M**
Project Location:	Niagara Falls Air Reserve Station	**Risk Assessment Code (RAC) Matrix**					
Project Number:	634250247	**Severity**	**Probability**				
Date Prepared:	11 November 2022		1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
Prepared By:	Patrick Gannon	1 Catastrophic	E	E	H	H	M
Reviewed By:	Adrian Hughes, Safety and Health Manager	2 Critical	E	H	H	M	L
Competent Person:	SSHO/Field Technician	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.
Step 2: Identify the RAC as E, H, M, or L for each hazard on the AHA. Select the highest RAC and note it at the top of the form.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS:

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Surface Water Sampling	Physical Hazard: Slips, Trips, Falls	Keep work area free of excess material and debris. Remove all trip hazards by keeping materials/objects organized and out of walkways. Be aware of uneven surfaces while walking around drilling and well installation locations. Wear appropriate PPE, including non-slip rubber boots if working on wet or slick surfaces.	3/3/M
	Physical Hazard: Lifting and Handling of Equipment/Tools	Follow proper lifting techniques. One person will not lift more than 60 pounds. Get assistance or use mechanical aids. Wear leather gloves for materials handling. Wear Kevlar gloves for cut resistance.	3/3/M
	Chemical Hazard: Exposure to Contaminants of Concern	Wear safety glasses and nitrile gloves Decontaminate sampling tools and PPE after use Wash hands and face after sampling events	3/4/L

Work Task Steps	Hazards	Controls	RAC Severity / Probability / RAC
Surface Water Sampling	Physical Hazard: Working Near Water	No one will work alone when collecting surface water samples	3/4/L
		If collecting samples from the shore, be alert to site conditions and proximity to water	
		If wading into water is required, one person will stay on shore	
		Wade only into shallow water; be alert for debris, obstructions	
	Physical Hazard: Heat Stress	Determine appropriate work schedule; take regular breaks	3/3/M
		Have adequate water and electrolyte drinks available	
		Designate shaded break areas	
		Be aware of symptoms of heat-related illness	
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation Exposures	Inspect work areas when arriving at a sampling site to identify hazard(s)	3/3/M
		Use insect repellant as necessary	
		Stay alert and safe distance away from biological hazards	
		Wear appropriate PPE including work gloves, long sleeves and pants, and snake chaps if probability of encountering snakes, ticks, poison ivy or oak	
		Workers with allergies should carry antidote kits, if necessary	
	Biological Hazards: Microorganisims	Wear nitrile gloves, safety glasses, and waders	4/3/L
		Wash PPE after use	
		Wash hands and face prior to eating, drinking, or smoking	
	Drowning Hazard	Personnel will not enter water greater than 24 inches deep	1/5/M
		Personnel will don a USCG-Rated Class II PFD (or greater)	
		A life ring will be present within 90’ of any person in the water	
		Personnel will stop work and leave the water if conditions change	

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • PPE • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • USCG Type II Personal Floatation Device • USCG Rated Life Ring	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use. • Use appropriate PPE • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher)	• Use and limitations of PPE • Lifting • APP and AHA review • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40-hour HAZWOPER training, annual updates • SSHO will require HAZWOPER 40-hour Worker Training and 30-hour OSHA Construction Safety Course

NOTES:
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OSHA = Occupational Safety and Health Administration.
PPE = Personal protective equipment.
PVC = Polyvinyl chloride.
RAC = Risk assessment code.
SSHO = Site Safety and Health Officer.
SSHP = Site Safety and Health Plan.

Attachment B

Occupational Safety and Health Administration 3000/300A Forms

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2021

U.S. Department of Labor
Occupational Safety and Health Administration

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Form approved OMB no. 1218-0176

Establishment name EA Engineering, Science, and Technology, Inc., PBC

City Hunt Valley State MD

Identify the person		Describe the case				Classify the case											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
						Death	Days away from work	Remained at work		Away From Work (days)	On job transfer or restriction (days)	(M)					
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	(G)	(H)	Job transfer or restriction (I)	Other record-able cases (J)	(K)	(L)	Injury (1)	Skin Disorder (2)	Respiratory Condition (3)	Poisoning (4)	Hearing Loss (5)	All other illnesses (6)
1		Environmental Scientist II	05/18/2021	River bank of Mississippi at Jefferson Barracks base	Slipped on wet riprap and fell on elbow causing a laceration requiring stitches.				X			X					
2		Hydrogeologist	6/3/2021	Stibnite Mine, Idaho	Found a tick imbedded in back of scalp				X			X					
3		Scientist I	8/4/2021	Former Papermill Napanoch, NY	Poison Oak on stomach, back and arms.				X				X				
4		Geologist	9/28/2021	Aberdeen Proving Ground	Suspected chigger bites with some infection on ankles requiring perscription tratment cream.				X				X				
5		Geologist	10/25/2021	EA Warwick, RI office parking lot	Lost balance while changing out of wet weather gear and fell against the vehicle bruising the sternum/body core area. Modified duty to light lifting.			X		0	13	X					
						Page totals	**0**	**0**	**1**	**4**	**0**	**13**	**3**	**2**	**0**	**0**	**0**	**0**

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
(1)	(2)	(3)	(4)	(5)	(6)

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2021

U.S. Department of Labor

Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	1	4
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	13
(K)	(L)

Injury and Illness Types

Total number of…
(M)

(1) Injury	3	(4) Poisoning	0
(2) Skin Disorder	2	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Establishment information

Your establishment name EA Engineering, Science, and Technology, Inc., PBC

Street 225 Schilling Circle, Suite 400

City Hunt Valley State Maryland Zip 21031

Industry description (e.g., Manufacture of motor truck trailers)
Environmental Remediation and Consulting

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)

OR North American Industrial Classification (NAICS), if known (e.g., 336212)
5 6 2 9 1 0

Employment information

Annual average number of employees 592

Total hours worked by all employees last year 1,231,888

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Ian D. MacFarlane
Company executive

Pres., CEO & Chair
Title

410-584-7000
Phone

19 January 2022
Date

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Attachment C

Resumes and Certifications of Key Personnel
(Will be included with Field Version of this Document)

(Any certification that is set to expire prior to, or during, field activities will be renewed before said expiration date. Onsite files will be amended with current certifications as appropriate.)

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Corporate Director of Safety and Health Resume

- **Robert Marcase, CIH, CSP, CHMM**

Robert O. Marcase, CIH, CSP, CHMM

Corporate Director of Health and Safety; Deputy Technical Chief, Environmental, Health, Safety, and Sustainability Compliance with Emphasis on Health and Safety

Mr. Marcase is a Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP), and Certified Hazardous Materials Manager (CHMM) with 26 years of experience in a wide range of environmental, safety and health, and industrial hygiene projects. His experience includes regulatory compliance strategy, industrial hygiene investigation and process analysis, occupational exposure assessment, facility-wide health and safety auditing, and air quality permitting and compliance. His experience also includes environmental assessments, building inspections, industrial air pollution testing, and water quality analysis.

Education

B.S./Environmental Science (Minor in Geology)/1995 (Slippery Rock University)

Registrations/Certifications

Certified Industrial Hygienist—2007 (No. 9283CP)
Certified Safety Professional—2010 (No. 21609)
Certified Hazardous Materials Manager (CHMM)–2012 (No. 15935)

Specialized Training

OSHA 40-Hour Hazardous Waste Operations and Emergency Response Training;
OSHA 8-Hour Hazardous Waste Operations and Emergency Response Refresher Training;
OSHA 30-Hour Construction Safety Training;
NIOSH 582 Certification, Collecting and Analyzing Asbestos Air Samples; 1998
Asbestos Building Inspector Certification, Maryland and Pennsylvania; 1999

Professional Affiliations/Appointments

American Industrial Hygiene Association; Full Member

Experience

Years with EA: 10	Total Years: 26

Professional Experience

Director of Corporate Health and Safety—As Director of EA's Corporate Health and Safety Program, manages health and safety compliance for more than $200 million of environmental services annually. Under his supervision, EA has maintained an OSHA recordable incident rate of 0.81 for 2021, well below the Fiscal Year 2021 Bureau of Labor Statistics industry averages of 1.5 for EA's primary NAICS code 562910. Under EA's 40+ current Federal contracts, reviewed/served as signing CIH and managed the implementation for more than 200 Accident Prevention Plans/Site Safety and Health Plans for U.S. Army Corps of Engineers, Air Force, Navy, U.S. Environmental Protection Agency (EPA), and other federal agencies. Managed the health and safety requirements, guidance, and protocols in accordance with Engineer Manual 385-1-1.

Industrial Hygiene Program Management—Managed health and safety programs for the Architect of the Capitol in Washington, D.C. The Architect of the Capitol manages and operates the Capitol Complex on behalf of the U.S. Congress, the Library of Congress, and the U.S. Supreme Court. The Capitol Complex encompasses more than 450 acres and more than 18.4 million square ft of space, all national historical sites and critical continuity of government facilities. Worked in the Architect of the Capitol Safety, Fire, and Environmental Programs office developing and managing diverse Complex-wide health and safety policies including hazardous building materials, respiratory protection, occupational exposure control, Indoor Air Quality Assessment, mold/water intrusion evaluation and control, and hazardous communications. Provided health and safety project management and oversight support on mega-projects such as the U.S. Capitol Dome Restoration project ($70 million), Cannon House Office Building Renovation ($800 million), and Capitol Power Plant Cogeneration project ($300 million) as well as all other construction activities at the Architect of the Capitol. Managed more than $500,000 in contract support and an inventory of scientific equipment worth more than $100,000.

Industrial Hygiene Project Management—Managed industrial hygiene projects for an industrial hygiene and toxicology consulting firm located in Baltimore. Responsibilities included scheduling company projects, writing proposals, establishing and meeting budgets, and supervising industrial hygienists; supervising asbestos, chemical, hazardous waste, and industrial hygiene surveys; monitoring, inspecting, and writing specifications for asbestos and hazardous waste projects; conducting environmental audits; and reviewing and approving industrial hygiene reports. Also performed onsite inspections for compliance with safety and health standards.

Permitting and Compliance Services—Provided permitting and compliance services to industrial and commercial clients, ranging from hospitals and universities to specialty chemical manufacturers. Experience includes preparation and revision of Resource Conservation and Recovery Act Part B permits, development and negotiation of Memoranda of Agreement, Title V applicability, and permitting; state and local air permit applicability and permit negotiation; Reasonably Available Control Technology applicability and specification; specification of emission control equipment; risk and catastrophic release modeling; and compliance assessment, planning, and monitoring. Has broad compliance auditing experience and identifying permitting needs and procedures for a variety of clients.

Environmental Management Systems—Providing technical assistance in the development and implementation of a compliance-focused environmental management system for a state transportation agency, including development and communication of policy; structuring and scoping of the environmental organization for the agency and associated responsibilities; completion of multimedia compliance audits of all facilities over a 5- to 7-year period; development of corrective actions; development of a web-based, password protected, system-wide compliance data management system; development of standard operating procedures for compliance functions; moderation of a steering committee; and development and presentation of training to agency employees. Lead third party auditor for implementation of an environmental management system by a county government laboratory. Leading compliance assessment and program development for a county government department of public works and transportation.

Indoor Air Quality/Mold—Performed numerous indoor air quality/mold inspections. Provided comprehensive mold assessment services for federal, state, municipal, and private clients. Services provided included microbiological bulk/air/wipe sampling, water intrusion and moisture inspections, air quality monitoring, employee training, preventative maintenance, remediation design and controls, and remediation oversight and clearance. Performed these services for numerous clients including the Maryland State Highway Administration, Maryland Aviation Administration, and multiple private sector clients. Developed mold abatement specifications for the Maryland State Highway Administration and major realty development companies.

EA Project Experience

Environmental Remediation Multiple Award I and Jr.; Environmental Command; Corporate Health and Safety Manager. Directs the Health and Safety Program over the past 2 years that covered remedial investigation/feasibility study, risk assessment, remedial design/remedial action, military munitions response, remedial oversight, operation and maintenance, long-term monitoring, and operational range assessments. Ensures compliance with Engineer Manual 385-1-1 and serves as the reviewer and concurrence signatory for project Accident Prevention Plans. Key projects include:

- **Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation/Feasibility Study at Fort Leavenworth, Kansas**—Reviewed and overseeing implementation of the Site Safety and Health Plan/Accident Prevention Plan for the PFAS remedial investigation at this 234-acre active army installation. Developed Activity Hazard Analysis for novel coronavirus 2019 hazard mitigation to safely perform field work during the pandemic. health and safety concerns included: reviewed and approved boat safety for overwater core and water sampling, review and coordinate daily safety briefs, directed the Site Safety and Health Officer in development of safe work practices for heat and cold stress during field activities, reviewed and approved near miss incidents while overseeing incident investigation for drilling subcontractor heat stress. Manages and maintains medical monitoring and fitness for duty determinations, exposure assessments for hazardous chemicals, reviews and develops risk assessment and hazard rankings, and assists/directs field staff in determination and use of proper personal protective equipment for specific work activities.

- **RAO, Twin City Army Ammunition Plant, Minnesota**—Former US Armey ammunitions plant in Minnesota contaminated with metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, volatile organic compound, cyanide, and explosives. Reviewed and approved Site Safety and Health Plan/Accident Prevention Plan for subsurface investigation including drilling/well installation, well abandonment, soil, groundwater, and surface water sampling. Developed exposure monitoring program and assisted Site Safety and Health Officer and Project Manager in determining occupational exposure to site specific hazardous chemicals. Manages and directs medical monitoring, safety and health training, drug screening, certificate maintenance, and safety orientation for site specific work activities.

2012 MAES (Project 7) and 2019 MAES Contracts U.S. Army Corps of Engineers–Baltimore; Corporate Health and Safety Manager—Maintains EA's written Safety and Health Program, including munitions and explosives of concern and radiation safety, and provides health and safety oversight for U.S. Army Corps of Engineers–Baltimore task orders to ensure compliance with Engineer Manual 385-1-1. Manages and conducts Hazardous Waste Operations and Emergency Response and non-Hazardous Waste Operations and Emergency Response Health and Safety training, medical surveillance, and respiratory protection programs; ensures preparation of Accident Prevention Plans by a Qualified Person; reviews Activity Hazard Analyses and associated Remedial Action Contracts and authorizes finalization and implementation; develops and maintains safety audit program and ensures audits are conducted by a Competent Person; Reviewer and concurrence signatory for project Accident Prevention Plans. Key projects include the following:

- **PFAS Site Investigation at 80 Army National Guard Facilities, Nationwide**—EA is conducting site investigations for PFAS to develop conceptual models of contamination. Site investigation activities include soil, surface water, and ground water sampling. Review and approve Site Safety and Health Plans as site specific scopes are identified. Ensure compliance with safety requirements for site access, drilling, reviewing subcontractor safety, development and implementation of medical programs, exposure and hazard assessments, site safety audits and Site Safety and Health Officer support, and identification and delivery of safety training requirements.

- **Integrated Natural Resources Management Plan at 24 Air National Guard Facilities, Nationwide**—Reviewed and approved the Abbreviated Accident Prevention Plan for site visits at Air National Guard facilities nationwide. Field teams from across EA were deployed to conduct multi-species flora/fauna surveys, erosion surveys, and Integrated Natural Resources Management Plan surveys. Site hazards ranged from dangerous fauna (bears, including development of bear protection plans, training, and subcontracted bear guards), poisonous flora, as well as hazardous walking surfaces. Managed medical monitoring and fitness for duty programs, drug and alcohol abuse policies, training requirement identification and safety training implementation.

- **Building Demolition, Walter Reed Medical Center**—Managed and reviewed the development of an Accident Prevention Plan/Site Safety and Health Plan for demolition of 12 buildings on the campus of the Walter Reed Medical Center in Washington, D.C. Reviewed and directed development of hazardous and toxic materials investigations for engineering design of remediation plans to safely remove asbestos, lead, and other toxic/hazardous materials in preparation for demolition. Hazards controlled for the project included electrical safety, fall protection plan development, structural engineering surveys, site layout for security, and tree and brush clearing activities. Reviewed and approved Activity Hazard Analyses for task specific activities and provide senior technical review of subcontractor remediation plans. 2012 MAES: $1,3459,804; 2019 MAES: $13,933,030 (awarded to date)

- **Performance-Based Remediation for Expansion of the Dissolved Ethylene Dibromide Plume Groundwater Treatment System, Kirtland Air Force Base, New Mexico; U.S. Army Corps of Engineers–Albuquerque District; Health and Safety Manager—**Project requires implementation of a Resource Conservation and Recovery Act Interim Measure for expanding the groundwater treatment system at Solid Waste Management Units ST-106/SS-111 at Kirtland Air Force Base, New Mexico for containment of the dissolved-phase ethylene dibromide off-base plume associated with the Bulk Fuels Facility and historical releases of jet propellant-4, jet propellant-8, and aviation gas.

Drum Disposal, Lonfit Planning Project; U.S. Army Corps of Engineers–Huntsville; Health and Safety Senior Technical Reviewer—Provided senior technical review for project which includes disposal of up to 63 drums located within a dilapidated Quonset hut in Asan, Guam. Authored Project Management Plan and Uniform Federal Policy-Quality Assurance Project Plan as well as responsible for supporting the Project Manager in organizing and scheduling project activities.
Project Date: June 2019 – Present

Installation Restoration Program at Joint Base Lewis-McChord; Pierce County, Washington; U.S. Army Corps of Engineers; Health and Safety Manager—EA is providing Environmental Remediation Program Services for Joint-Base Lewis-McChord and Yakima Training Center. Work under this contract includes remediation systems operation, maintenance, monitoring, and optimization. Contribution to this effort includes task managing multiple field efforts to collect representative groundwater samples utilizing low-flow sampling techniques with submersible, bladder, and peristaltic pumps from approximately 30 groundwater wells and collecting groundwater samples from passive diffusion bag samplers from over 100 monitoring wells. Chemicals of concern at the sites are volatile organic compounds including trichloroethene and tetrachloroethene, diesel and gasoline range organics, and metals.
Project Date: January 2018 – Present

Cleanup of the Former York Naval Ordnance Plant York, Pennsylvania—Health and safety support during cleanup of Military Munitions Response Program hazards at the former York Naval Ordnance Plant Formerly Used Defense Sites. Responsible for preparing a site-specific conceptual site model for the Formerly Used Defense Sites based on the historical operational information and the previous investigations for the Military Munitions Response Program. Project includes surface clearance for munitions and explosives of concern and munitions debris, analog and digital geophysics, intrusive anomaly investigations, and munitions constituents sampling. Site follows Pennsylvania Department of Environmental Protection Act 2 and U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act cleanup using Act 2 guidance and cleanup criteria. Responsible for preparation and review of planning documents, oversite of unexploded ordnance investigations (surface clearance, geophysics, and intrusive investigations) and munitions constituents sampling and analysis, and review of investigation results. Prepared a Remedial Investigation report which was approved by Pennsylvania Department of Environmental Protection And EPA. Prepared a Remedial Alternatives Analysis with a recommended alternative to address Risk at the Former New York Naval Ordnance Plant. Remedial action was approved by stakeholders Pennsylvania Department of Environmental Protection and EPA. Prepared a cleanup plan to address residual munitions and explosives of concern and munitions constituents contamination which include removal of former firing range buildings. Provided Munitions Response/Construction Support to support during Harley-Davidson building expansion program. Prepared a design, sediment and erosion control plan, and specifications to support subcontractor selection process for cleanup. Conducted hazmat surveys and identified residual asbestos-containing material, which needed to be address thru abatement (friable asbestos-containing on steam lines, roofing material and asbestos-containing sprayed on walls). Remedial action will address residual asbestos-containing, Resource Conservation and Recovery Act hazardous waste (lead dust and sand in the backstop) as well as munitions and explosives of concern, munitions constituents and building debris. Prepared planning documents (Health and safety plan, sampling and analysis plan, quality control plan) to support cleanup activities. Cleanup activities commenced in Spring 2021.
Project Date: December 2014 – Present

Remedial Investigation/Feasibility Study Oversight, Valley Pike Volatile Organic Compounds Superfund Site, Riverside, Ohio; EPA Region 5; Health and Safety Manager—Health and Safety Manager for completion of Remedial Investigation and Feasibility Study Potentially Responsible Party oversight at the Valley Pike volatile organic compounds Superfund Site located in Riverside, Ohio under the EPA Remedial Acquisition Framework Environmental Services and Operations Contract. The site is located southwest of the Mullins Rubber Products Incorporated facility in a mixed industrial and residential area that includes approximately 500 residential properties. Groundwater contaminated with tetrachloroethene and trichloroethene was discovered in 2013 and the residential area has been impacted by vapor intrusion issues from the groundwater plume. Activities completed to date (December 2020) include development of planning documents (Health and Safety Plan, Uniform Federal Policy–Quality Assurance Project Plan, and Project Management Plan). Activities to be completed include oversight of Potentially Responsible Party led remedial investigation field activities including sample collection and treatability study and technical review of Potentially Responsible Party submittals including technical memorandum (site characterization, current and future land uses); Screening Level Ecological Risk Assessment Report; Baseline Risk Assessment Report; and Remedial Investigation Report.
Project Date: August 2020 – Present

Oklahoma–Arkansas Group Optimized Remediation Contract; Air Force Plant 3, Altus Air Force Base, Tinker Air Force Base, and Vance Air Force Base, Oklahoma, and Little Rock Air Force Base, Arkansas; U.S. Army Corps of Engineers–Tulsa District (contracting agency for Air Force Civil Engineer Center)— Health and Safety Manager for 10-year, performance-based contract to achieve high resolutions site characterizations, decision documents, Remedy-in-Place, Response Complete, Site Closeout, Remedial Action-Operation, Long-Term Monitoring, and/or Five-Year Reviews at 66 sites across five installation.

Marion Pressure Treating Company Superfund Site, Marion, Louisiana; EPA; Remedial Design; Health and Safety Manager—Providing health and safety oversight and technical support during the remedial design associated with a former pressure-treated wood product company located in Marion, Louisiana. Creosote was reported to be the only wood preservative used during the wood treatment process. The Marion Pressure Treating Company site was proposed for the National Priorities List in 1999 and added to the list in 2000. A remedial investigation and feasibility study were completed at the site in 2001, and the Record of Decision was completed in 2002. A remedial design was developed in September 2003, and an independent technical review of the design was performed by U.S. Army Corps of Engineers in 2006. However, due to issues with the selected technology, the remedial action was never performed. EA conducted a supplemental field investigation employing the use of a cone penetrometer testing rig in conjunction with the Tar-specific Green Optical Technology® to delineate the extent of creosote at the site. EPA issued a Record of Decision Amendment in 2016 thereby establishing the remedy to be implemented at the site. The remedial design is based on the remedy of *in situ* solidification/stabilization of the dense non-aqueous phase liquid area, removal soil and sediment from the Big Creek and the waste piles on the south side of the site into the Consolidation Cap Area, and extension of the Resource Conservation and Recovery Act cap.
Project Date: 2010 – Present

Environmental and Engineering Assessments for Department of Defense Fuel Systems Worldwide; Air Force Civil Engineer Center; Health and Safety Manager—Health and Safety Manager to provide senior technical review of health and safety plans for tasks providing Leak Detection Testing and Monitoring for the Defense Logistics Agency-Energy Leak Detection Centrally Managed Program formerly known as the Defense Energy Support Center who is responsible for the environmental compliance of capitalized petroleum, oil, and lubricants storage and distributions systems at Department of Defense facilities throughout both the continental United States and outside the United States worldwide.
Project Date: June 2018 – Present

Highways Division Safety Consulting Services (Hawaii, Maui, and Kauai Districts); Hawaii Department of Transportation; Health and Safety Senior Technical Reviewer—Provide senior technical review for various safety consulting services at the Hawaii District baseyards (Hilo, Honokaa, Waimea, North Kona, South Kona and Kau), Maui District baseyards (Kahului, Keanae, Molokai, and Lanai), and Kauai District baseyard (Puhi). The goal of the project was to provide safety consulting services for the various baseyards including training, inspections, plan updates, recordkeeping, reporting, and other miscellaneous tasks in accordance with applicable regulatory requirements for each baseyard.
Project Date: October 2020 – Present

Water Treatment Plant Upgrades, Naval Security Group Activity, Northwest Annex, Chesapeake, Virginia; Naval Facilities Engineering Systems Command Washington; Health and Safety Manager—Provide health and safety management and support during project management and technical execution of furnishing and installing six 2,000-pound granular activated carbon contactors in two trains of lead-lag-polishing series. Redevelopment and sampling of existing monitoring wells associated with the former Navy Exchange fueling station (source area) is also included. Responsible for the preparation/submittal of the Remedial Action Work Plan and associated documents (Quality Assurance Project Plan, Accident Prevention Plan Construction Quality Control Plan,

Environmental Protection Plan, Stormwater Pollution Prevention Plan, Traffic Plan, etc.), management of subcontractors and field staff, as well as report preparation.
Project Date: March 2020 – Present

Spirit Lake Estuary Remedial Design; Duluth, Minnesota; EPA Region 5/Region 9; Health and Safety Senior Technical Reviewer and Health and Safety Manager—Senior Technical Reviewer and Health and Safety Manager for a remedial design consisting of multiple remedy elements to address over 700,000 cubic yards of polycyclic aromatic hydrocarbons and metal contaminated sediment at the Spirit Lake site; remedy elements include sediment removal, capping, enhanced monitored natural recovery, monitored natural recovery, and onsite disposal in three project-constructed confined disposal facilities. Supporting as a lead reviewer for a design team of over 30 people to design confined disposal facilities; stream and river diversion structures; dredge prisms and methods; staging, access, dewatering, and disposal. Provided significant support in the contractor procurement, negotiation, and construction planning support for first $30 million of environmental remediation activities. Provides leadership and support for construction activities and field staff coordination as Construction Quality Manager.
Project Date: 2017 – Present

***Performance-Based Remediation, Kirtland Air Force Base, New Mexico; U.S. Army Corps of Engineers–Albuquerque District, Health and Safety Manager*—**Project requires implementation of a Resource Conservation and Recovery Act Interim Measure for expanding the groundwater treatment system and groundwater extraction/conveyance system at Solid Waste Management Unit ST-106/SS-111 at Kirtland Air Force Base, New Mexico for containment of the dissolved-phase ethylene dibromide off-base plume associated with the Bulk Fuel Facility and historical releases of jet propellant-4, jet propellant-8, and aviation gas. The groundwater treatment system expansion included the construction of a second 400 gallons per minute granular activated carbon filter treatment system and the design of sand filters for both treatment trains with total capacity of 800 gallons per minute. Provided health and safety management support and quality assurance for the successful expansion of the groundwater treatment system as well as the groundwater extraction/conveyance system. Provides direction and support on safety matters as Accident Prevention Plan Reviewer as well as development of project-wide risk management planning document and procedures.
Project Date: 2015–2019

Site Management Program; Architect of the Capitol, Washington, D.C.; Program Manager—EA has supported the Architect of the Capitol since 2007 under various contracts, providing a wide range of mission support, including industrial hygiene services. The Office of the Architect of the Capitol is responsible to the U.S Congress for the maintenance, operation, development, and preservation of the 18.4 million square feet of buildings and more than 450 acres of land throughout the Capitol Complex. The Architect of the Capitol Power Plant provides steam and chilled water service through a network of underground piping and utility tunnels to 21 buildings and facilities on Capitol Hill. The tunnels total approximately 2.5 miles in length and vary in cross-section and age, with most tunnels exceeding 50 years of age. The Congressional Office of Compliance became aware of deteriorating and potentially dangerous conditions within these tunnels and issued a formal complaint against Architect of the Capitol that resulted in a Settlement Agreement between the Architect of the Capitol and Office of Compliance. This Settlement Agreement required the correction of nearly 2,000 discrete health and safety findings. Under this Contract, EA has provided consulting services, design services, safety training services, facilitation services, support products, and program and project management for Architect of the Capitol, as described below. Within all consulting services, EA provides expert services from Certified Industrial Hygienists, Certified Safety Professionals, Professional Engineers, LEED Accredited Professionals, Certified Energy Managers, and Project Management Professionals.

Occupational Health and Safety Program Support (Consulting Services)—EA has provided a wide range of consulting services to Architect of the Capitol to support the $200 million Utility Tunnel Modernization Program. EA provides onsite and offsite support to the Architect of the Capitol program staff in program and project planning, audits, evaluations, analysis of program elements, development and testing of scenarios, and Information Technology system solution development, rollout, support, and professional consultation. EA was contracted to support the development and implementation of a Program (supported by a Site Management Team comprised of an Architect of the Capitol management team with contractor support) with an initial focus of developing processes and procedures for tracking the health and safety finding life cycle as a matter of regulatory record. The Site Management Team focused initially on the correction of physical hazards such as overhead hazards (falling concrete), confined space and communication issues, excessive heat, and potential asbestos exposure and was primarily construction activity driven. As the Program progressed, EA's role expanded to include the audit and enhancement of the health and safety program elements necessary to safely operate the utility tunnel system. EA provided Certified Industrial Hygienists and Certified Safety Professionals to review and enhance these programs.

- ***Permit-Required Confined Space***—EA worked closely with Architect of the Capitol safety personnel and management to enhance and implement the Permit-Required Confined Space program by updating program documentation, performing field inspections of confined space entrant activities, performing atmospheric monitoring, and ensuring personal protective equipment was appropriate for hazards encountered during the entry.

- ***Occupational Exposure Assessment*****—**EA performed occupational exposure assessments and negative exposure assessments for airborne contaminants such as hydrogen sulfide, carbon monoxide, asbestos, and silica. In addition, EA developed new record keeping and documentation procedures and tools to ensure the exposure assessments provided regulatory compliant information.

- ***Heat Stress Prevention*****—**The more than 4 miles of tunnels that supply steam and chilled water service throughout the Capitol Complex can often create significantly elevated temperatures; consequently, EA worked closely to partner with Architect of the Capitol staff and management to implement and update a heat stress prevention policy. EA developed exposure criteria for the unique operational activities and environment found in the tunnels, including confined space issues, entrants often wearing impermeable coveralls and respirators, long distances to rest areas, etc. Wet Bulb Globe Temperature measurements and employee health monitoring were implemented to ensure work rest cycles and acclimatization were occurring appropriately.

- ***Emergency Action and Response Plan and Other Consulting Services*****—**Over time, EA's role has also expanded to develop and implement key operational systems within Architect of the Capitol's framework. Specifically, EA created, launched, and trained Architect of the Capitol personnel in an Emergency Action and Response Plan, requiring extensive coordination with the D.C. Department of Fire and Rescue, U.S. Capitol Police, and Congress. EA continues to provide support to the Architect of the Capitol in the annual emergency preparedness drill cycle, documentation of issues/enhancements, updates to the Emergency Action and Response Plan, and training.

- ***Asbestos and Survey Services*****—**EA developed and administered two gap analyses of the Architect of the Capitol's existing Asbestos Operations and Management System and its Utility Distribution System Standard Operation Procedures. EA's evaluation of conditions involved review of historical documentation, a survey of field personnel, and review of procedures. EA then performed qualitative and quantitative analyses to determine the veracity of compliance with appropriate regulations and guidelines, identified targets for improvement, proposed solutions, facilitated work teams to generate consensus, and helped guide the implementation of improvements. Finally, EA developed site-specific training materials for Asbestos Operations and Maintenance Plan requirements. To ensure full implementation, EA provided training to more than 55 individuals over multiple training sessions.

Emergency Egress and Safety Signage Improvements (Design Services)—EA provided a team of health, safety, and engineering professionals to evaluate emergency egress signage requirements (exit signs) and Occupational Safety and Health Administration-required signage and safety markings for physical hazards within the tunnel system. EA's in-house team of Certified Industrial Hygienists, Certified Safety Professionals, and Professional Engineers assessed the tunnel system for hazards and egress route requirements per Occupational Safety and Health Administration and National Fire Protection Agency Life Safety Code requirements. EA's developed plan sets and bid contract documents and specifications for the correction of the more than 200 deficiencies noted within the tunnels. EA's team continues to provide Construction Administration support by developing responses to requests for information, coordinating pre-construction facility reviews with contractors and Architect of the Capitol, performing "punch list" inspections of completed installations, and developing final as-built facility plans based on contractor red-line drawings.

Training Programs and Other Facilitation Services—In 2008, EA staff facilitated a one-day planning summit with over 20 Architect of the Capitol stakeholders, including senior administration from the Architect of the Capitol, U.S. Army Corps of Engineers, and EPA. The summit was held at the Dirksen Senate Office Building in Washington, D.C. and was well attended with over 75 individuals. The focus of the summit was to develop a strategic plan for the Utility Tunnel Modernization Program that defined key drivers, critical success factors, and reporting requirements. EA presented a beta version of the Utility Tunnel Information System web-based program that was developed by EA as a management solution. Stakeholder input was received through an EA facilitation specialist. EA prepared the agenda, handouts, briefing packages, presentations, and coordinated post-summit communication. EA has also provided training for more than 100 employees and contractors for Permit-Required Confined Space, facility specific asbestos awareness, health and safety hazard reporting, and health and safety requirements to safely enter the tunnels.

On a day-to-day basis, EA provides collaborative management and reporting with Architect of the Capitol and contract staff on a biweekly basis and at other project-focused meetings. Specifically, EA was responsible for preparing the Monthly Senior Leadership Team reports for multiple programs used by the Acting Architect of the Capitol and key staff in managing decisions, and the monthly Architect’s Brief for programs that is used to brief staff members of the Architect of the Capitol on progress, performance, and forecasts. EA’s team also provides support for all health and safety issues related to the program.

Health and Safety Support Products—EA developed a web-based program management tool (Utility Tunnel Information System) to manage health and safety issues associated with the utility tunnels around the Capitol. The task included the development of an internet mapping system for analysis and map production along with the ability to create sophisticated reports from the system. EA currently hosts and manages Utility Tunnel Information System.

- ***Application Development—***Supporting the Architect of the Capitol in the development of Utility Tunnel Information System to manage health and safety issues associated with the utility tunnels, supporting the Congressional Campus in Washington, D.C. The password-protected web application, currently being maintained by EA, gives users access to a number of information management functions that include an online file repository, a list of tunnel safety findings and associated corrective measures, construction schedules, and an internet mapping (Geographic Information System) application. The mapping tool was developed with user-friendly point-and-click functionality, where no previous Geographic Information System knowledge is required by the user to create customized maps or access the associated data. The system serves as the primary program management tool for Architect of the Capitol’s Utility Tunnel Safety Program, allowing Safety Program team members, regulators, various contractors, and Architect of the Capitol staff to coordinate efforts through a central information repository. Specific elements of the online application include:

    - ***Finding and Corrective Measure Tracking—***Provides the ability to add, edit, view, search, and track all health and safety issues and their associated corrective measures within the utility tunnel network. Users can track changes over time and manage assigned corrective actions for all identified issues.

    - ***Construction Schedule—***Provides the ability to plan, schedule, and track construction activities associated with health and safety corrective measures. Users can view all completed, in-progress, and future construction activities for a given section of tunnel and print detailed Gantt chart style schedules.

    - ***Financial Analysis—***Provides the ability to track budgets and costs in multiple tiers and in varying methods to appropriately address and respond to Congressional inquiries, Also provides the ability to measure and manage financial performance at the project and program levels.

Project Date: 2007–2014; 2019 – Present

Phase I/II Environmental Site Assessments – Food and Drug Administration Pharmaceutical Laboratory, St. Louis, Missouri; Food and Drug Administration/U.S. Army Corps of Engineers and TerranearPMC.; Lead

Industrial Hygienist—Lead Industrial Hygienist for the decommissioning evaluation of a former Food and Drug Administration pharmaceutical research laboratory. Followed the ANSI Z9.11 Laboratory Decommissioning Standard to investigate and evaluate multiple chemical, biological, and radiological hazards. Supervised on-site activities for health and safety. Developed sampling methodologies and strategies to evaluate boundaries of contaminants compared to multiple end-use clean-up criteria.
Project Date: February–March 2014

Mold and Building Envelope Investigation, Internal Revenue Service Processing Center; General Services Administration; Project Manager—Assessment of extent of mold impacts and potential sources of water intrusion in main IRS processing center in Kearneysville, West Virginia. Scope included detailed visual inspection of building envelope, visual inspection of mold in wall cavities, and development of recommendations for intrusive investigation.
Project Date: August 2011 – January 2012

Mold and Building Envelope Investigation, Internal Revenue Service Processing Center; General Services Administration; Project Manager—Structural assessment of building envelope for detailed evaluation of sources of water intrusion in main Internal Revenue Service processing center in Kearneysville, West Virginia. Airborne mold monitoring during and after investigation activities. Development of corrective action plan for building defects and mold remediation plan.
Project Date: June 2012 – 2014; 2019 – Present

Environmental and Engineering Assessments for Department of Defense Fuel Systems Worldwide; Air Force Civil Engineer Center; Technical Review of Health and Safety Plans—Providing technical review and support for health and safety plan development for field effort program wide for activities including Leak Detection Testing and Monitoring for the Defense Logistics Agency Energy Leak Detection Centrally Managed Program formerly known as the Defense Energy Support Center who is responsible for the environmental compliance of capitalized petroleum, oil, and lubricants storage and distributions systems at Department of Defense facilities throughout both the continental United States and outside the United States worldwide. Work activities reviewed include: engineering tests and evaluations at Defense Logistics Agency-Energy fuel systems as well as Department of Defense and Defense Logistics Agency who sponsors fuel projects for Defense Fuel Support Points and provides integrity and leak detection testing of bulk storage tanks, hydrant fueling systems, off-loading facilities, fuel terminals, and ground fuel pipelines.
Project Date: December 2009 – 2014; 2019 – Present

Environmental Programs, Baltimore, Maryland; Loyola University Maryland; Lead Safety Auditor—The compliance program consists of conducting a campus wide environmental audit and the completion of a new Spill Prevention Control and Countermeasure Plan to ensure compliance relative to federal, state, and local regulations and conformance with best management practices.
Project Date: February 2011 – 2014; 2019 – Present

Lead, Asbestos, and Indoor Air Quality Services for Baltimore City Public Housing; Baltimore, Maryland; Housing Authority of Baltimore City; Health and Safety Technical Review—Review documentation and procedures in support of the implementation and operation of Baltimore City agency lead poisoning prevention program, asbestos monitoring program, indoor air quality program, and programs for other environmental service areas.
Project Date: 2010–2014; 2019 – Present

Massachusetts Port Authority; Logan Airport Air Monitoring – Equipment Inspection and Services; Boston, Massachusetts—Quality assurance/quality control support for all aspects of air monitoring program to determine impacts of construction of new taxiway at Logan International Airport. Reviewed updated Quality Assurance Project Plan, Work Plan, and Standard Operating Procedure documents for Year 2 of air monitoring program. Reviewed data collection and management as well as audited field activities for all analyses including TO-11a (carbonyls and formaldehydes), TO-13a (polycyclic aromatic hydrocarbons), TO-15 SIM (volatile organic compounds), and gravimetric analysis ($PM_{2.5}$ analysis).
Project Date: May 2010 – April 2012

Indoor Air Quality Surveys; General Services Administration—Project for indoor air quality surveys at the J. Caleb Boggs Federal Building in Wilmington, Delaware; the Mitchell H. Cohen Courthouse and Cohen Annex in Camden, New Jersey; the Clarkson S. Fisher Federal Building and Fisher Annex in Trenton, New Jersey, and the Social Security Administration Trust Fund Building in Bridgeton, New Jersey. Project included indoor air sampling and measurements and visual inspection of heating, ventilation, and air conditioning systems.
Project Date: July 2010 – November 2011

Indoor Air Quality Surveys; General Services Administration—Project Manager for indoor air quality surveys at five facilities in Philadelphia (Robert Nix Federal Building and U.S. Post Office, U.S. Custom House, William J. Green, Jr. Federal Building, James A. Byrne U.S. Courthouse, and the Veterans Administration Center), four facilities in Baltimore (U.S. Custom House, Appraisers Store, G.H. Fallon Federal Building, and Edward A. Garmatz U.S. Court House), and the Maude R. Toulson Federal Building in Salisbury, Maryland. Project included indoor air sampling and measurements and visual inspection of heating, ventilation, and air conditioning systems.
Project Date: August 2009 – 2014; 2019 – Present
Project Value – $63,219; Contract Type – Firm Fixed Price; EA Project Nos. – 6202840; EA Project Manager – R. Marcase

Environmental Compliance Program Support; Maryland Aviation Administration, Maryland; Task Manager—Currently providing technical support of a compliance-focused environmental management system for Maryland Aviation Administration facilities including Baltimore/Washington International Thurgood Marshall Airport and Martin State Airport. Instrumental in creating facility-wide environmental compliance documentation for the Maryland Aviation Administration. Activities include site audits for document preparation, planning, and design meetings for a web based tracking system, and client interview and data gathering. Providing support in identification of regulatory requirements and assessment of compliance with requirements, with particular emphasis in underground storage tanks and bulk fuel management. Managed efforts to provide documentation and recommendations for both underground and aboveground storage tanks pertaining to environmental regulation compliance inspections. Efforts include performing a detailed evaluation and inventory of existing underground and aboveground storage tank systems to determine compliance with applicable regulations.
Project Date: 2006–2014; 2019 – Present

Compliance-Focused Environmental Management System; Maryland State Highway Administration, State-Wide, Maryland; Task Manager—Team Leader for development of compliance-focused environmental management system for State Highway Administration's facilities under voluntary agreement with EPA. Reviewed State Highway Administration operations and Maryland regulations, and identified compliance requirements in support of development of environmental compliance inventory/assessment program for 28 primary vehicle maintenance shops. Lead auditor for implementation of this program. The effort is part of a multi-phase approach to assess, design, and implement compliance-focused environmental management system at over 125 State Highway Administration facilities over the next 5 years.
Project Date: May 2006 – 2014; 2019 – Present

Spill Prevention Control and Countermeasure Plan Preparation; Maryland Environmental Service in support of the Maryland Port Administration, Maryland; Task Manager—Provided Task Management and technical support for on behalf of the Maryland Port Administration for the preparation of Spill Prevention Control and Countermeasure Plans for multiple Maryland Port Administration facilities. The Spill Prevention Control and Countermeasure Plans were prepared for five Maryland Port Administration facilities including the Cambridge, Fairfield, Masonville, North Locust Point, and South Locust Point Marine Terminals. Efforts included conducting site inspections and preparation of the Spill Prevention Control and Countermeasure Plans in accordance with 40 CFR 112 and EPA Spill Prevention Control and Countermeasure Regulation (EPA 540-I-01-006, October 2002).
Project Date: August 2006 – November 2007

Dundalk Marine Terminal Air Monitoring Program; Maryland Environmental Service on behalf of the Maryland Port Administration, Maryland; Task Manager, Senior Technical Support—Field Engineer responsible for developing and implementing a complex air monitoring program at the 570-acre site. The project is the result of a regulatory consent order between the Maryland Port Administration and the Maryland Department of the Environment. The Maryland Department of the Environment is concerned over the potential for exposure of the adjoining communities of hexavalent chromium that is present in high concentrations in the site fill material. The project has been designed to have nine individual ambient air monitoring stations, each to measure atmospheric concentrations of hexavalent chromium and total suspended particulate matter. A unique monitoring method has been developed that will quantify concentrations below 1 nanogram per cubic meter. A meteorological monitoring station has also been established on the site.
Project Date: October 2006 – 2014; 2019 – Present

Indoor Air Quality Assessment and Microbial Survey, Princess Anne, Maryland; State Highway Administration; Senior Technical Support—Performed an indoor air quality and microbial survey for a public sector client. In response to employee complaints, an indoor air quality screening and microbial evaluation was performed in an effort to determine the cause of employee health complaints and unidentified odors.
Project Date: May–June 2006

Air Permitting and Emission Inventory Management; Grubb and Ellis/Citicorp Financial, Silver Spring, Maryland; Air Quality Compliance Activities, Task Manager, and Field Technical Operations—Provided client support and project management to assure timely submittal of quarterly and annual Maryland Department of the Environment Emissions Certification Reports for an electrical generation facility providing essential back-up power for critical financial transactions. Coordinate and implement emissions testing as a field technical compliance specialist to provide actual process emission data.
Project Date: January 2007 – 2014; 2019 – Present

Source Testing Oversight and Coordination; Perdue Agri-Recycle, Seaford, Delaware; Field Engineer—Field Engineer responsible for managing field activities and providing technical liaison between plant personnel and source testing firms to provide a clear picture of plant-wide air emissions sources. This state-of-the-art facility converts chicken farm agricultural waste to commercial fertilizer products. Instrumental in providing diagnostic testing to aid in implementation of process design changes to aid in air quality compliance and emissions reduction.
Project Date: September 2006 – 2014; 2019 – Present

Comprehensive Environmental Permitting; Agro-Iron Chesapeake, Baltimore, Maryland; Technical Support —Provided technical support during comprehensive environmental permitting activities for a new inorganic

chemical process facility for manufacturing inorganic water treatment chemicals, including iron chlorides, iron sulfates, aluminum sulfate, sodium aluminate, and sodium hypochlorite. An existing inorganic chemical processing facility was being retrofitted and refurbished for this purpose. Project elements included, investigation of air and water permitting pathways in support of project planning; and identification, preparation, and negotiation of the required approvals and permits. These included Baltimore City Erosion and Sediment Control Plan and Stormwater Management Plan approvals, with the associated maintenance and performance bond agreements; the Stormwater Pollution Prevention Plan required under the National Pollutant Discharge Elimination System General Permit for Stormwater Discharge from Industrial Activities; the Accidental Release Prevention program; and the Air Quality Permit to Construct application.
Project Date: February 2007 – 2014; 2019 – Present

Other Project Experience

Industrial Hygiene Services and Hazardous Materials Abatement Management, The Milton S. Hershey Medical Center, Hershey, Pennsylvania**—**Managed projects and personnel including subcontractors for Hazardous Material Abatement projects ranging from small scale, short duration asbestos removal projects to long term capital improvement multimedia hazardous material abatement projects.

Laboratory Audit and Industrial Hygiene Survey, The Maryland Motor Fuels Laboratory, Linthicum, Maryland
—Performed health and safety audits on a yearly cycle for laboratory operations including laboratory operations review, engineering control suitability review, occupational exposure risk determination, and exposure sampling.

Facility-Wide Occupation Exposure Assessment, Confidential Industrial Client, Huntingdon, Pennsylvania—
Developed and implemented a facility-wide industrial hygiene sampling protocol to assess potential occupational exposure from process hazards. Sampling strategies were developed as a result of a facility inspection and a thorough understanding of industrial processes and associated hazards.

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Safety and Health Manager

- **Adrian Hughes, CSP, ASP, PG**

Adrian Hughes, V; PG,ASP,CSP

Safety Professional/Industrial Hygienist

With over 15 years of safety and health experience covering over 135 non-overlapping months, Mr. Hughes provides supervision/oversight, quality control (QC), and safety and health responsibilities on site involving excavations, heavy equipment, remediation system installation and operation, drilling, and environmental sampling (surface water, process water, groundwater, sediment, soil, and subsurface and surface vapor). He is responsible for daily health and safety meetings, ensuring Accident Prevention Plan (APP) compliance, and daily quality control reports. Mr. Hughes is trained and experienced in performing and demonstrating calibration of monitoring equipment; providing health and safety oversight and/or environmental monitoring during drilling, excavations and trenching, and/or environmental sampling activities; providing on-site training relating to project safety; preparing Site Safety and Health Plans (SSHP); implementation of emergency procedures; performing air monitoring; and selecting, wearing, and training others regarding personal protective equipment (PPE). Mr. Hughes has conducted accident investigations, performed deficiency tracking, and implemented corrective actions.

Qualifications

Education

B.S.; Towson University; Geology; 2000

Specialized Training

Certified Safety Professional; 2020-Present
Associate Safety Professional; 2016-Present
Professional Geologist (KY); 2013-Present
OSHA 40-Hour HAZWOPER; 2005
OSHA 8-Hour HAZWOPER Refresher; 2006-Present
OSHA 8-Hour Supervisor Training; 2012-Present
OSHA 30-Hour Construction Oversight; 2011
Excavation Safety Training (OSHA 1926.650-652)
Smith System Driver; 2007-2011
Loss Prevention System 8-Hour; 2007
DOT Hazardous Materials; 2007
DOT Security Awareness; 2007
IATA Dangerous Goods Transportation; 2007
Federal Railroad Administration; 2007-2009
ASTM Certification for Phase I-II Environmental Site Assessments; 2009
Innovex X-Ray Fluorescence (XRF); 2010-Present
CPR and First Aid (Current Due to State of Emergency)
Bloodborne Pathogens; 2021-2022
Radon Measurement (2012-Present)
Competent Person Fall Protection (2016-Present)
Asbestos Inspector/Mgt Planner (2019-Present)

Professional Experience

Safety Program Manager - Contaminated Building Demolition Program; United States Army; Edgewood Area of Aberdeen Proving Ground, Maryland
(31 Total Months; October 2018-Present)

- Fulfilled above role for oversight of the planning and demolition of chemical and biological agent contaminated buildings performed by third-party contractor to USACE-Huntsville. Activities to date included planning document review (APP/SSHP/Sub-Plans) for demolition, asbestos abatement, chemical/biological/radiological contamination characterization and remediation, environmental sampling, environmental monitoring, and environmental assessment.

Responsibilities included:

- Perform third-party health and safety oversight during above activities while reporting to the APG Directorate of Public Works’ Installation Safety Office, USACE-Baltimore (CENAB), USACE-Huntsville, and State of Maryland entities;
- Generated daily reports and provided to stakeholders;
- Reviewed and ensured compliance of the asbestos abatement plan, demolition plan, hazardous energy control plan and other related sub-plans (ensuring state and federal compliance).
- Perform audits, near-miss evaluations, accident and incident investigations, and performed concurrent operations with Boards-of-Investigation.

SSHO, Associate Safety and Health Manager, & Competent Person; Demolition, Environmental Assessment, and Environmental Remediation; United States Air Force, Nellis AFB, Nevada (5 Total Months; June-October 2018)

- Fulfilled above role for site activities including well installation, construction and grading activities, munitions clearance and soil remediation, demolition of multi-story above ground structures, recycling of Conex villages, oversight of asbestos abatement, lead decontamination of onsite materials, IDW management and sampling, work zone and PPE enforcement, fall protection & aerial lift usage, ladder use, radiologically-contaminated media sampling, isotopic analysis of aqueous media, review and implementation of ancillary chemical safety submissions (CSS) and biological safety submissions (BSS), conducted air monitoring (site contaminants/nuisance dust, reviewed structural engineer surveys, and demolition plans.

Responsibilities included:

- Perform health and safety oversight during above activities;
- Performed and enforced site and equipment inspections;
- Generated corrective actions following daily and/or weekly inspections;
- Perform health and safety oversight during activities described above, competent person for fall protection, aerial lift usage, and ladder usage;
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment;
- Followed site-specific excavation permit utility avoidance prior to intrusive activities;
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP/SubPlans onsite;
- Conduct daily site safety and health inspections for job zones
- Reviewed and ensured compliance of the asbestos abatement plan, demolition plan, hazardous energy control plan and other related sub-plans (ensuring state and federal compliance)
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO & Competent Person; Environmental Sampling Activities; United States Army Environmental Command, Various Installations
(2 Total Months; March and April 2018)

- SSHO for site activities including multi-media environmental sampling; well installation, development, and sampling; boating activities and float plan generation; IDW management and sampling; work zone establishment and enforcement; environmental monitoring; ladder use; IDW management and sampling; and heavy equipment usage.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above, competent person for fall protection, aerial lift usage, and ladder usage
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Followed site-specific excavation permit utility avoidance prior to intrusive activities
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO & Competent Person; Environmental Sampling Activities; United States Air Force, Various Installations
(11 Total Months; March-May, July, September through December 2017 and January, February, & May 2018)

- SSHO for site activities including multi-media environmental sampling; well installation, development, and sampling; boating activities and float plan generation; IDW management and sampling; work zone establishment and enforcement; environmental monitoring; ladder use; IDW management and sampling; and heavy equipment usage.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required

- Perform health and safety oversight during activities described above, competent person for fall protection, aerial lift usage, and ladder usage
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Followed site-specific excavation permit utility avoidance prior to intrusive activities
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO; Puchack Well Field Superfund Site in Pennsauken, NJ; EPA Region 3 via Leidos/SERAS (1 Month; August 2017):

- SSHO for site activities including high-pressure injections, sampling and field analysis of hexavalent chromium-contaminated media, heavy equipment usage, air monitoring, and heat stress monitoring.

Responsibilities included:

- Perform health and safety oversight during above activities
- Present daily safety briefings that included awareness training for site physical/chemical/biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Develop, implement, and ensure compliance with the APP/SSHP
- Conduct safety site inspections (initial, periodic, daily) to evaluate work conditions for job zones
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel and maintain/enforce appropriate PPE use

SSHO & Competent Person; Victory Village Munitions and Explosives of Concern Investigation; United States Coast Guard; Concord, California
(1 Month; June 2017)

- SSHO for site activities including multi-media environmental sampling, digital geophysical mapping; vegetation clearance, removal, and construction debris removal; intrusive MEC investigation; IDW management and sampling; work zone establishment and enforcement; environmental monitoring; ladder use; IDW management and sampling; target reacquisition and investigation; and heavy equipment usage.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and weekly inspections, if required
- Perform health and safety oversight during activities described above
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Followed site-specific excavation permit utility avoidance prior to intrusive activities
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones (grids/sub-grids)
- Prepare safety and health compliance memoranda and completed site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO & Competent Person; Geotechnical and Radiological Investigation for USACE at a Confidential Site in Baltimore
(1.5 Months; January and February 2017)

- SSHO for site activities including well installation, aerial lift usage, deep geotechnical boring installation, radiological monitoring, radiological contamination delineation, hot and cold stress monitoring, IDW management, radiological zone delineation including work zone establishment and enforcement, and heavy equipment usage – all within an active manufacturing facility. Competent person for fall protection, aerial lift usage, and ladder use.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily, weekly, and monthly inspections
- Perform health and safety oversight during well installation, heavy equipment usage, chemical and radiological decontamination activities, soil sampling, and IDW characterization and offsite disposal
- Perform health and safety oversight during oversized load equipment delivery and site operations trailer delivery and exchange of soil and aqueous IDW (including chemical and radioactively-impacted IDW)
- Assisted with onsite QC operations following QCS including QC over onsite delivery drilling materials
- Followed site-specific excavation permit utility avoidance prior to well installation activities
- Completion of audit process and near miss investigations
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/ and radiological hazards
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Develop, implement, and ensure compliance with the APP
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level C, Level D, and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO & Competent Person; FMY-02 Sanitary Landfill Intrusive Investigation at Joint Base Myer-Henderson Hall in Arlington, VA
(1.5 Months; November and December 2016)

- SSHO for site activities including vapor intrusion monitoring, monitoring point installation, site survey, monitoring well installation, utility avoidance, IDW management and characterization, environmental monitoring, cold stress monitoring, work zone establishment and enforcement, and heavy equipment usage.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily, weekly, and monthly inspections
- Perform health and safety oversight during well installation, heavy equipment usage, decontamination activities, soil sampling, and IDW characterization and offsite disposal
- Perform health and safety oversight during oversized load equipment delivery and site operations trailer delivery and exchange of granular activated carbon (used and unused)
- Assisted with onsite QC operations following QCS including QC over onsite delivery drilling materials
- Followed site-specific excavation permit utility avoidance prior to well installation activities
- Completion of audit process and near miss investigations
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/ and radiological hazards
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Develop, implement, and ensure compliance with the APP
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO & Competent Person; Building 235 Soil Excavation at Joint Base Myer-Henderson Hall in Arlington, VA
(2 Months; August and September 2016)

- SSHO for site activities including excavation, trenching, asphalt removal, traffic protection, IDW management and characterization, air monitoring, fall protection, ladder use, work zone establishment, contaminated medium sampling, heat stress monitoring, direct-push drilling, air-knifing/utility avoidance, and heavy equipment usage.

Responsibilities included:

- Perform health and safety oversight during above activities
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily, weekly, and monthly inspections
- Enforced tenets of excavation safety plan and evacuation plan
- Perform health and safety oversight during excavation, soil boring heavy equipment usage, decontamination activities, soil sampling, and IDW characterization and offsite disposal
- Perform health and safety oversight during oversized load equipment delivery and site operations trailer delivery and exchange of granular activated carbon (used and unused)
- Assisted with onsite QC operations following QCS including QC over onsite delivery of clean fill
- Followed site-specific excavation permit utility avoidance with high-pressure air knifing in potentially contaminated soils prior to direct-push soil sampling activities
- Completion of audit process and near miss investigations
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/ and radiological hazards
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Develop, implement, and ensure compliance with the APP
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Remedial Investigation at the Former York Naval Ordnance Plant in York, PA (3 Months; June, July, and October 2016)

- SSHO for site activities including contaminated media sampling, safety and health monitoring, direct-push and hollow-stem auger drilling, IDW characterization and management, heavy equipment usage, digital geophysical mapping, and intrusive MEC-related activities.

Responsibilities included:

- Perform health and safety oversight during above activities including heavy equipment use, inspections, monitoring, and corrective actions
- Perform health and safety oversight during soil boring and sampling activities, heavy equipment usage, , and groundwater sampling
- Assisted with onsite quality control operations and quality control document submission
- Completion of audit process and near miss investigations
- Present daily safety briefings consistent with the APP and SSHP for site physical, chemical, biological, and radiological hazards
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda
- Develop, implement, and ensure compliance with all safety-related documents
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; White Swan-Sun Cleaners' Source Area Superfund Site in Wall Township, NJ (5 Months; January through May 2016)

- SSHO for site activities including asbestos assessment and abatement, respiratory protection and monitoring, tree and vegetation removal, excavation of surface soils with heavy equipment, asphalt removal, vegetation clearance and tree felling, traffic protection, well installation and development with heavy equipment, IDW management and assessment, air monitoring, fall protection, ladder use, permanent fence installation, contaminated media sampling, heat and cold-stress monitoring, exchange of granular activated carbon, and high-pressure air sparge and soil vapor extraction system installation and monitoring for a chlorinated solvent-contaminated site.

Responsibilities included:

- Perform health and safety oversight during above activities including heavy equipment use, inspections, and corrective actions
- Perform health and safety oversight during Rotosonic well installation activities, heavy equipment usage, high-pressure well development activities, and sampling groundwater
- Perform health and safety oversight during oversized load equipment delivery and site operations trailer delivery and exchange of granular activated carbon (used and unused)
- Assisted with onsite quality control operations following QCS
- Completion of audit process and near miss investigations
- Perform daily safety briefings consistent with the APP and SSHP for site physical/chemical/biological/ and radiological hazards
- Ensure site workers abided by Respiratory Protection Program and followed respirator-use procedures
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda
- Develop, implement, and ensure compliance with the APP
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D, Mod Level D, and Level C)
- Maintain and enforce appropriate PPE use

SSHO; Operational Range Assessment Program (ORAP) Phase II Quantitative Assessment at Fort Sill, OK (5 months; January, May, June, July, and August 2014 with abandonment in November 2015):

- SSHO for site activities including well installation (Rotosonic) and high-pressure well development, subsequent well abandonment, sampling of environmental media (surface water, groundwater, and sediment), moving heavy equipment, and heavy equipment usage for managing soil stocks under conditions requiring heat-stress monitoring

Responsibilities included:

- Perform health and safety oversight during Rotosonic well installation activities, heavy equipment usage, high-pressure well development activities, and sampling of surface water, groundwater, and sediment (including incremental sampling)
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Develop, implement, and ensure compliance with the APP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; ORAP Phase II Quantitative Assessments at Fort Knox, KY, Fort Leonard Wood, MO; Fort Campbell, KY, Fort Huachuca, AZ, and Fort Irwin, CA (23 non-overlapping months; September 2011 through April 2013, November & December 2013, January 2014-June 2015, and July-October 2015):

- SSHO for site activities including multi-media environmental sampling (surface water, groundwater, and sediment), dye-tracing investigations, boating access to locations, and operations involving UXO-avoidance.

Responsibilities included:

- Perform health and safety oversight during the activities listed above
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Develop, implement, and ensure compliance with the APP
- Conduct site inspections to evaluate work conditions for job zones

- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Puchack Well Field Superfund Site in Pennsauken, NJ; EPA Region 3
(17 months; May 2012 through September 2013):

- SSHO for site activities including well installation (Rotosonic) and development, sampling of impacted groundwater, moving heavy equipment, and operations and maintenance of an injection system to inject sodium lactate amendment into the subsurface to remediate dissolved hexavalent chromium within three vertically-discrete aquifers.

Responsibilities included:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Develop, implement, and ensure compliance with the APP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; ORAP Phase II Quantitative Assessment at Fort Campbell, KY
(4 months; January, March, May, and July 2013):

- SSHO for Rotosonic drilling, borehole installation; dye injections, placement, and monitoring; hydraulic aquifer testing under pressurized conditions; and sinkhole capacity testing.

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Supplement unexploded ordnance (UXO) qualified personnel providing specific munitions of explosive concern (MEC) awareness and recognition training
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (YSI)
- Develop, implement, and ensure compliance with the APP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; ORAP Phase II Quantitative Assessment at Fort Bragg, NC
(3 months; November 2011 through December 2011 and December 2015):

- SSHO for drilling, installation (Mud Rotary), and development of monitoring wells to assess groundwater.

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Supplement unexploded ordnance (UXO) qualified personnel providing specific munitions of explosive concern (MEC) awareness and recognition training
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Develop, implement, and ensure compliance with the APP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel

- Maintain and enforce appropriate PPE use

SSHO; ORAP Phase II Quantitative Assessment at McGuire-Dix-Lakehurst AFB, NJ (2 months; October 2011 through November 2011):

- SSHO for drilling activities (Direct Push and Hollow-Stem Auger) and installation and development of monitoring wells to assess groundwater quality.

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Supplement UXO-qualified personnel providing specific MEC awareness and recognition training
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Site Characterization of Arsenic Contaminated Soil at Hull Street in Baltimore, MD (1 month; September 2011):

- SSHO for drilling activities (Hollow-Stem Auger) to assess soil contamination

Responsibilities include:

- Perform health and safety oversight during boring installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID)
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Borrow Soil Sampling for the Brown Station Landfill in Upper Marlboro, MD (3 months; May 2011 through July 2011):

- SSHO for drilling activities (Hollow-Stem Auger) and excavations to assess soil contamination

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID)
- Develop, implement, and ensure compliance with the SSHP
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use
- Educate site personnel regarding heavy equipment operation
- Ensure safe operation around heavy equipment

SSHO; Site Characterization of Subsurface Mercury Vapors in Baltimore, MD (2 months; May 2010 through June 2010):

- SSHO for drilling activities (Hollow-Stem Auger and Direct-Push) to install soil vapor wells and sample for subsurface mercury vapor

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Perform health and safety oversight during soil vapor well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID, multi-meter, landfill meter, and vapor extraction pumps)
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Multiple Sites - Maryland State Highway Administration Well Abandonment in Western MD (3 months; November 2009 through January 2010):

- SSHO for well abandonment activities, including heavy equipment, for deep bedrock wells

Responsibilities include:

- Perform health and safety oversight during well abandonment activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID)
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Intrusive Archaeological Investigation via Rotosonic Drilling at Meldahl Dam in Maysville, KY (2 months; September 2009 through October 2009):

- SSHO for drilling (Rotosonic) activities to obtain subsurface archaeological artifacts

Responsibilities include:

- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Direct, distribute, and inspect appropriate PPE to site personnel
- Perform health and safety oversight during deep borehole installation activities
- Maintain and enforce appropriate PPE use

SSHO; Multiple Sites - New Jersey Power and Light - Belmar, Boonton, and Cape May, NJ (8 months; January 2009 through August 2009):

- SSHO for excavation, drilling and well installation (Air Rotary and Hollow-Stem Auger), and environmental sampling activities for coal tar and related contaminated sites.

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards

- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID and FID)
- Monitor air quality at the site and inform site personnel with results as needed
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Perform health and safety oversight during multimedia sampling activities including soil, sediment, surface water, and groundwater
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use
- Document health and safety deficiencies and subsequent corrective measures

SSHO; Chlorinated Solvent Plume Remediation - BASF Facility and Trustwood Parcel in Williamsburg, VA (19months; June 2007 through December 2008):

- SSHO for excavation, drilling, well installation (Hollow-Stem Auger), injection, remediation, and environmental sampling activities for a chlorinated solvent contaminated site

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID and FID)
- Monitor air quality at the site and inform site personnel with results as needed
- Monitor and screen soils and/or drill cuttings using a PID
- Perform health and safety oversight during multimedia sampling activities including soil, sediment, surface water, and groundwater
- Perform health and safety oversight during excavation activities
- Perform health and safety oversight during high-pressure injection activities
- Develop and implement the work plan
- Ensure compliance with the work plan
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use
- Document health and safety deficiencies and subsequent corrective measures

SSHO; Sykesville Oil Spill Superfund Site in Sykesville, MD (10 months; June 2006 through March 2007):

- SSHO for excavation, drilling and well installation (Hollow-Stem Auger and Air Rotary), remediation, air sparging and soil vapor extraction, and environmental sampling activities

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (FID)
- Monitor air quality at the site and inform site personnel with results as needed
- Monitor and screen soils and/or drill cuttings using a PID
- Perform health and safety oversight during excavation activities
- Perform health and safety oversight during high-pressure pumping and treating activities
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones

- Perform initial and daily site health and safety inspections
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use
- Document health and safety deficiencies and subsequent corrective measures

SSHO; Subsurface Investigation at a Former Asphalt Recycling Facility in Baltimore, MD
(4 months; February 2006 through May 2006):

- SSHO for drilling and well installation (Hollow-Stem Auger and Air Rotary) and environmental sampling activities

Responsibilities include:

- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Monitor air quality at the site and inform site personnel with results as needed
- Monitor and screen soils and/or drill cuttings using a PID
- Perform health and safety oversight during multimedia sampling activities including soil, sediment, surface water, and groundwater
- Perform health and safety oversight during well installation activities (groundwater and soil gas)
- Perform health and safety oversight during high-pressure recovery activities
- Develop and implement the work plan
- Ensure compliance with the work plan
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use
- Document health and safety deficiencies and subsequent corrective measures

SSHO; Chlorinated Solvent Plume Remediation – Former Film Manufacturer in Charlestown, WV
(6 months; August 2005 through January 2006):

- SSHO for excavation, drilling, well installation (Air Rotary), injection, remediation, and environmental sampling activities

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Monitor and screen soils and/or drill cuttings using a PID
- Perform health and safety oversight during multimedia sampling activities including soil, sediment, surface water, sludge, and groundwater
- Perform health and safety oversight during well installation activities
- Perform health and safety oversight during excavation activities
- Perform health and safety oversight during high-pressure injection activities
- Develop and implement the work plan
- Ensure compliance with the work plan
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel

- Maintain and enforce appropriate PPE use
- Document health and safety deficiencies and subsequent corrective measures

SSHO; Various Sites – Voluntary Cleanup Program in Baltimore, MD (6 months; February 2005 through July 2005):

- SSHO for excavation, drilling, well installation, injection, remediation, and environmental sampling activities (Hollow-Stem Auger; Direct-Push; Air-Rotary; Rotosonic).

Responsibilities include:

- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use (PID and FID)
- Monitor air quality at the site and inform site personnel with results as needed during excavations
- Monitor and screen soils and/or drill cuttings using a PID
- Perform health and safety oversight during multimedia sampling activities including soil, sediment, surface water, groundwater, and soil vapor
- Perform health and safety oversight during well installation (groundwater and soil vapor) activities
- Develop and implement the work plan
- Ensure compliance with the work plan
- Educate personnel on sampling procedures consistent within the work plan
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Educate site personnel regarding heavy equipment operation
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO; Towson University Subsurface Assessment of Assateague and Chincoteague Islands; Assateague Island, MD and Chincoteague Island, VA (2 months; March 2001 through April 2001):

- SSHO for drilling activities and installation of soil borings (Direct Push) for sampling and characterization of hydric soils.

Responsibilities include:

- Perform health and safety oversight during well installation activities
- Present daily safety briefings that included awareness training for site physical/chemical/ biological hazards
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Develop, implement, and ensure compliance with the SSHP
- Conduct site inspections to evaluate work conditions for job zones
- Perform initial and daily site health and safety inspections
- Prepare health and safety compliance memoranda
- Train site personnel on the uses and maintenance of PPE
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO Resume

- **Michael Wright**

Michael E. Wright

Site Health and Safety Officer

Mr. Wright has experience as a Geologist and Site Safety and Health Officer in the environmental consulting industry. He also has experience in the environmental and geotechnical drilling industry.

Professional Experience

Environmental Drilling**—**Strong understanding of various drilling techniques used in the environmental industry to install monitoring/injections wells. Responsibilities included well installation and well development on sites governed by HAZWOPER due to various impacted environmental media. He has performed environmental monitoring for airborne contaminants, temperature-related stress monitoring, and hazard assessment and control.

Health and Safety (2018-2022)
Experience with health & safety oversight including assisting with health & safety plan development, implementation of health & safety plan, site inspections to evaluate work conditions for potential job site hazards, ensuring use of proper personal protective equipment (PPE), inspecting PPE for damage, investigating reports of hazardous conditions and taking actions as appropriate to remedy the situation, subcontractor oversight, ensuring proper use/calibration and maintenance of safety and monitoring equipment, ensuring air sampling/monitoring was properly performed, and oversight of subcontractors.

Education

B.S./Geology/2018 (SUNY Oswego)

Specialized Training

OSHA 40-Hour Hazardous Waste Operations and Emergency Response Training; 2018
OSHA 8-Hour Hazardous Waste Operations and Emergency Response Refresher; 2019
OSHA 8-Hour Hazardous Waste Operations and Emergency Response Supervisor Training; 2019
OSHA 10-Hour Construction Safety Training; 2019
OSHA 30-Hour Construction Safety Training; 2020
Confined Space Entry Training; 2019
Asbestos Awareness Training; 2021
NYSDEC Erosion and Sediment Control Training; 2020
Loss Prevention Systems Training Certification
CRP, AED, First Aid Training; 2021
Blood Borne Pathogen Training; 2021

Professional Affiliations/Appointments

Geological Society of America

Experience

Years with EA: 2 Total Years: 4

EA Project Experience

SSHO and Competent Person; Environmental Sampling Activities AGFA Corporation, Shoreham NY
14 of 28 Months (April 2019 to Present)
SSHO for site activities including annual well inspections for onsite and offsite monitoring wells and repaired damaged well pads on offsite wells. Performed sampling of environmental media, earthwork, intrusive activities, and site monitoring.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above,
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Environmental Sampling Activities; National Heatset Printing Site, East Farmingdale, New York; New York State Department of Environmental Conservation

6 of 28 Months (April 2019 to Present)
SSHO for site activities including groundwater sampling and collection for volatile organic compounds using U.S. Environmental Protection Agency low flow pumping techniques. Performed monthly operation and maintenance for three onsite treatment systems and one offsite treatment system. Performed personal and perimeter screening for volatile organic compounds, management of investigation-derived waste, heavy equipment oversight, and hazard evaluation and control.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above,
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Environmental Sampling Activities; Perfection Plating, Watervliet, New York; New York State Department of Environmental Conservation
4 of 28 Months (April 2019 to Present)
SSHO for site activities including groundwater sampling for hexavalent chromium using bailers as well as per- and polyfluoroalkyl substances using U.S. Environmental Protection Agency low flow techniques. Performed PPE assessments, reviewed hazard evaluation and controls, equipment and personnel decontamination, air and temperature related monitoring, and IDW management.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above,
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Injection Oversight, Roxy Cleaners, North Greenbush, New York; New York State Department of Environmental Conservation
1 of 28 Months (2019)
SSHO for site activities including long-term groundwater monitoring, and performance of an ozone injection pilot study to remediate groundwater and installation of two overburden injection trenches. Also, oversight for bioremediation injections on three bedrock wells using an inflatable packer and a trash pump to pressure inject and two overburden trenches via gravity feeding.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above

- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Construction and UXO Oversight; Hancock Field Air National Guard Base Site; Syracuse, New York; U.S. Army Corps of Engineers–Omaha District
3 of 28 Months (April 2019 to Present)
SSHO for site activities including oversight of contractors preforming the demolition and removal of a firing-in buttress as well as the unexploded ordnance clearance of munitions present in timbers removed during the demolition. Conducted daily air monitoring and daily field reports.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above, competent person for fall protection, aerial lift usage, and ladder usage
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Followed site-specific excavation permit utility avoidance prior to intrusive activities
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO and Competent Person; Drilling and Groundwater Sampling; Paulus – Phase II Environmental Site Assessment – EJ Victory Site; Johnson City, New York; Paulus Development
2 of 28 Months
SSHO for site activities including oversight of the installation and development of seven overburden monitoring wells around the former EJ Victory Building. Also collected groundwater samples for per- and polyfluoroalkyl substances at three monitoring well locations using low flow purging techniques.

- Perform health and safety oversight during above activities
- Performed site-specific training on PPE, general safety, equipment inspections, and quality control
- Performed and enforced site and equipment inspections
- Generated corrective actions following daily and/or weekly inspections, if required
- Perform health and safety oversight during activities described above
- Assisted with onsite operations following QCS including QC over onsite delivery of materials & equipment
- Followed site-specific excavation permit utility avoidance prior to intrusive activities
- Present daily safety briefings consistent with the APP and SSHP (and associated sub plans) for site physical/chemical/biological/radiological hazards – generated and enforced APP/SSHP onsite
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda and site indoctrination procedures
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate PPE to site personnel (Level D and Mod Level D)
- Maintain and enforce appropriate PPE use

SSHO Certifications

- **Michael Wright**

HEARTSAVER

Heartsaver® First Aid CPR AED

American Heart Association.

Michael Wright

has successfully completed the cognitive and skills evaluations in accordance with the curriculum of the American Heart Association Heartsaver First Aid CPR AED Program.

Optional modules completed:

Heartsaver Total

Issue Date

1/4/2022

Training Center Name

American Medical Response (AMR) of Central New York

Training Center ID

NY04334

Training Center City, State

Syracuse, NY

Training Center Phone Number

(315) 701-7094

Renew By

01/2024

Instructor Name

Susan Burnett

Instructor ID

01170525452

eCard Code

226011585824

QR Code

To view or verify authenticity, students and employers should scan this QR code with their mobile device or go to www.heart.org/cpr/mycards.

20-3002 1/21

American Heart Association.
2020
CPR & ECC
GUIDELINES

Certificate

Michael Wright

has successfully completed

Heartsaver® First Aid CPR AED Online Portion

Congratulations on learning lifesaving skills with the American Heart Association. Hands-on skills practice and testing, conducted by an authorized AHA BLS or Heartsaver Instructor, is required to receive a Heartsaver First Aid CPR AED course completion card.

For greater success, it is recommended the hands-on skills session be conducted shortly after completing the online portion. Please take this certificate with you to your hands-on skills session.

This certificate does not constitute successful completion of the full Heartsaver First Aid CPR AED Course.

Path Taken: Heartsaver Total

Topics Included

Survivor Story (Superintendent)
Hands-Only CPR
Adult CPR, AED, and Choking Relief
Drug Overdose
Water Safety
Key Steps of First Aid (Finding the Problem*)
Precautions (Exposure to Blood & Removing Gloves*)
Breathing Problems (Asthma)
Breathing Problems
Allergic Reactions (Using an Epinephrine Pen*)
Heart Attack
Fainting
Diabetes and Low Blood Sugar
Stroke
Seizures
External Bleeding* (Direct Pressure and Bandaging & Tourniquets)
Shock
Wounds (Eye, Nose, and Tooth Injuries)
Penetrating and Puncturing Injuries
Amputation
Internal Bleeding
Head, Neck, and Spinal Injuries
Broken Bones and Sprains
Burns and Electrical Injuries
Bites and Stings
Heat-Related Emergencies
Cold-Related Emergencies
Poison Emergencies
Risks of Smoking/Vaping
Benefits of Healthy Lifestyle

IMP2273SY9KD	01/03/2022 23:18:12
Certificate Number	Date Completed

Mike Wright

has successfully completed this online course

Bloodborne Pathogens Online Course

August 20, 2021

American
Red Cross

AdvanceOnline Solutions Online Institute

Certificate of Completion

Michael Wright

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

As an OSHA Outreach Training Program trainer, I affirm that I have conducted this OSHA Outreach Training Program training class in accordance with OSHA Outreach Training Program requirements. I will document this class to my OSHA Authorizing Training Organization. Upon successful review of my documentation, I will provide each student their course completion card within 90 calendar days of the end of the class. — Rick Gleason

Instructor Rick Gleason
Course ID A0310
Certificate ID 6745_1684262

Date 4/14/2020 2:25:00 PM
Time Online 30:28:30
AdvanceOnline Solutions, Inc.
1811 Bering Drive, Suite 430
Houston, Texas 77057
www.advanceonline.com
(713) 621-1100

AdvanceOnline
SOLUTIONS

NEW YORK
STATE OF
OPPORTUNITY

Department of
Environmental
Conservation

Endorsed Training

Certificate of Completion

MICHAEL E. WRIGHT

Is hereby awarded this Certificate signifying completion of the course:

"NYS DEC 4-Hour Erosion and Sediment Control Training"

Attested Day of Training: 03/16/2020

*Assigned Trainee Stormwater Identification Number – **SWT #**«032020-13*

This Erosion and Sediment Control (E&SC) Training is Endorsed by the NYS Department of Environmental Conservation, Division of Water, for "Trained Contractors" and Certain "Qualified Inspectors" who must receive 4 hours of E&SC training every three years to satisfy requirements under the Construction Activity State Pollution Discharge Elimination System (SPDES) General Permit.

Expiration: 3 years from date of training

Instructed by: John E. Folchetti, P.E. (NYSDEC **SWT #0045-T**)

http://www.dec.ny.gov/chemical/8699.html#DEC ~ 625 Broadway, 4th Floor, Albany NY 12233-3505 ~ (518) 402-8111 ~ DWSWtrng@gw.dec.state.ny.us

Certificate of Completion

This certifies that

Michael E. Wright

has successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA/EPA Regulations as well including 29 CFR 1926.65 for Construction.

This course (Version 3) is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044).

Safety Unlimited, Inc., Provider #5660170-2, is accredited by the International Association for Continuing Education and Training (IACET) and is accredited to issue the IACET CEU. As an IACET Accredited Provider, Safety Unlimited, Inc. offers CEUs for its programs that qualify under the ANSI/IACET Standard. Safety Unlimited, Inc. is authorized by IACET to offer 0.8 CEUs for this program.

Julius P. Griggs
Julius P. Griggs
Instructor #892

2112275313332
Certificate Number

12/27/2021
Issue Date

ACCREDITED
IACET
PROVIDER

Scan this code or visit safetyunlimited.com/v to verify certificate.

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley,CA 93063
(855) 784-2677 or 805 306-8027
https://www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training

Certificate of Completion

This certifies that

Michael E. Wright

has successfully completed

8 Hour HAZWOPER Supervisor Training

This certificate does not in itself indicate initial 24 or 40 Hour HAZWOPER Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120(e)(4)

And all State OSHA/EPA Regulations as well including 29 CFR 1926.65 for Construction.

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044)

Safety Unlimited, Inc., Provider #5660170-2, is accredited by the International Association for Continuing Education and Training (IACET) and is accredited to issue the IACET CEU. As an IACET Accredited Provider, Safety Unlimited, Inc. offers CEUs for its programs that qualify under the ANSI/IACET Standard. Safety Unlimited, Inc. is authorized by IACET to offer 0.8 CEUs for this program.

Julius P. Griggs

Julius P. Griggs
Instructor #892

1912304313332
Certificate Number

12/30/2019
Issue Date

ACCREDITED
IACET
PROVIDER

Scan this code or visit safetyunlimited.com/v to verify certificate.

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley,CA 93063
(888) 309-SAFE (7233) or 805 306-8027
https://www.safetyunlimited.com

Annual Refresher Training NOT Required

Certificate of Completion

This certifies that

Michael E. Wright

has successfully completed

Asbestos Awareness Training

Certification is NOT for Asbestos Abatement

In Accordance With Federal OSHA and EPA Regulations

29 CFR 1910.1001(j)(7), 29 CFR 1915.1001(k)(9), 29 CFR 1926.1101(k)(9), 40 CFR Part 763 Subpart G and State OSHA/EPA Regulations

This course is approved for 2 Contact Hours (0.2 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044)

Safety Unlimited, Inc., Provider #5660170-2, is accredited by the International Association for Continuing Education and Training (IACET) and is accredited to issue the IACET CEU. As an IACET Accredited Provider, Safety Unlimited, Inc. offers CEUs for its programs that qualify under the ANSI/IACET Standard. Safety Unlimited, Inc. is authorized by IACET to offer 0.2 CEUs for this program.

Julius P. Griggs

Julius P. Griggs
Instructor #892

21081762313332
Certificate Number

8/17/2021
Issue Date

ACCREDITED
IACET
PROVIDER

Scan this code or visit safetyunlimited.com/v to verify certificate.

Annual Refresher Training Required

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley,CA 93063
(855) 784-2677 or 805 306-8027
https://www.safetyunlimited.com

NATIONAL ENVIRONMENTAL TRAINERS

Certificate of Completion

Michael Wright

has satisfactorily passed an exam and completed a 40-hour training course entitled
Hazardous Waste Operations and Emergency Response
meeting the requirements identified in Title 29 CFR 1910.120 (OSHA HAZWOPER Regulations). This course has been awarded 6.68 Industrial Hygiene CM Points by the American Board of Industrial Hygiene-Approval Number 13334. This course is also eligible for 3.33 Continuance of Certification (COC) points from the Board of Certified Safety Professionals.

Signature of Instructor

REGISTERED PROFESSIONAL INDUSTRIAL HYGIENIST
CLAY BEDNARZ
09320705

NATIONAL
ENVIRONMENTAL
TRAINERS Inc. ®
07/02/2018

Certificate Number: 959407
www.nationalenvironmentaltrainers.com

Clay A. Bednarz, MS, RPIH

The Official Site of Environmental Health & Safety Training®

LPS

Loss Prevention System
Training Certification

Michael Wright / Parratt-Wolff, Inc.

Trainee Name/Company

has completed the following LPS Training

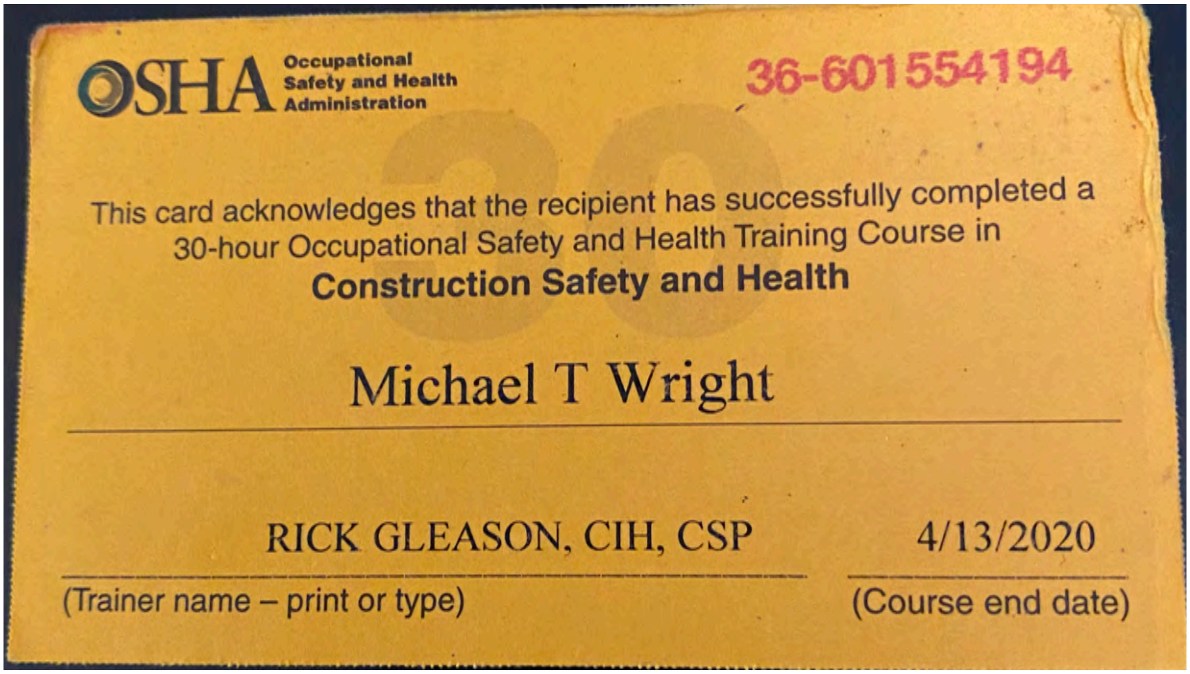
☐ ***Awareness*** **X *Basic*** ☐ ***Standard*** ☐ ***MGR/SUP***

☐ ***Trainer***

Preston Simmons/ PWI / 7/13/2018

Trainer Name/Company/Training Date

Global Real Estate and Facilities SSHE Safety, Security, Health and Environment



OSHA Occupational Safety and Health Administration

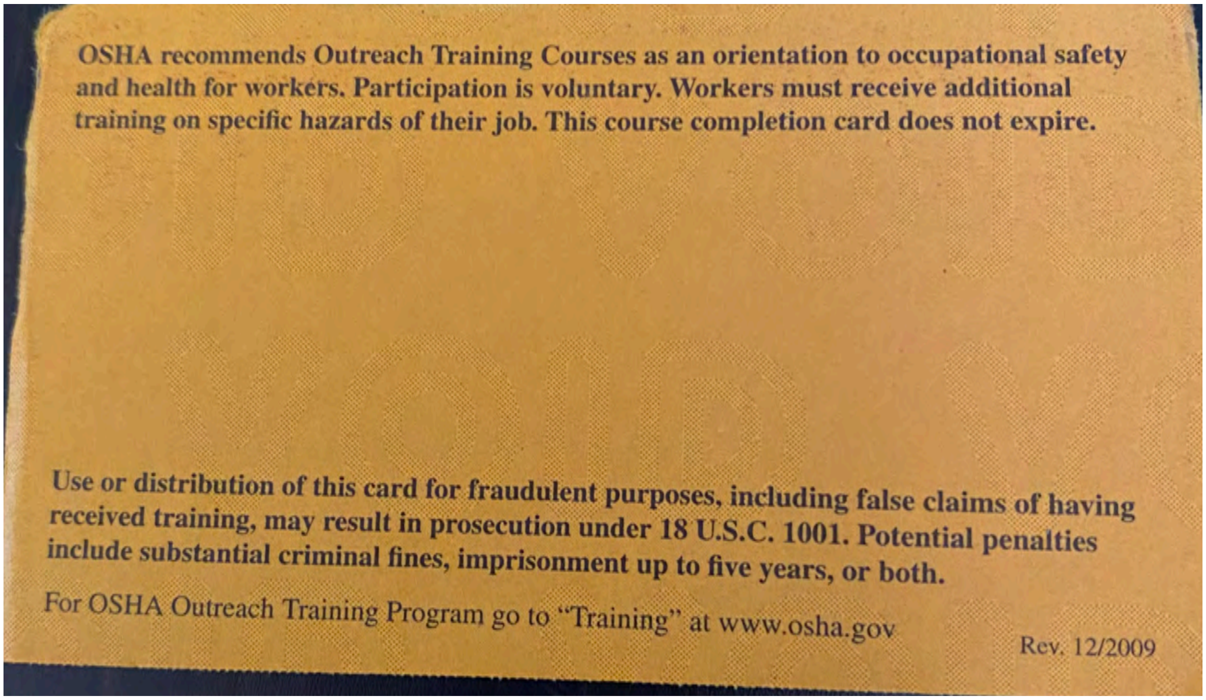
36-601554194

This card acknowledges that the recipient has successfully completed a 30-hour Occupational Safety and Health Training Course in
Construction Safety and Health

Michael T Wright

RICK GLEASON, CIH, CSP
(Trainer name – print or type)

4/13/2020
(Course end date)



OSHA recommends Outreach Training Courses as an orientation to occupational safety and health for workers. Participation is voluntary. Workers must receive additional training on specific hazards of their job. This course completion card does not expire.

Use or distribution of this card for fraudulent purposes, including false claims of having received training, may result in prosecution under 18 U.S.C. 1001. Potential penalties include substantial criminal fines, imprisonment up to five years, or both.

For OSHA Outreach Training Program go to "Training" at www.osha.gov

Rev. 12/2009

Syracuse Builders Exchange
FOUNDED 1872

THIS CERTIFIES THAT

MICHAEL WRIGHT

successfully completed the OSHA 10-Hour Construction Outreach Course and is therefore awarded this

CERTIFICATE OF COMPLETION

Given this 6th Day of September 2019

As an OSHA authorized trainer, I verify I have conducted this OSHA outreach training course in accordance with OSHA Outreach Training Program requirements. I will document this class to my authorizing OSHA Training Organization. Upon successful review of my documentation, I will provide each student their certification card within 90 days of the end of class.

Lisa C. B

Lisa Brownson, Instructor - Safety Source Consultants, 7009 Lakeshore Rd, Cicero, NY 13039

lisa.brownson@gmail.com

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First Aid, Cardiopulmonary Resuscitation, and Bloodborne Pathogens

- **Michael Wright**

HEARTSAVER

Heartsaver® First Aid CPR AED

American Heart Association.

Michael Wright

has successfully completed the cognitive and skills evaluations in accordance with the curriculum of the American Heart Association Heartsaver First Aid CPR AED Program.

Optional modules completed:

Heartsaver Total

Issue Date

1/4/2022

Training Center Name

American Medical Response (AMR) of Central New York

Training Center ID

NY04334

Training Center City, State

Syracuse, NY

Training Center Phone Number

(315) 701-7094

Renew By

01/2024

Instructor Name

Susan Burnett

Instructor ID

01170525452

eCard Code

226011585824

QR Code

To view or verify authenticity, students and employers should scan this QR code with their mobile device or go to www.heart.org/cpr/mycards.

20-3002 1/21

Mike Wright

has successfully completed this online course

Bloodborne Pathogens Online Course

August 20, 2021

American
Red Cross

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First Aid, Cardiopulmonary Resuscitation, and Bloodborne Pathogens

- **Jeremy Fontaine**

American Red Cross
Training Services

Certificate of Completion

Jeremy Fontaine

has successfully completed requirements for

Bloodborne Pathogens Training

Date Completed: 11/22/2022
Validity Period: 1 Years

Conducted by: American Red Cross

To verify certificate, scan code or visit redcross.org/digitalcertificate and enter ID.

Learn and be inspired at LifesavingAwards.org

012NCF8

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HEARTSAVER

Heartsaver®
First Aid CPR AED

American
Heart
Association.

Jeremy Fontaine

has successfully completed the cognitive and skills evaluations in accordance with the curriculum of the American Heart Association Heartsaver First Aid CPR AED Program.

Optional modules completed:

Heartsaver Total, Child CPR AED, Infant CPR, Exam

Issue Date

6/28/2021

Training Center Name

American Medical Response (AMR) of Central New York

Training Center ID

NY04334

Training Center City, State

Syracuse, NY

Training Center Phone Number

(315) 701-7094

Renew By

06/2023

Instructor Name

Susan Burnett

Instructor ID

01170525452

eCard Code

216013689914

QR Code

To view or verify authenticity, students and employers should scan this QR code with their mobile device or go to www.heart.org/cpr/mycards.

20-3002 1/21

Attachment D

Field and Inspection Forms

TAILGATE SAFETY MEETING

1. Reason for Briefing:

	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position

Briefing Given By:

3. Topics: (Check All That Apply)

	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description		Emergency Response/Equipment
	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
	PPE		Medical Monitoring
	Safe Work Practices		Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Being Performed		Confined Spaces
	OE Precautions		Other:

4. Remarks:

SAFETY INSPECTION REPORT

Site / Location: ___________________________ Date: ____/____/____

Type of Inspection: ____ Initial ____ Daily ____ Weekly ____ Other

List Job Function Inspected:____

Inspection List:

Category	Yes	No	NA	Comments
Biological Hazards				
Biting/Stinging insects.				
Poisonous plants (i.e. poison ivy, poison oak, nettles)				
Wildlife				
Work Environment				
Work area clean and orderly.				
Walk surface dry and/or slip-resistant.				
Spilled materials or liquids cleaned immediately.				
Trash in appropriate containers and removed as needed.				
Emergency Planning				
Emergency contacts phone numbers available.				
Emergency routes to hospital available.				
Weather forecast discussed for daily activities. Cold/Heat Stress discussed. Actions to take.				
First Aid kit(s) available.				
Eye wash station available.				
Current certified Fire Extinguisher available.				
Cell phones available.				
PPE				
Required PPE (Hardhats, safety shoes, safety glasses with side shields) worn.				
Safety Vest available and worn when needed.				
Proper dermal protection available for the task and worn.				
Hearing protection available and worn when needed.				
Utilities				
State-Specific Diggers Hotline been contacted.				
Electrical been located. Buried Overhead (Been sheathed if within 10 ft /boom)				
Telephone				
Cable				
Buried water/sewer/gas.				
Vehicle/Pedestrian Traffic				
Lights in proper working order.				
Alarms working properly.				
Internal safety equipment in proper working order. (i.e. safety belts, shoulder harness)				

Deficiency Date:

Deficiency Description:____
____
____

Date of Correction:

Actual Date of Correction:

Re-Inspection Required: ____ Yes ____ No. Date Re-Inspection: ____/____/___

Signature: ______________________________________ Onsite SSHO

VISITORS LOG

Project Location: ______________________ **Month of:** _________________________

DATE:	NAME:	AGENCY OR COMPANY:	PURPOSE OF VISIT:	SAFETY BRIEFING:	ESCORT REQ:	TIME IN:	TIME OUT:	REMARKS:

ACCIDENT/LOSS REPORT

This report must be completed by the injured employee or supervisor and faxed to EA Corporate Human Resources **within 24 hours** of any accident. The fax number is: **(410) 771-1780**.

NOTE: Whenever an employee is sent for medical treatment for a work-related injury or illness, Page 4 of this report must accompany that individual to ensure that all invoices/bills/correspondence are sent to Human Resources for timely response.

A. DEMOGRAPHIC INFORMATION

Name of Injured Employee:						
Home Address:						
Home Phone:		Date of Birth:				
Age:		Sex:	M:		F:	
Marital Status:		Hourly Rate:				
Employee Number:		Date of Hire:				
Number of Dependents:						
Employee's Job Title:						
Department Regularly Employed by:						
Was the Employee Injured on the Job:		Yes:	No:			
Primary Language of the Employee						

B. ACCIDENT/INCIDENT INFORMATION

Date of Accident:		Time of Accident:	
Report to Whom:		Name of Supervisor:	
Exact Location Where Accident Occurred (including street, city, state, and county:			
Explain what happened (include what the employee was doing at the time of the accident and how the accident occurred):			
Describe the injury and the specific part(s) of the body affected (e.g., laceration, right hand, third finger)			

Object or Substance that Directly Injured the Employee:			
Number of Days or Hours Employee Usually Works per Week:			
Is the Employee Expected to Lose at Least One Full Day of Work?			
Does the Employee Have a Previous Claim (Yes or No):		If yes, status (Open/Closed):	
Was the Employee Assigned to Restricted Duty (Yes or No)?			

C. ACCIDENT INVESTIGATION INFORMATION (Yes or No)

Was Safety Equipment Provided?		If yes, was it used	
Was an Unsafe Act Being Performed?		If yes, describe:	
Was a Machine Part Involved?		If yes, describe:	
Was the Machine Part Defective?		If yes, in what way?	
Was a Third Party Responsible for the Accident/Incident?		If yes, list name, address, and phone number:	
Was the Accident/Incident Witnessed?		If yes, list name, full address, and phone number:	

D. PROVIDER INFORMATION

Was First Aid Given Onsite (Yes or No)/		If yes, what type of medical treatment was given	
Physician Information (if medical attention was administered)?		Name, full address, and phone number	
Hospital Address		Name, full address, and phone number:	
Was the Employee Hospitalized (Yes or No)?		If yes, on what date?	
Was the Employee Treated as an Out-Patient. Receive Emergency Treatment, or Ambulance Service (Yes or No)?			

Please attach the physician's written Return to Work slip.

NOTE: A physician's Return to Work Slip is required prior to allowing the worker to return to work.

E. AUTOMOBILE ACCIDENT INFORMATION (complete if applicable)

Authority Contacted and Report Number			
EA Employee Vehicle Year, Make, and Model			
V.I.N.		Plate/Tag No.:	

Owner's Name and Address:			
Driver's Name and Address:		Driver's License No.:	
Relation to Insured:			
Describe Damage to Your Property:			
Describe Damage to Other Vehicle or Property:			

Other Driver's Name and Address:	
Other Driver's Phone No.:	
Other Driver's Insurance Company and Phone Number:	
Location of Other Vehicle:	
Name, Address, and Phone No. of Other Injured Parties:	

Witness 1 Name:		Phone No.:	
Address:			
Statement:			
Signature of Witness 1:			

Witness 2 Name:		Phone No.:	
Address:			
Statement:			
Signature of Witness 2:			

F. ACKNOWLEDGEMENT

Name of Supervisor:			
Report Prepared by:		Date Prepared:	

I have read this report and the contents as to how the accident/loss occurred are accurate to the best of my knowledge.

Signature of Injured Employee Date

I am seeking medical treatment for a work-related injury/illness.

Please forward all bills/invoices/correspondence to:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.
11019 McCORMICK ROAD
HUNT VALLEY, MARYLAND 21031

ATTENTION: Michele Bailey
HUMAN RESOURCES

(410) 584-7000
(410) 771-1780 (FAX)

"NEAR MISS" INCIDENT REPORT

A "near miss" is a potential hazard or incident that has not resulted in any personal injury or property damage. Unsafe working conditions, unsafe employee work habits, improper use of equipment, or use of malfunctioning equipment have the potential to cause work-related injuries. It is everyone's responsibility to report and correct these potential accidents/incidents immediately.

Please complete this form as a means to report these "near miss" situations.

Department/Location ________________________ Date: ____________ Time: _________ a.m. / p.m.

Please check all appropriate conditions:

______ Unsafe act
______ Unsafe condition
______ Unsafe equipment
______ Unsafe use of equipment
______ Other

Description of incident or potential hazard ____

____

____

____

Employee Signature ________________________________ Date ____________________

"NEAR MISS" INVESTIGATION

Description of the "Near Miss" Condition ____

____

____

Causes (primary and contributing) ____

____

____

Corrective Action Taken (i.e., remove the hazard; replace, repair, or retrain in the proper procedures for the task)

____

Signed ______________________________________ Date Completed ____________________

Form not completed within 4 hours of incident for the following reason(s) ________________

____

____

______________________________________ __________________________
Corporate Health and Safety Officer Date

******Forward to Corporate Health and Safety Officer when completed.******

U.S. Army Corps of Engineers
Safety Inspection Checklist
Drilling Equipment

Date of Inspection

Location (Plant or Facility)	Contract Number
Contractor Name	Project Name
Inspector Name (Print)	Inspector Signature

This checklist serves as a guide only, it does not replace or eliminate the need to comply with the requirements set forth in Engineering Manual 385-1-1, Safety and Health Requirements Manual, dated 15 September 2008. The references included in this checklist correspond to the applicable sections of EM 385-1-1.

Item Description	REF	Yes	No	N/A	Remarks (Any NO or N/A item)
1. Is drilling equipment operated, inspected, and maintained as specified in the manufacturer's operating manual?	18.H.02				
2. Is a copy of the manual for all drilling equipment available?	18.H.02				
3. Has a survey been conducted to identify overhead electrical hazards and potential ground hazards and their locations identified in the site layout plan?	18.H.03				
4. Are all findings of the survey a part of the AHA?	18.H.03.b				
5. Does the AHA contain copies of Material Safety Data Sheets for all drilling fluids available?	18.H.03.a				
6. Have all members of the drilling crew been trained the operation, inspection, and maintenance of the equipment; the safety features and procedures to be used; and overhead electrical lines and underground hazards?	18.H.05				
7. Does the drilling equipment have two easily accessible emergency shut down devices (one for the operator and one for the helper)?	18.H.06				
8. Is the equipment posted with a warning of electrical hazards?	18.H.07				
9. Is there a spotter or an electrical proximity warning device available to ensure safe distances from power lines are maintained?	18.H.07.b				
10. Before moving earth drilling equipment, has the travel route been surveyed for overhead and terrain hazards, particularly overhead electrical hazards, mast lowered?	18.H.08				
11. Is equipment set-up in a stable manner, with cribbing if necessary?	18.H.09				
12. Are outriggers being used in accordance with the manufacturer's recommendations, if drilling is in confined space are requirements of 34A followed?	18.H.09				
13. Are drill rigs properly secured/identified when parked on highway or shoulder?	18.H.10				
14. Are drill crew members prohibited from wearing loose clothing, jewelry, or equipment which might become caught in moving machinery?	18.H.11.b				

U.S. Army Corps of Engineers **Safety Inspection Checklist** **Drilling Equipment**	Date of Inspection

Item Description	**REF**	**Yes**	**No**	**N/A**	**Remarks (Any NO or N/A item)**
15. Are slip rings or other rod slipping devices on the drill?	18.H.11.h				
16. Are steps being taken to control dust?	18.H.11.i				
17. Are augers cleaned only when the rotating mechanism is in neutral and the auger is stopped?	18.H.11.j				
18. Are augers guarded?	18.H.11.j				
19. Are open bore holes capped and flagged?	18.H.11.k				
20. Are open excavations barricaded?	18.H.11.k				

Other Remarks

SAFETY INSPECTION FOR MISCELLANEOUS EQUIPMENT **U.S. Army Engineer District, New Orleans**	Date of Inspection:
Contractor or Unit	Contract No. Or Activity
Inspected by (Signature)	Witness (Signature)

	RIGGING AND WIRE ROPE CHECKLIST **NOTE: Safety and Health Requirements Manual (EM385-1-1 (15 Sep 08)) references in parentheses.**	Yes	No	N/A
1	Has all defective rigging as been removed from service? (15.A.01) (b)			
2	Is the hoist rope configured so it does not wrap around the load? (15.A.02)			
3	Are running lines located within 6' - 6" of ground or working level guarded or the area restricted by physical barriers to preclude injury from broken lines? (15.A.03)			
4	When hoisting loads, is a positive latching device used (self-closing safety latches, hooks with spring-loaded gate, and anchor type shackle with a bolt, nut and retainer pin.)? (15.A.05)			
5	Have hooks, shackles, rings, pads, etc. showing excessive wear or that have been bent, twisted, or damaged been removed from service? (15.A.06)			
6	Are wires ropers inspected, maintained and replaced IAW EM 385-1-1, paragraph 16.D.12? (15.D.01)			
7	Is the clip attached to the live wire on wedge sockets? Note: Clip shall not be attached to live end.(15.D.04)			
8	Except for eye splices in ends of wire for wire rope slings, is wire rope used in hoisting, lowering, or pulling load one continuous piece without knot or splice? (15.D.07)			
9	Are wire rope splices free of clips or knots? (15.D.08)			
10	Are only alloyed type chains used in rigging? (15.E.01)			
11	Are hooks, links, or fasteners made from approved materials? (15.E.04)			
12	Is protection provided between the sling and sharp or rough surfaces of the load to be lifted? (15.E.03)			
13	Are hooks used in rigging provided have a safety latch? (15.H.07) (b) and ASME B30.10			
14	When shoulderless eyebolts are used, are they used in such a way to ensure they are not loaded at an angle? (15.H.10) (g)			

REMARKS:

MVN Form 385-11R
October 4, 2010

Proponent: CEMVN-SS

Attachment E

Site Safety and Health Plan

ATTACHMENT E
SITE SAFETY AND HEALTH PLAN

FOR THE

ACCIDENT PREVENTION PLAN

PHASE I REMEDIAL INVESTIGATION OF PER-AND POLYFLUOROALKYL SUBSTANCES, NIAGARA FALLS AIR RESERVE STATION NIAGARA FALLS, NEW YORK

PREPARED FOR:

UNITED STATES ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
2 Hopkins Plaza
Baltimore, Maryland 21201

PREPARED BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
EA Engineering, P.C. and Its Affiliate
EA Science and Technology*
269 W. Jefferson Street
Syracuse, New York 13202

DoD Contract Number: W912DR19D0005/Delivery Order: W912DR22F0247

November 2022

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*EA Engineering, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC who does business as EA Science and Technology in the State of New York

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AFFF	Aqueous film-forming foam
AHA	Activity Hazard Analyses
APP	Accident Prevention Plan
ASD	Assistant Secretary of Defense
Ca	Carcinogen
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	Contaminants of Concern
COVID-19	Coronavirus Disease 2019
CPR	Cardiopulmonary resuscitation
DoD	Department of Defense
DR	Designative Representative
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
EM	Engineer Manual
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDLH	Immediately dangerous to life and health
mg/m^3	Milligram(s) per cubic meter
NA	Not available
NFARS	Niagara Falls Air Reserve Station
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Level
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane sulfonate
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PPE	Personal protective equipment
ppm	Part(s) per million
RI	Remedial Investigation
RMSF	Rocky Mountain spotted fever
SHM	Site Health Manager
SI	Site Inspection
SL	Screening level
SSHO	Site Safety and Health Officer

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

SSHP	Site Safety and Health Plan
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
USACE	U.S. Army Corps of Engineers
VOC	Volatile organic compound

LIST OF EMERGENCY CONTACTS

The following list of emergency contacts shall be supplemented with the Installation Specific Addenda.

Ambulance	911
Police Department	911
Fire Department	911
Nearest Hospital	716-297-4800
Regional Poison Control	800-222-1222

Directions to Hospital

A map for hospital routes will be provided in the Installation Specific Addenda.

Other Important Emergency Contacts

Title	Name	Phone Number
EA Health and Safety Manager	Robert Marcase	410-329-5192 (direct)
EA Project Manager	Robert Casey	315-430-7429(cell))
EA Site Safety and Health Officer	Michael Wright	315-565-6572
Field Manager	Amanda Kohn	315-565-5648

1. SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

This Site Safety and Health Plan (SSHP) has been prepared by EA Engineering, P.C. and its affiliate EA Science and Technology (EA) to support remedial investigation (RI) activities designed to delineate the impact of Per- and Polyfluoroalkyl Substances (PFAS) in identified aqueous film-forming foam (AFFF) release areas at Niagara Falls Air Reserve Station (NFARS) in Niagara Falls, New York, as an attachment to the Accident Prevention Plan (APP).

The scope of the Phase I RI includes site characterization activities to delineate the nature and extent of PFAS resulting from historical AFFF releases. For the purposes of this RI, delineation is defined as the lateral and vertical extent of PFAS in all impacted media. At the conclusion of RI activities, the data should be sufficient to:

- Develop a comprehensive understanding of the vertical and lateral extent of PFAS in soil, groundwater, sediment, and surface water

- Determine the source strength of residual PFAS in soil within the unsaturated source zones

- Develop and/or refine conceptual site models using validated environmental data to describe hydrogeological conditions and identify migration pathways and potential receptors

- Complete a human health risk assessment, if warranted.

1.1 SITE LOCATION AND BACKGROUND

AFFF Release Areas at NFARS were investigated in 2017 under the Site Inspection (SI) phase conducted in in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The 2018 SI Report identified historical AFFF releases at multiple sites at NFARS, which have resulted in PFAS compounds (specifically perfluorooctanoic acid [PFOA], perfluorooctane sulfonate [PFOS], and perfluorobutane sulfonate [PFBS]) present in on-site and downgradient environmental media. Based on the results of site investigations completed at the AFFF release areas at NFARS, seven areas of interest are being carried forward to the next phase (RIs) following the CERCLA process:

- FT007P – AFFF Area 1: Former Fire Training Area (Site 9) and Outfall 007
- SS850P – AFFF Area 2: Hanger 850
- SS706P – AFFF Area 3: Building 706
- SS700P – AFFF Area 4: Building 700 and Outfall 004
- SS015P – AFFF Area 5: Blue Angels Crash Site
- SS101P – AFFF Area 6: Fox Row/Taxiway Alpha and Outfalls 005 and 009
- SS316P – AFFF Area 8: Hulby Street

In 2019, subsequent to the SI, the Department of Defense (DoD) adopted screening levels for soil and groundwater, as described in a memorandum from the Office of the Assistant Secretary of

Defense titled "Investigating PFAS Substances within the DoD Cleanup Program" and signed into use on 15 September 2021 (Assistant Secretary of Defense [ASD] 2021). The ASD screening levels apply to three compounds: PFOS, PFOA, and PFBS. In May 2022, the U.S. Environmental Protection Agency added five additional compounds to the regional screening level and removal management lists including PFOS, PFOA, hexafluoropropylene oxide dimer acid and its ammonium salt (also referred to as GenX chemicals), perfluorononanoic acid, and perfluorohexanesulfonic acid.

The SSHP will be primarily implemented by EA and its subcontractors in coordination with the U.S. Army Corps of Engineers (USACE) project manager and Air Force Civil Engineering Center remedial project manager. Compliance with the SSHP is required of all EA personnel, subcontractors, and associated third parties on-site. A copy of the SSHP will be maintained on-site during work activities and will be available for inspection and review by site or agency personnel. Field personnel will review applicable aspects of the SSHP before site work and will sign an "SSHP Review" acknowledgment form (**Appendix D**) indicating that they have reviewed the pertinent aspects of the plan.

The content of the SSHP may be revised and/or amended should additional information become available regarding the hazards present at the site and/or should significant changes occur in the statement of work, operational procedures, site hazards, and/or hazard control measures. The SSHP may be modified by the Site Safety and Health Officer (SSHO) upon review and approval by the USACE and Air Force Civil Engineering Center. Feld personnel will be informed of changes to the SSHP through safety meetings and written addendum or revision to the SSHP.

1.2 CONTAMINANT CHARACTERIZATION

PFAS resulting from AFFF, non-AFFF, and secondary PFAS releases across NFARS have been detected in the groundwater and soil. PFAS are the primary contaminants of concern (COCs). In addition, a listing of hazardous substances with anticipated use during site fieldwork is provided below (**Table 2-1**). A Hazardous Substances Inventory List will be prepared by the SSHO. The SSHO will maintain safety data sheets for hazardous substances to be used during site work.

1.3 PURPOSE

This SSHP has been prepared to support a Phase 1 of the RI for PFAS resulting from AFFF, non-AFFF, and secondary PFAS releases at NFARS (Figure 1 of the APP).

Work conducted under this contract will be performed in accordance with applicable federal, state, and local safety and occupational health laws and regulations, including Occupational Safety and Health Administration (OSHA) standards (e.g., 29 Code of Federal Regulations [CFR] 1910 and 29 CFR 1926), USACE Safety and Health Requirements Manual (Engineer Manual [EM] 385-1-1, 30 November 2014), and all applicable health and safety procedures of EA. The contents of the SSHP are subject to review and revision as new information becomes available.

The procedures and standards in this SSHP are prepared for employees and subcontractors of EA working at the PFAS RI for NFARS under this contract. These policies are based on the available current information on potential hazards and contaminants, as identified in previous investigations. Personnel covered by this SSHP must consider newly acquired data or conditions when conducting their work, and must use appropriate, generally accepted practices to safeguard the health of on-site personnel.

1.3.1 Project Description

The site description and project background information, including work activities to be conducted at the site, are included in Section 2 of the APP.

1.3.2 Project Tasks

The scope of work for activities at the installations covered by this SSHP are detailed in Section 2.4 of the APP.

1.4 HEALTH AND SAFETY POLICY

The following basic policies apply to field operations involving hazardous wastes:

1. Personnel assigned to field operations involving hazardous wastes will participate in a medical surveillance program for hazardous waste operations.

2. Only personnel who have been certified and trained through the Federal OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) (29 CFR 1910.120) will be assigned to both supervise and do work involving hazardous waste or hazardous substances.

3. Compliance with this SSHP, to include subcontractors, will be documented by the Site Safety and Health Supervisor in the master copy of the SSHP.

All EA personnel shall follow the EA Corporate Safety and Health Program Manual.

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2. HAZARD AND RISK ANALYSIS

The primary work phases are described in Chapter 2 of the APP. Each task has been analyzed to assess the potential safety, chemical, physical, radiological, ergonomic, and biological hazards that may be encountered by site personnel and prescribe the proper engineering and/or administrative controls and/or personal protective equipment (PPE). These controls will ensure that the risks to site personnel safety and health are reduced or eliminated while performing the project. The results of the task hazard analysis are documented using a task-specific Activity Hazard Analysis (AHA). An AHA has been developed for each task associated with this project. The AHAs are provided in Attachment A of the APP. The primary hazard groups of concern associated with this site are as follows:

Chemical Hazards
General Physical Hazards
Fire/Explosion Hazards
Vehicle and Pedestrian Hazards
Utilities-Related Hazards
Noise Hazards
Weather Hazards
Material Handling/Moving/Lifting Hazards
Biological Hazards
Heavy Equipment Hazards

2.1 CHEMICAL HAZARDS

The potential for exposure to chemical hazards may occur during site activities. PFAS compounds are identified COC, however field personnel will not ingest water from sampling locations. The anticipated COC concentrations are below direct contact risk. Potential site chemicals and the related action limits have been identified on **Table 2-1** based on the contaminant characterization presented in Section 1.2 and chemicals to be used on-site. Chapter 7 presents the exposure limits, routes of exposure, and symptoms of exposure for chemicals of potential concern that may be present at this site.

The potential for exposure to chemical hazards may occur during system operation and sampling. It is anticipated for this project there will be minimal chemical exposure. Dermal contact with these chemical hazards is possible. Dermal protection appropriate for the chemical will be worn when handling or contacting potentially contaminated environmental media (Section 3).

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Table 2-1. Potential Site Chemical Hazards

Compound	PEL or TLV/STEL	IDLH	Route of Exposure	Symptoms
VOCs				
Diesel Fuel *Skin*	100 mg/m^3 (Approximately 15 ppm)	—	Inhalation, Ingestion, Skin/Eye Contact	Dermatitis.
Gasoline	300 ppm/500 ppm	Ca	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; (potential occupational carcinogen).
PFAS Compounds				
perfluoroisobutylene (PFIB)	0.01 ppm	NA	Ingestion, skin/eye contact, minimal inhalation risk	Increased cholesterol levels, possible kidney or liver damage, reproductive effects, reduced ability of the body's immune system, increased risk of high blood pressure or preeclampsia in pregnant women (potential occupational carcinogen).
perfluorobutyl ethylene	100 ppm	NA	Ingestion, skin/eye contact, minimal inhalation risk	Increased cholesterol levels, possible kidney or liver damage, reproductive effects, reduced ability of the body's immune system, increased risk of high blood pressure or preeclampsia in pregnant women (potential occupational carcinogen).
ammonium perfluorooctanoate	0.01 mg/m3	NA	Ingestion, skin/eye contact, minimal inhalation risk	Increased cholesterol levels, possible kidney or liver damage, reproductive effects, reduced ability of the body's immune system, increased risk of high blood pressure or preeclampsia in pregnant women (potential occupational carcinogen).
Other				
Portland Cement and nuisance dusts	1 mg/m^3	5000 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose; cough, expectoration; exertional dyspnea (breathing difficulty), wheezing, chronic bronchitis; dermatitis.
Diesel Fuel$^{(a)}$	100 mg/m^3 (approximately 15 ppm)	NA	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis, headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonitis (aspiration liquid), possible liver, or kidney damage.
Gasoline$^{(a)}$	300 ppm/500 ppm	Ca	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis, headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonitis (aspiration liquid), possible liver, or kidney damage.
Spray paint	10 mg/m^3	Ca 5,000 mg/m^3	Inhalation	Lung fibrosis. Potential occupational carcinogen.
Liquinox	Not applicable	Not applicable	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, gastrointestinal and respiratory tract.

Notes:
a) Used during daily operation of vehicles and heavy machinery
Ca = Carcinogen
IDLH = Immediately dangerous to life and health
mg/m^3 = Milligram(s) per cubic meter
NA = Not available
PEL = Permissible Exposure Limit
ppm = Part(s) per million
Skin = Skin absorption can contribute to overall body dose
STEL = Short Term Exposure Limit (15 minutes)
TLV = Threshold Limit Value
VOC = Volatile organic compound

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2.2 GENERAL PHYSICAL HAZARDS

Field operations at the site may include many general safety hazards, such as:

- Drilling Equipment (Geo Probe and Skid Steer).
- Holes, ditches, etc.
- Precariously positioned objects, which may cause crushing or other injuries (e.g., hand tools, field equipment, safety equipment)
- Sharp objects (e.g., metal shards, debris or trash in the woods, hydraulic lines in vehicles) that may cause cuts, injection, or other injuries
- Slippery surfaces, posing slip and fall hazards (e.g., muddy areas or wet leaves)
- Uneven terrain, posing slip, trip, and fall hazards (all activities)
- Unstable surfaces (e.g., muddy areas or areas covered with leaf litter on a slope) that may pose fall, crushing, or other injuries.

Site personnel will look constantly, closely, and carefully for these basic safety hazards and immediately inform the SSHO of previously unidentified conditions that may present a hazard. If hazards are present, these hazards will be recorded by the SSHO, and precautionary measures will be taken to prevent injury. Materials handling at hazardous waste sites can vary from heavy equipment handling to manually moving/lifting items. Hazards associated with materials handling at the NFARS site will include potential physical injury.

Injuries to back and abdominal muscles from improperly lifting of loads are the most common occupational injuries reported. Such injuries can range from relatively mild strains to major, permanently disabling injuries. Before lifting a load (e.g., sample coolers, field equipment), personnel will consider the overall weight, distribution of weight, unwieldiness or awkwardness of the load, distance to be carried, obstacles to be negotiated, site conditions, and visibility. Workers will lift with their legs, keeping their back straight, keep the load close to their body, not twist while lifting, and not lift more than 50 pounds.

2.2.1 Fire/Explosion Hazards

The Fire Protection and Prevention Plan is presented in Section 9.27 of the APP.

2.2.2 Heavy Equipment Hazards

No heavy equipment will be required to complete this Statement of Work.

2.2.3 Vehicle and Pedestrian Hazards

Work is being conducted in a controlled area on the NFARS property with no immediate external vehicle or pedestrian hazards.

2.2.4 Noise Hazards

Noise hazards are addressed within the Hearing Conservation Program (Section 9.10) of the APP.

2.2.5 Utilities

No known utilities are in the vicinity of the area where controls will be emplaced, nor will intrusive work occur.

2.2.6 Hand and Power Tools

Limited hand tools (wrenches, or similar tools) will be required to complete this investigation. Necessary PPE requirements are addressed in section 5 below.

Use, Inspection, and Maintenance:

- Unsafe tools will not be used.
- Impact tools, such as chisels, will be kept free of mushroomed heads.
- Wooden handles will be kept free of splinters or cracks and will be kept tight in the tool.
- Hand and power tools will be used, inspected, and maintained in accordance with the manufacturer’s instructions and recommendations and will be used only for the purpose for which designed.
- Hand and power tools will be inspected, tested, and determined to be in safe operating condition before use: continued periodic inspections will be made to ensure safe operation condition and proper maintenance.
- Hand and power tools will be in good repair and with all required safety devices installed and properly adjusted: tools having defects that will impair their strength or render them unsafe will be removed from service.

Guarding:

- Power tools designed to accommodate guards will be equipped with such guards.
- Portable power-driven circular saws will be equipped with guards above and below the base plate or shoe. When the tool is withdrawn from work, the lower guard will automatically and instantly return to the covering position.

Switches:

- All hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels greater than 2 inches in diameter, disc sanders, belt sanders, reciprocating saws, saber saws, and other similar operating powered tools shall be equipped with a momentary contact "on-off" control and may have a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

- All other hand-held powered tools, such as circular saws, chain saws, and percussion tools without positive accessory holding means, shall be equipped with a constant pressure switch that will shut-off the power when the pressure is released. This is a general safety precaution as these tools are not yet required to complete the investigation.

- Exception: This paragraph does not apply to concrete vibrators, concrete breakers, powered tampers, jack hammers, rock drills, and similar hand operated power tools.

PPE:

- Loose and frayed clothing, loose long hair, dangling jewelry (including dangling rings, chains, earrings, and wristwatches) will not be worn while working with power tools.

- Employees using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dust, fumes, mists, vapors, or gases will be provided with the PPE necessary to protect them from the hazard.

2.2.7 Weather Hazards

Weather hazards and controls are presented in the Severe Weather Contingency Plan (Section 9.40 of the APP).

2.2.8 Material Handling/Moving/Lifting Hazards

Material handling at hazardous waste sites can vary from heavy equipment handling to manually moving/lifting items. Hazards associated with material handling include physical injury, detonation, fire, explosion, and vapor generation, among others. Injuries to back and abdominal muscles from improperly lifting of loads are the most common occupational injuries reported. Such injuries can range from relatively mild strains to major, permanently disabling injuries. Before lifting a load, personnel will consider the overall weight, distribution of weight, unwieldiness or awkwardness of the load, distance to be carried, obstacles to be negotiated, site conditions, and visibility. Loads anticipated to be moved during the Phase I RI of PFAS at the Niagara Falls Air Reserve Station include coolers, portable handwashing and decontamination stations, hand tools, and health and safety equipment. When using equipment to move materials, proper work practices will be followed, and equipment used will be designed for the task to be performed. Equipment will be inspected in accordance with the requirements presented in Chapter 7 of the APP.

No repetitive motions are anticipated that would require further evaluation for this investigation.

2.3 BIOLOGICAL HAZARDS

A survey of the potential biological hazards (harmful plants, animals, and insects) was conducted for work areas. The results are summarized in the subsections below.

2.3.1 Bees, Hornets, and Wasps

 **Carpenter Bee**	 **Honeybee**	 **Bumble Bee**
 **Paper Wasp**	 **Hornets (General)**	 **Yellow Jacket**

Environment	Nests/hives are found in brush, grasses, and on the ground (especially for wasps). Habitat is more likely in drainages.
Health Hazards	Stinging of site personnel. Swelling and discomfort are typical; however, some people (rare) are hypersensitive to the injected toxins.
Symptoms	Swelling, itching, and minor pain are typical symptoms. Persons hypersensitive to the injected toxins may experience anaphylactic shock (violent and immediate response: intense swelling of body, life-threatening, potentially fatal).
Treatment	See First Aid Procedures below.
Protective Measures	*Awareness*: Note the presence of habitat or potential habitat and demarcate as appropriate (SSHO/Designated Representative [DR]) will apply paint/tape/other to mark the location; employees will stay clear of the habitat). *PPE*: Level D PPE is required. See descriptions in the Chapter 5, and task specific AHAs. Personnel will spray exposed skin with insect repellant containing n, n-diethyl meta-toluamide (DEET) A(approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET. Permethrin is for clothing only following manufacturer instructions. *Note*: Personnel with hypersensitivity to stings are required to carry an antidote pen on their person, instruct personnel on the use and location of the pen, and notify the SSHO/DR. If stung, personnel must notify the SSHO/DR immediately.
First Aid Procedures	General First Aid procedures in the event of a sting include washing the area with soap and water, removing the stinger (if present), applying a cold compress, and applying a topical antihistamine. In the event of excessive swelling (greater than 10 centimeters), swelling of the lips/throat, faintness, dizziness, confusion, rapid heartbeats, hives, or nausea/cramps/vomiting occurs notify the SSHO/DR and seek professional medical treatment. An antidote pen will be applied to address anaphylactic shock.
Inoculation	Not applicable.

2.3.2 Insects

 **Mosquito**	
Environment	Nests/hives are found in brush, grasses, and on the ground in wooded areas (most common) where there is standing water. This included non-natural pools like equipment tarps and site pooling of water.
Health Hazards	Stinging of site personnel and biting of site personnel. Swelling and discomfort are typical. In New York, mosquitoes may be a vector for West Nile Virus, Zika Virus, and Encephalitis.
Symptoms	Swelling, itching, and minor pain are typical symptoms. West Nile: bout 1 in 5 people who are infected will develop a fever and other symptoms. Less than 1% of those infected develop a serious, sometimes fatal, neurologic illness. Zika: If symptomatic, then typically fever, rash, joint pain, red eyes appearing 3–12 days after bite, lasts a few days, and most symptoms are mild.
Treatment	Refer to First Aid Procedures below.
Protective Measures	*Awareness*: Note the presence of habitat or potential habitat and demarcate as appropriate (SSHO will apply paint/tape/other to mark the location; employees will stay clear of the habitat). *PPE*: Level D PPE is required. See descriptions in Chapter 5. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET.
First Aid Procedures	General First Aid procedures in the event of a sting include washing the area with soap and water, maintain proper hygiene of the sting area, as some personnel have been known to scratch the site until an open wound is present. Apply topical antihistamines to alleviate the symptoms and monitor for worsening of the above symptoms in the event of exposure to any infectious diseases. If symptoms worsen beyond mild, seek emergency medical care.
Inoculation	Not applicable for most of the above.

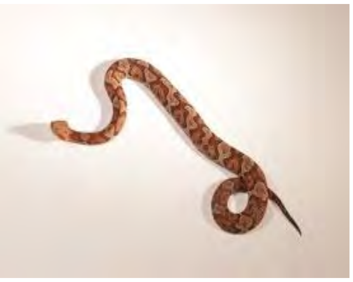
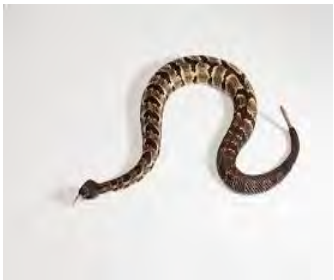
2.3.3 Arachnids (Spiders and Scorpions)

 **Black Widow**	 **Brown Recluse Spider**
Environment/ Habitat	**Black Widows**: Found in dark, out of the way places including storage sheds, brickwork, eaves, discarded building material, storm sewers, down spouts, outdoor lighting, and under outdoor furniture. These spiders are nocturnal and construct an irregular, unorganized, loosely woven web 1–6 feet above the ground with raisin-sized "cottony" egg sacs, grass clippings and often other debris. **Brown Recluse:** Found in dark, out of the way places including storage sheds, brickwork, eaves, discarded building material, storm sewers, down spouts, outdoor lighting, and under outdoor furniture. These spiders are nocturnal and construct an irregular, unorganized, loosely woven web 1–6 feet above the ground with raisin-sized "cottony" egg sacs, grass clippings and often other debris.
Health Hazards	The toxicity of the venom is inversely proportional to size. Systemic symptoms of the spiders are presented below.
Symptoms	**Black Widow:** Symptoms from bites are systemic, spreading through the lymphatic system and usually start about 1–3 hours post-bite, whereupon the patient seeks treatment. The most common symptoms are intense pain, rigid board-like stomach muscles, muscle cramping, malaise, local sweating, nausea, oliguria, vomiting, and hypertension. **Brown Recluse Spider:** Many bites are painful at inception and can produce slightly necrotic wounds that usually heal in a short duration without severe scarring. Other symptoms that may accompany the bite includes itching, shivering, vomiting, and a slight fever. The symptoms are usually short in duration and subside in several days.
Treatment	Refer First Aid procedures below.
Protective Measures	*Awareness:* Typically, a bite from this spider is not noticed until several hours later when the symptoms above become noticeable or severe. Look for disorderly webs; shake out clothing, boots, and gloves prior to wearing; and minimize disturbance of potential habitat. *PPE:* Level D PPE is required. See descriptions in Chapter 5 of the SSHP. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33% solution) and clothing with insect repellant containing permethrin/permanone or DEET. If bitten, personnel must notify the SSHO immediately.
First Aid Procedures	*Bites/Stings:* Wash the area with soap and water; apply a cold compress and elevate the area above the level of the heart; then seek professional medical treatment. DO NOT apply heat or steroid creams, remove venom by suction, apply electricity, or apply a tourniquet.
Inoculation	Not applicable.

2.3.4 Ticks

<table>
<tr><th>
Black Legged</th><th>
Brown Dog</th><th>
Lone Star</th></tr>
<tr><td>Environment</td><td colspan="2">Ticks are typically found along well-defined paths of grassy or transitional vegetation waiting for hosts to pass. Ticks cannot fly nor jump and wait on leaves or long grasses in a position called questing, holding two pairs of legs outstretched while two pairs of legs maintain a connection on the vegetation. Most people are infected by nymphal stages during the spring and summer. Nymphs are small enough to escape notice and can stay attached longer than adults, increasing risk of disease transmission.</td></tr>
<tr><td>Health Hazards</td><td colspan="2">Transmission of Amblyomma (tularemia, ehrlichiosis, Rocky Mountain spotted fever [RMSF], boutonneuse fever); Dermacentor (RMSF, Colorado tick fever, tularemia, Siberian tick typhus, and Central European tick-borne encephalitis, as well as being an agent of tick paralysis); Hyalomma (Siberian tick typhus, Crimean-Congo hemorrhagic fever); Ixodes (Lyme disease, babesiosis , human granulocytic ehrlichiosis, Russian spring-summer encephalitis); and Rhipicephalus (RMSF and boutonneuse fever).</td></tr>
<tr><td>Symptoms</td><td colspan="2">Symptoms of tick-borne diseases start within 2 weeks of being bitten. The most common symptoms for tick-borne disease are fever, headache, and muscle pain. There are disease-specific symptoms such the bull’s eye rash that can be seen in some cases of Lyme disease.</td></tr>
<tr><td>Treatment</td><td colspan="2">See First Aid procedures below for acute actions. Treatment typically includes a complete dose of an antibiotic.</td></tr>
<tr><td>Protective Measures</td><td colspan="2"><i>Awareness:</i> Wear light-colored clothing and perform tick checks in the morning, in the evening, after bathing, and intermittently throughout the day. During work hours, have other site personnel inspect clothing for the presence of ticks.
<i>PPE:</i> Level D PPE is required. See PPE suites in AHAs and APP. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET. Tuck and Tape for Ticks: tuck trouser legs into boots and tape boots to trouser legs. Also, tuck shirts into pants and wear a belt.</td></tr>
<tr><td>First Aid Procedures</td><td colspan="2">If you find a tick attached to your skin, remove the tick as soon as possible. Use fine-tipped tweezers to grasp the tick as close to the skin’s surface as possible. Pull upward with steady, even pressure. If the mouthparts break off and remain in the skin, remove the mouthparts with tweezers. If you are unable to remove the mouth easily with clean tweezers, leave it alone and let the skin heal. After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol or soap and water. Never crush a tick with your fingers. Dispose of a live tick by putting it in alcohol, placing it in a sealed bag/container, wrapping it tightly in tape, or flushing it down the toilet.
Monitor yourself and other site personnel for symptoms described above. Report all tick bites, suspected tick bites, and/or potential symptoms of tick-borne illness to the Unexploded Ordnance Safety Officer immediately and less than 24 hours from the incident.</td></tr>
<tr><td>Inoculation</td><td colspan="2">Currently, there is no effective vaccine available for the illnesses listed above.</td></tr>
</table>

2.3.5 Poisonous Snakes

 **Northern Copperhead**	 **Timber Rattlesnake**
Environment	Copperheads live in a range of habitats, from terrestrial to semi-aquatic, including rocky, forested hillsides, and wetlands. They are also known to occupy abandoned and rotting wood or sawdust piles, construction sites, and sometimes suburban areas. They climb into low bushes or trees to hunt prey and will also bask in the sun and swim in the water. The timber rattlesnake occurs in a wide variety of terrestrial habitat including lowland cane thickets, high areas around swamps and river floodplains, hardwood and pine forests, mountainous areas, and rural habitats in farming areas. They typically become reduced in numbers in highly urbanized or areas of housing development.
Health Hazards	Snake bites often result in temporary tissue damage in the immediate area of bite. Their bite may be painful but is very rarely (almost never) fatal to humans.
Symptoms	A bite area may be tender and mildly swollen. Symptoms include redness and swelling around the bite, severe pain at the site of the bite, nausea and vomiting, labored breathing (in extreme cases, breathing may stop altogether), disturbed vision, increased salivation and sweating, numbness or tingling around your face and/or limbs.
Treatment	First Aid procedures are provided below for acute actions. Treatment is required by medical professionals and typically includes a complete dose of an antibiotic.
Protective Measures	**Awareness:** Avoid tall grass, be aware of snakes hanging from tree limbs, check before sticking hands into crevasses, holes, hollow logs. **PPE:** Level D PPE is required. Descriptions are provided in Chapter 5 of the SSHP. Heavy pants and boots can protect against snake bites.
First Aid Procedures	Workers should take the following steps if they are bitten by a snake: seek medical attention as soon as possible (dial 911 or call local Emergency Medical Services); try to remember the color and shape of the snake, which can help with treatment of the snake bite; keep still and calm, this can slow down the spread of venom; inform your supervisor; apply First Aid if you cannot get to the hospital right away. First aid includes: lay or sit down with the bite below the level of the heart; wash the bite with soap and water; cover the bite with a clean, dry dressing.
Inoculation	Currently, there is no vaccine available for the illnesses listed above.

Notes:

Very little snake habitat is present on-site. Increased awareness should occur in areas with trees and around naturally running water.

2.3.6 Poisonous Plants

 **Poison Ivy (Shrub)**	 **Poison Oak**
Environment	The plants listed above are all regionally found.
Health Hazards	**Poison Ivy (Urushiol Oil):** Poison Ivy secretes urushiol oil, which causes contact dermatitis that can become severe if introduced into mucous membranes (i.e., eyes, nose).
Symptoms	**Urushiol Oil:** Swelling and itching; red rash within a few days of contact; bumps, streaking, and weeping blisters (blisters fluids not contagious). The rare potential exists for a severe allergic reaction including severe swelling or difficulty breathing.
Treatment	First Aid procedures are provided below.
Protective Measures	**Awareness:** Identify and avoid the plants listed above. Attempt to access the sampling locations using another route, or slightly relocate sampling locations, if the plants are present in the work area. Notify the SSHO if/when these plants are observed. **Prevention:** Clean tools used near known or suspected Poison Ivy with soap/water. **PPE:** Modified Level D PPE is required. Descriptions are provided in Chapter 5 of the SSHP.
First Aid Procedures	**Urushiol Oil:** Immediately rinse skin and wash with soap and water; apply a cold compress and hydrocortisone cream (do not apply to open blisters); and seek professional medical attention if severe swelling or difficulty breathing is observed. Generally, an oral antihistamine (e.g., diphenhydramine) may be taken to reduce the allergic response.
Inoculation	Not applicable.

2.3.7 Harmful Animals

Rodents, snakes, stray dogs, stray cats, raccoons, or other animals may be encountered on job sites. The only effective measure to preclude animal bites is avoidance. If wild animals are encountered, retreat to the support vehicle, and notify the SSHO immediately:

- Contact with wild animals will be avoided. Do not reach into an object such as a pipe that may contain a rodent or other animal or attempt to remove the animal. If possible, delay activity in this area until the animal leaves or has been removed by an animal control unit. If it is necessary to use or move an object where an animal is hiding, the SSHO may have to notify the local animal control agency to subdue an animal that may cause a risk to workers (e.g., a raccoon). Do not approach an animal under any circumstance, as this may cause the animal to be in an aggressive state. Persons bitten by an animal will seek medical assistance immediately, especially if it is suspected that the animal may be rabid. Aggressive or disoriented behavior, as well as foaming at the mouth, can be signs of rabid animals. Until medical assistance can be reached, persons will watch for symptoms of severe swelling, nausea, and shock. The local animal control agency will be contacted if a stray dog is observed on the property, especially if its presence will affect work activity or the animal’s safety. Do not attempt to leash a stray dog (no matter how harmless it may appear); doing so would greatly increase the risk of an animal bite.

2.3.8 Microorganisms

The possibility of ingestion or exposure to microorganisms may occur on-site within standing pools of water or any nearby water catchments. Personnel are prohibited from consuming non-potable water and will follow proper hygiene procedures prior to potential hand-to-mouth contact. Personnel will be required to follow hygiene procedures of handwashing and face washing each time exiting the primary work zone into the Support Zone. Discussions surrounding the Coronavirus Disease 2019 (COVID-19) infection are presented below.

2.3.9 Novel Coronavirus (COVID-19)

During an active outbreak of COVID-19, precautions need to be taken to prevent the spread of the virus in accordance with Center for Disease Control guidelines.

Symptoms of COVID-19 include, but are not limited to, fever, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, and diarrhea that may appear 2 to 14 days after exposure. There is the potential for asymptomatic community transmission; therefore, preventive measures will be taken during all operations.

3. STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

Chapter 4 of the APP shows the organization, qualifications, and responsibilities of staff. Appendix C to the APP present proofs-of-competency for key roles and key personnel for safety.

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4. TRAINING

Training and certifications required for site personnel to complete this investigation are presented in Chapter 6 of the APP. Proofs-of-competency are presented in Appendix C of the APP.

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5. PERSONAL PROTECTIVE EQUIPMENT

Based on the hazard assessment conducted by the Site Health Manager (SHM), and for tasks where engineering controls cannot eliminate the occupational hazards at the NFARS site PPE is required. Employees have received OSHA compliant PPE training as part of HAZWOPER training.

5.1 SELECTION

The selection of the appropriate PPE was performed by the SHM. The type of PPE and level of protection will be reevaluated periodically (as required, but typically associated with a set of changing conditions requiring evaluation of PPE changes) by the SSHO, with feedback from site workers, in light of any new information about the site or site operations. Selection of the protective ensembles described below conforms to the levels of protection as described in the National Institute for Occupational Safety and Health Publication 85-115. Selection is based on an evaluation of the performance characteristics of the PPE relative to the site requirements/limitations, task-specific condition and duration, and hazards and potential hazards identified at the site.

5.2 PERSONAL PROTECTIVE EQUIPMENT USE

As previously stated, EA will provide PPE and the proper training on maintenance and use; however, the employees are required to use the PPE as provided and for the use of which it was intended.

5.3 TRAINING AND PROPER FITTING

Employees have received OSHA compliant PPE training as part of HAZWOPER training. If the SSHO determines during site work that an employee needs to be re-trained, the SSHO will not allow the employee to perform the work activities until this re-training has occurred and will document the re-training as described in Table 6-1 of the APP.

5.4 INSPECTION AND IN-USE MONITORING

Inspection of PPE will be performed prior to use by the employee and is listed in Table 7-1 of the APP. PPE that does not pass inspection will be discarded and replaced.

5.5 MAINTENANCE AND STORAGE

Disposable PPE will be removed and disposed of in the Contamination Reduction Zone. Non-disposable PPE will be wiped clean for dust in the Contamination Reduction Zone. All PPE will be properly stored in site support vehicles.

5.6 LEVELS OF PROTECTION AND REQUIREMENTS

Levels of protection at the site include Level D or Modified Level D. PPE required as part of first aid activities is not presented in this section; however, it will be provided for first aid/cardiopulmonary resuscitation (CPR) providers.

5.6.1 Level D Protection

Several work tasks at the NFARS site, in Niagara County, New York, contain no known atmospheric hazards and do not include splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemicals; therefore, Level D PPE includes:

- Work clothing consisting of long-sleeve shirts and work pants when working in heavily vegetated areas with potential for exposure to poisonous plants. Short sleeve shirts are acceptable when outside of heavily vegetated areas or when worn in conjunction with over-the-counter barrier creams. Coveralls are also acceptable at all times.

- For work where a laceration hazard exists, heavy duty cloth, leather, or nylon cut-resistant gloves are recommended

- Safety-toed boots (in accordance with American National Standards Institute Z41) and ASTM International Standards F2412 and F2413]).

- Hard hats in accordance with American National Standards Institute/International Safety Equipment Association Z89.1.

- High visibility apparel (e.g., blaze orange/yellow clothing and/or reflective safety vests) apparel is required when working near traffic or at well heads located in the street, or when working near heavy equipment or traffic. It should be noted that that during hot work (e.g., welding), personnel either wear a flame-retardant safety vest or another employee (spotter) with a safety vest will be assigned to act as a lookout during the hot work.

- Safety glasses (Z87.1-rated) when sampling or when conducting general site surveys. Add rated goggles when a splash hazard exists.

- All disposable PPE will be bagged in plastic bags for non-hazardous disposal.

5.6.2 Modified Level D Protection

Modified Level D Protection includes Level D protection with the addition of:

- Nitrile gloves (when sampling within sampling aqueous and solid media across the site).

6. MEDICAL SURVEILLANCE

Site personnel for work to be completed at the NFARS site will be required to be enrolled in the medical surveillance program with their employer. Site workers that anticipate being exposed to contaminants at the PEL for 30 or more days a year or that may don respiratory protection will be enrolled in a medical surveillance program and will satisfactorily complete a comprehensive medical examination by or under the supervision of a licensed physician knowledgeable in occupational medicine prior to the initiation of field work. EA employees and subcontractors involved in those activities that may contact contaminated media (specifically, sampling activities and addressing investigation-derived waste) will be in the medical surveillance program. Medical examinations will be provided according to the following schedule:

- Prior to fieldwork assignment
- At least annually for employees covered by the program (biennially for those employees that do limit site work, with the approval of the occupational physician)
- At termination of employment or reassignment to an area where the employee had not been examined within the past 6 months
- As soon as possible after the development of signs or symptoms that may indicate an overexposure to hazardous substances or health hazards
- More frequently if the physician deems such examination necessary to maintain employee health.

Documentation for compliance with medical surveillance will be kept on-site (this information is also initially presented in Attachment B of the APP). Further documentation is maintained in EA's Office of Human Resources (410-584-7000). The records shall be complete and accurate and be kept on file for at least 30 years after termination of employment. A minimum of the following information shall be kept:

- Name and social security number
- Physician's written opinions, recommendations, limitations, and test results
- Employee medical complaints related to hazardous waste operations
- Information provided to the physician by the employee concerning possible exposures, accidents, etc.

6.1 FIRST AID AND MEDICAL TREATMENT

At least two on-site workers will be currently certified in both first aid and CPR by the American Red Cross or equivalent organization. For this site, the Site Superintendent, and/or SSHO at a minimum are certified and will be on-site. Documentation of all personnel certifications will be kept on-site. EA has identified a hospital for emergency medical care for this project site. The hospital to be used during emergencies for this site is Mt. St. Mary's Hospital (716-297-4800).

Employees will have the telephone number to the hospital during working hours should an occupational illness or injury occur. Individuals on-site currently certified in first aid will be called out at the start of each day's activities during the health and safety meeting. Certifications will be present on-site and will include separate Engineer Manual 385-1-1 03.A.06a-c-compliant bloodborne pathogen training. For information on this training, refer to Chapter 6 of the APP. Site-specific Bloodborne Pathogen Exposure Control Plan is contained in Section 9.6 of the APP.

6.2 MEDICAL RESTRICTION

Should an occupational injury or illness occur that restricts or limits an employee's ability to function at full capacity, EA maintains a policy of providing these employees with restricted or modified duty assignments whenever possible to allow them to continue to be productive.

6.3 MEDICAL RECORDS

Medical and personal exposure monitoring records will be maintained according to the requirements of 29 CFR 1910.120 (f) and shall be kept for a minimum of 30 years beyond employment. Employee confidentiality shall be maintained.

7. EXPOSURE MONITORING

7.1 GENERAL

Exposure monitoring will be instituted during operations at the site. The monitoring program may be modified by the SHM with input from the SSHO if site conditions and monitoring results warrant. Monitoring will be accomplished under the direction of the SSHO, who will interpret the results. The SSHO will receive support by the Field Manager and by site workers to ensure that monitoring is documented in a way to also reduce the risk associated with COVID-19. The results will be recorded on an environmental monitoring record (Attachment D of the APP).

7.2 AIR MONITORING PROGRAM

No air monitoring is required at this time as the potential for exposure to chemical hazards will be minimal. An addendum will be generated if site conditions change, and an Air Monitoring Plan is required.

7.2.1 General Area Monitoring

No air monitoring is required at this time as the potential for exposure to chemical hazards will be minimal. An addendum will be generated if site conditions change, and an Air Monitoring Plan is required.

Noise-generating monitoring and associated equipment is discussed in Chapter 9.10 of the APP and temperature-related monitoring is presented in Chapter 9.19 of the APP.

7.2.2 Breathing Zone Monitoring

Based on the negative exposure assessment, it is not likely that site personnel will be exposed to elevated concentrations of site COCs.

7.2.3 Real-Time Air Monitoring

No air monitoring is required at this time as the potential for exposure to chemical hazards will be minimal. An addendum will be generated if site conditions change, and an Air Monitoring Plan is required.

7.2.4 Perimeter Monitoring

Based on the above, perimeter monitoring is not required except for nuisance dust.

7.3 CALIBRATION AND MAINTENANCE

No air monitoring is required at this time as the potential for exposure to chemical hazards will be minimal. An addendum will be generated if site conditions change, and an Air Monitoring Plan is required.

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8. TEMPERATURE RELATED STRESS

A Heat Stress Monitoring Plan is presented in Chapter 9.19 of the APP. A Cold Stress Monitoring Plan is presented in Chapter 9.20 of the APP.

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9. STANDARD OPERATING PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

9.1 SITE RULES

During field activities, personnel will remain in verbal, radio, or mobile phone contact with each other. The Site Superintendent and SSHO will use mobile telephones and will be responsible for handling communications during emergencies that may arise. Safe work practices that will be followed by site workers include, but are not limited to, the following rules:

- Working before or after daylight hours without special permission is prohibited.
- Eating and drinking, chewing gum or tobacco, and smoking on the site is prohibited.
- Possessing, using, purchasing, distributing, or having controlled substances in their system throughout the day or during meal breaks is prohibited.
- Consuming or possessing alcoholic beverages is prohibited.
- Good housekeeping—The work area will be kept as clean as possible including frequent trash removal and efforts to keep floors dry and clean. Work areas will be kept clear of debris, tools, or other potential tripping hazards.
- Wash hands and face thoroughly upon leaving the site.
- Immediately repair or replace defective PPE, but not while in the work area.
- Prescription drugs will not be taken by personnel unless specifically approved by a qualified occupational physician and then only within the Support Zone.
- Personnel on-site will use the buddy system; visual contact will be maintained between team members while in the work area.

9.2 DAILY START-UP AND SHUTDOWN PROCEDURES

The following general protocols will be followed daily prior to start of work activities and are a summarization of activities, training, and documentation covered in pertinent sections of the APP for the NFARS site.

- The SSHO will review site conditions to establish whether modification of work and safety plans is needed.
- Personnel will be briefed and updated on new safety procedures as appropriate.
- Safety equipment will be checked for proper function.

- The SSHO will ensure that first aid equipment is readily available.

- The SSHO will conduct monitoring activities and document accordingly.

- Personnel will proceed through appropriate decontamination procedures and facilities (e.g., hand washing, PPE removal) when exiting the site, at the end of daily operations, and before breaks at the Niagara Falls Air Reserve Station site

9.2.1 Spill Containment

Emergency spill containment is presented in Section 9.2 of the APP. All work will occur donning an enhanced PPE suite to address splash protection, the on-site eyewash will be of a full variety (not nominal), and an on-site shower will be available to provide 3 gallons per minute for 15 minutes per each potentially exposed worker. Personal monitoring will be required for this task to prove the validity of the negative exposure assessment.

9.2.2 Site Control Measures

Work zones are designed to prevent employees, visitors, and the surrounding environment from exposure to contamination during intrusive site activities. Site work zones will be established by the Site Superintendent/SSHO prior to initiating operations to control site access during site activities, as needed. Establishment of site work zones is based upon site conditions, activities, and exposure potentials.

9.2.3 Exclusion Zone

There is no anticipated Exclusion Zone for the NFARS site. The establishment of an Exclusion Zone will be consistently refined as needed based on site conditions.

9.2.3.1 Contaminant Reduction Zone

There is no anticipated Contamination Reduction Zone for the NFARS site. The establishment of a Contamination Reduction Zone will be consistently refined as needed based on site conditions.

9.2.3.2 Support Zone

The Support Zone shall consist of a staging area outside of the Contaminant Reduction Zone. It will contain the team vehicles, the site trailer, and other elements necessary to support site activities. PPE is not required in this area. A wide variety of work tasks at various locations is planned under the principal work statement. The SSHO will determine the appropriate location of the Support Zone and ensure that it is demarcated properly.

9.2.3.3 Site Entry and Exit

Persons entering the site, or treatment system will be required to wear the PPE assigned by the SSHO as specified in Section 5.6.

Potentially contaminated PPE will be removed in the Contamination Reduction Zone.

9.2.4 Emergency Equipment and First Aid

Emergency equipment and first aid information is presented in Chapter 12. The hospital for site personnel is Mt. St. Mary’s in Lewiston, NY. Discussion about the hospital route is located in section 9.2.2. of the APP.

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10. PERSONNEL HYGIENE AND DECONTAMINATION

Fieldwork will be conducted in Level D or Modified Level D (when sampling) when sampling wells. It will continue to be used until air sampling results confirm employee exposure is below the action level on Table 7-1 of the APP and allows for a downgrade to Modified Level D protection.

Site personnel will wash their hands, face, and exposed skin surfaces prior to ingestion of food, liquids or any other hand-to-mouth activities and when leaving the site. Decontamination units will be located in contamination reduction zones. Hand washing with potable water, soap, and paper towels will be available at the restroom facilities. The work trailer and site vehicles will also be furnished with hand sanitizer.

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11. EQUIPMENT DECONTAMINATION

Decontamination will be supervised by the SSHO. The decontamination supplies and equipment will be maintained by the SSHO. Equipment decontamination will occur in Modified Level D PPE.

11.1 EQUIPMENT DECONTAMINATION

It is not expected that personnel and equipment decontamination measures will be needed during the project. However, if needed, general requirements are reviewed below:

- The SSHO must review specific decontamination procedures with personnel required to enter controlled work zones of the site and will monitor and ensure use of prescribed decontamination procedures. Personnel will be instructed to minimize contact with contaminants, to the extent feasible, to reduce the potential for personal or equipment contamination. Personnel decontamination occurs at the decontamination area before leaving the work area. Personnel must clean, remove and place contaminated disposable protective clothing in marked containers before leaving the work area. Workers will be instructed to practice good personal hygiene by washing face, hands and forearms before eating, drinking, smoking, etc. As necessary, the SSHO will establish procedures to prevent the spread of contamination from vehicles and equipment into other areas. Instruments used on-site must be wet wiped with clean water prior to leaving the site. Discolorations, stains, corrosion, and substances adhering to objects may indicate that contaminants have not been removed.

11.2 WASTE DISPOSAL PROCEDURES

PPE that cannot be decontaminated (i.e., chemical resistant suits, gloves, boot covers, respirator cartridges, etc.) will be placed in plastic trash bags. The disposal of any additional investigation-derived waste will be in accordance with U.S. Environmental Protection Agency, state, and federal requirements.

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12. EMERGENCY EQUIPMENT AND FIRST AID

A complete first aid kit (one per team or 25 personnel), meeting the requirements of a Type III, 16-unit or larger in a waterproof container will be readily available on-site and contain, at a minimum, a pocket mouthpiece for CPR, absorbent compresses, adhesive bandages, adhesive tape, antiseptic swabs, burn gel, sterile pads, and a triangular bandage. The contents of the kit(s) will be evaluated and possibly modified for this specific project. Kit(s) will be located not more than 300 feet from the work activity and may be transported in on-site vehicles.

The contents will be checked prior to their utilization for sterility and to replace expended items. The SSHO or other designated individual will inventory the kit(s) at least weekly and document the results in a log, an email to the SHM, or on the Daily Safety Inspection Checklist. Expended or non-sterile contents will be replaced with serviceable items.

Prior to the start of work, the SSHO will discuss with site personnel the prevention steps, symptoms, and medical personnel available to assist with injuries or questions on diseases, plants, or animals that could be encountered while working on this project. Diseases, plants, and animals are discussed in Chapter 2.

A working cell phone or radio with adequate signal in this area will be maintained on-site and fully charged at the start of each workday.

Fire extinguisher sizes and placement are discussed in Section 9.27 of the APP and will be inspected at a frequency commensurate with Table 7-1 of the APP.

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13. EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

Emergency response and contingency procedures are discussed in Section 9.2 of the APP including emergency contact telephone numbers. Directions and route to the nearest hospital are presented in Figure 9-1 (Section 9.2) of the APP.

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14. REFERENCES

Assistant Secretary of Defense (ASD). 2021. *Investigation Per- and Polyfluoroalkyl Substances within The Department of Defense Cleanup Program.* United States Department of Defense. 15 September.

U.S. Army Corps of Engineers (USACE). 2014. *Engineer Manual 385-1-1 Safety and Health Requirements Manual*. 30 November.

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Attachment F

Safety Data Sheets

SAFETY DATA SHEET

Conforms to OSHA HazCom 2012, CPR, NOM-018-STPS-2000 Standards & GHS

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name: Bentonite

Product Identities: Sodium bentonite, bentonite clay, Prime Gel, Pond Seal, High Yield, SlikGel, Swell Plug, PS-8, montmorillonite

Supplier/Manufacture:
Diversified Minerals Inc.
1135 E. Wooley Road
Oxnard CA, 93030
(888) 364-9595

Poison Control System:
(800) 222-1222

Recommended Uses: It is mostly used in drilling mud in the oil and gas well drilling industries. The property of swelling also makes sodium bentonite useful as a sealant, especially targeted for the sealing of subsurface disposal systems for spent nuclear fuel and for quarantining metal pollutants of groundwater. Similar uses include making slurry walls, waterproofing of below grade walls and forming other impermeable barriers (e.g. to plug old wells or as a liner in the base of landfills to prevent migration of leachate into the soil. Sodium bentonite is also used in a variety of pet care items such as cat litter to absorb odors.

Restrictions on Use: N/A

SECTION 2: HAZARD IDENTIFICATION

WARNING

Irritant: Causes eye, skin and inhalation irritation

Use proper engineering controls, work practices, and personal protective equipment to prevent exposure to wet or dry product.

Read SDS for details.

GHS Classification: (Please see GHS Classifications on our website under Resources)

Carcinogenicity - Category 1A
Specific Target Organ Toxicity Repeat Exposure - Category 2

GHS LABEL ELEMENTS Symbol(s)

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS RN	ACGIH TLV (mg/m^3)	OSHA-PEL (mg/m^3)
Bentonite	1302-78-9	10	NA
Silica	14808-60-7	0.1	10(R) 30(T)
Inert or nuisance dust	- - -	10	5(R) 15(T)

Bentonite is absorbent aluminum phyllosilicate clay, consisting mostly of montmorillonite. Trace amount of elements may be detected due to the naturally variable chemical compositions of earth materials.

SECTION 4: FIRST-AID MEASURES

Eye Contact: Rinse eyes thoroughly with water for at least 15 minutes, including under lids to remove all particles. Seek medical attention for discomfort or if irritation or other symptoms do not subside.

Skin Contact: Wash with cool water and pH neutral soap or a mild skin detergent Seek medical attention for rash, irritation and dermatitis.

Inhalation: Move person to fresh air. Seek medical attention for discomfort or if coughing or other symptoms do not subside.

Ingestion: Treat symptomatically. If bowel obstruction is suspected, seek immediate medical attention**.**

SECTION 5: FIRE-FIGHTING MEASURES

Flashpoint & Method: Non-combustible

General Hazard: Avoid breathing dust.

Extinguishing Media: Use extinguishing media appropriate for surrounding fire.

Firefighting Equipment: Bentonite poses no fire-related hazard.

Combustion Products: In excess of 1000°C compounds will break down into their constituent oxides.

SECTION 6: ACCIDENTAL RELEASE MEASURES

General: Place spilled material into a container. Avoid actions that cause the bentonite to become airborne. Avoid inhalation of bentonite and direct contact with skin. Wear appropriate Personal Protective Equipment (PPE) as described in Section 8 below.

Waste Disposal: Dispose of bentonite according to Federal, State, Provincial and local regulations.

SECTION 7: HANDLING AND STORAGE

General:	Handle with care and use appropriate control measures. Keep dry until used. Properly ground all pneumatic conveyance systems. The potential exists for static build-up and static discharge when moving cement powders through a plastic, non- conductive, or non-grounded pneumatic conveyance system. The static discharge may result in damage to equipment and injury to workers.
Engulfment hazard:	To prevent burial or suffocation, do not enter a confined space, such as a silo, bin, bulk truck or other storage container or vessel that stores or contains bentonite. Bentonite can build up or adhere to the walls of a confined space. The bentonite can suddenly release, collapse, or fall unexpectedly.
Housekeeping:	Avoid actions that cause bentonite to become airborne during clean-up such as dry sweeping or using compressed air. Use HEPA vacuum or thoroughly wet with water to clean-up dust. Use PPE described in Section 8 below.
Storage Temperature:	Unlimited.
Storage Pressure:	Unlimited.
Storage Moisture:	Keep dry.
Clothing:	Promptly remove and launder clothing that is dusty or wet with bentonite. Thoroughly wash skin after exposure to bentonite.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:	Use local exhaust and general dilution ventilation or other suppression methods to maintain dust levels below exposure limits.
Personal Protective Equipment (PPE):	
Respiratory Protection:	Under ordinary circumstances no respiratory protection is required. Wear a NIOSH approved respirator that is properly fitted and is in good condition when exposed to dust above exposure limits.
Eye Protection:	Wear ANSI approved glasses or safety goggles when handling dust or wet bentonite to prevent contact with eyes. Wearing contact lenses when using bentonite, under dusty conditions, is not recommended.
Skin protection:	Wear gloves, boot covers and protective clothing impervious to water to prevent skin contact. Do not rely on barrier creams, in place of impervious gloves. Remove clothing and PPE that become saturated with wet bentonite and immediately wash exposed areas.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid	**Evaporation Rate:**	NA
Appearance:	Beige	**pH (in water):**	10
Odor:	Odorless	**Boiling Point:**	NA
Vapor Pressure:	NA	**Freezing Point:**	None, solid
Vapor Density:	NA	**Viscosity:**	None, solid
Specific Gravity	2.4-2.6	**Solubility in water:**	Negligible

SECTION 10: STABILITY AND REACTIVITY

Stability:	Stable. Keep dry until use.
Incompatibility:	NA
Hazardous Polymerization:	None.
Hazardous Decompositions:	Will not spontaneously occur.

SECTION 11 AND 12: TOXICOLOGICAL AND ECOLOGICAL INFORMATION

For questions regarding toxicological and ecological information refer to contact information in Section 1.

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of waste and containers in compliance with Federal, State, Provincial and Local regulations.

SECTION 14: TRANSPORT INFORMATION

This product is not classified as a Hazardous material under US D.O.T or Canadian TDG regulations.

SECTION 15: REGULATORY INFORMATION

OSHA/MSHA Hazard Communication:

This product is considered by OSHA/MSHA to be a hazardous chemical and should be included in the employer's hazard communication program.

CERCLA/Superfund: This product is not listed as a CERCLA hazardous substance.

EPCRA
SARA Title III: This product has been reviewed according to the EPA Hazard Categories promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 and is considered a "hazardous substance" a delayed health hazard.

EPRCA
SARA Section 313: This product does not contain any of the substance subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372

California Proposition 65:

WARNING: This material may contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm

SECTION 16: OTHER INFORMATION

General Abbreviations:

>	Greater than	NIOSH	National Institute for Occupational Safety and Health
<	Lesser than	NTP	National Toxicology Program
ACGIH	American Conference of Governmental Industrial Hygienists	OSHA	Occupational Safety and Health Administration
CAS RN	Chemical Abstracts Reference Number	PEL	Permissible Exposure Limit
CERCLA	Comprehensive Environmental Response, Compensations and Liability Act	pH	Negative log of hydrogen ion
CFR	Code of Federal Regulations	PPE	Personal Protective Equipment
CL	Ceiling Limit	R	Respirable Particulate
DOT	Department of Transportation	RCRA	Resource Conservation and Reauthorization Act
g/cm^3	Grams per cubic centimeter	SARA	Superfund Amendments and Reauthorization Act
HEPA	High-Efficiency Particulate Air	SDS	Safety Data Sheet
HMIS	Hazardous Materials Identification Systems	T	Total Particulate
IARC	International Agency for Research on Cancer	TDG	Transportation of Dangerous Goods
mg/m^3	Milligrams per cubic meter	TLV	Threshold Limit Value
MSHA	Mine Safety and Health Administration	TWA	Time Weighted Average (8 hour)
NA	Not Applicable	WHMIS	Workplace Hazardous Materials Information System
NFPA	National Fire Protection Association	---	-----

This SDS (Section 1-16) was revised on May 21, 2015.

An electronic version of this SDS is available at: www.dmicement.com

The data in the Safety Data Sheet related only to the specific material designated herein and does not relate to use in combination with any other material on or in any process. Diversified Minerals Inc. (DMI) believes the information contained herein is accurate; however, DMI makes no guarantees with respect to such accuracy and assumes no liability in connection with the use of the information contained herein which is not intended to be and should not be construed as legal advice or as insuring compliance with any federal, state or local laws or regulations. Any party using this product should review all such laws, rules, or regulations prior to use, including but not limited to Federal, Provincial, State and Local regulations.

NO WARRANTY IS MADE, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

Material Safety Data Sheet

1 . Identification of the material and supplier

Product name	**BP Biodiesel Blend**
SDS no.	0000002821
Product use	Fuel for compression ignition diesel engines.
Synonyms	Diesel B20 TME
Supplier	BP Australia Pty Ltd (ABN 53 004 085 616) Melbourne Central, 360 Elizabeth Street, Melbourne, Victoria 3000, Australia Tel: +61 (03) 9268 4111 Fax: +61 (03) 9268 3321
EMERGENCY TELEPHONE NUMBER	1800 638 556
Product code	0000002821

2 . Hazards identification

Statement of hazardous/dangerous nature	HAZARDOUS SUBSTANCE. NON-DANGEROUS GOODS.
Risk phrases	R40- Limited evidence of a carcinogenic effect. R65- Harmful: may cause lung damage if swallowed. R66- Repeated exposure may cause skin dryness or cracking. R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Safety phrases	S2- Keep out of the reach of children. S24- Avoid contact with skin. S29- Do not empty into drains. S36/37- Wear suitable protective clothing and gloves. S43- In case of fire, use water, dry chemical powder or carbon dioxide. Do not use water jet. S61- Avoid release to the environment. Refer to special instructions/safety data sheet. S62- If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

3 . Composition/information on ingredients

Contains Fatty Acid Methyl Esters (FAME). May also contain small quantities of proprietary performance additives.

Ingredient name	CAS no.	%
Fuels, diesel Contains small quantities of polycyclic aromatic hydrocarbons (PAHs).	68334-30-5	80 - 95

Other ingredients, determined not to be hazardous according to NOHSC criteria, and not dangerous according to the ADG Code, make up the product concentration to 100%.

4 . First-aid measures

Eye contact	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
Skin contact	Wash with soap and water. Get medical attention if irritation develops.
Inhalation	If inhaled, remove to fresh air. Get medical attention if symptoms appear.
Ingestion	If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Aspiration hazard if swallowed. Can enter lungs and cause damage. Get medical attention.
Advice to doctor	Treatment should in general be symptomatic and directed to relieving any effects. Product can be aspirated on swallowing or following regurgitation of stomach contents, and can cause severe and potentially fatal chemical pneumonitis, which will require urgent treatment. Because of the risk of aspiration, induction of vomiting and gastric lavage should be avoided. Gastric lavage should be undertaken only after endotracheal intubation. Monitor for cardiac dysrhythmias. Note: High Pressure Applications Injections through the skin resulting from contact with the product at high pressure constitute a major

medical emergency. Injuries may not appear serious at first but within a few hours tissue becomes swollen, discoloured and extremely painful with extensive subcutaneous necrosis.
Surgical exploration should be undertaken without delay. Thorough and extensive debridement of the wound and underlying tissue is necessary to minimise tissue loss and prevent or limit permanent damage. Note that high pressure may force the product considerable distances along tissue planes.

5 . Fire-fighting measures

Extinguishing media	
Suitable	Use foam or all-purpose dry chemical to extinguish. This material is toxic to aquatic organisms. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.
Not suitable	Do not use water jet.
Hazardous decomposition products	Decomposition products may include the following materials: carbon dioxide carbon monoxide other hazardous substances.
Unusual fire/explosion hazards	Combustible liquid and vapour. Vapour may cause flash fire. Vapours may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.
Special fire-fighting procedures	Do not fight fire when it reaches the material. Withdraw from fire and let it burn. Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. First move people out of line-of-sight of the scene and away from windows.
Protection of fire-fighters	Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear.

6 . Accidental release measures

Personal precautions	No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapour or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see section 8).
Environmental precautions	Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.
Large spill	Stop leak if without risk. Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see section 13). Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilt product. Note: see section 1 for emergency contact information and section 13 for waste disposal.
Small spill	Stop leak if without risk. Move containers from spill area. Absorb with an inert material and place in an appropriate waste disposal container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.

7 . Handling and storage

Handling	Aspiration hazard if swallowed. Can enter lungs and cause damage. Do not ingest. If ingested, do not induce vomiting. Never siphon by mouth. Avoid breathing vapours, spray or mists. Use only with adequate ventilation. Keep away from heat, sparks and flame. To avoid fire or explosion, dissipate static electricity during transfer by earthing and bonding containers and equipment before transferring material. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Avoid contact of spilt material and runoff with soil and surface waterways. Wash thoroughly after handling. When using do not eat, drink or smoke.
Storage	Keep container tightly closed. Keep container in a cool, well-ventilated area. Store and use only in equipment/containers designed for use with this product. Empty packages may contain some remaining product. Hazard warning labels are a guide to the safe handling of empty packaging and should not be removed. Do not enter storage tanks without breathing apparatus unless the tank has been well ventilated and the tank atmosphere has been shown to contain hydrocarbon vapour concentrations of less than 1% of the lower flammability limit and an oxygen concentration of at least 20% volume. Always have sufficient people standing by outside the tank with appropriate breathing apparatus and equipment to effect a quick rescue.
Combustibility Classification	Combustible liquid Class C1 (AS 1940).

Additional information-Storage	This product must be handled in compliance with Australian Standard: The storage and handling of flammable and combustible liquids [Standard 1940-2004 as amended and adapted]. Light hydrocarbon vapours can build up in the headspace of tanks. These can cause flammability/explosion hazards even at temperatures below the normal flash point (note: flash point must not be regarded as a reliable indicator of the potential flammability of vapour in tank headspaces). Tank headspaces should always be regarded as potentially flammable and care should be taken to avoid static electrical discharge and all ignition sources during filling, ullaging and sampling from storage tanks. Will present a flammability hazard if heated above flash point but bulk liquids at normal storage temperatures will present virtually no fire hazard. If fuel contacts hot surfaces, or leaks from high pressure fuel pipes, the vapour and/or mists generated will create a flammability or explosion hazard. Product contaminated rags, paper or material used to absorb spillages, represent a fire hazard, and should not be allowed to accumulate. Dispose of safely immediately after use. Empty containers represent a fire hazard as they may contain flammable product residues and vapour. Never weld, solder or braze empty containers. To avoid fire, eliminate ignition sources.

8 . Exposure controls/personal protection

Ingredient name	**Occupational exposure limits**
Fuels, diesel	**ACGIH TLV (United States). Absorbed through skin.** TWA: 100 mg/m³, (measured as total hydrocarbons) 8 hour(s). Issued/Revised: 1/2002 Form: Total hydrocarbons

For information and guidance, the ACGIH values are included. For further information on these please consult your supplier.

Biological Limit Values	No biological limit allocated.
Exposure controls	
Occupational exposure controls	Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective occupational exposure limits. In accordance with good industrial hygiene and safety work practices, airborne exposures should be controlled to the lowest extent practicable.
Hygiene measures	Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period.
Personal protective equipment	
Respiratory protection	Use only with adequate ventilation. Do not breathe vapour or mist.
Skin and body	Avoid contact with skin. Wear suitable protective clothing.
Hand protection	Wear protective gloves if prolonged or repeated contact is likely. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Gloves should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions.
Eye protection	Safety glasses with side shields.

9 . Physical and chemical properties

Physical state	Liquid.
Colour	Colourless. to Light brown. / Amber.
Odour	Mild
Flash point	>61.5 °C (Closed cup)
Auto-ignition temperature	>220°C (>428°F)
Explosive properties	Combustible liquid and vapour. Vapour may cause flash fire. Vapours may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.
Vapour pressure	Not available.
Vapour density	Not available.
Viscosity	Kinematic: 2.1 to 4.5 mm^2/s (2.1 to 4.5 cSt) at 40°C
pH	Not available.
Boiling point / range	Not available.
Melting point / range	Not available.
Relative density/Specific gravity	Not available.
Density	820 to 850 kg/m^3 (0.82 to 0.85 g/cm^3)
Solubility	Not available.

10 . Stability and reactivity

Stability	The product is stable.
Conditions to avoid	Avoid all possible sources of ignition (spark or flame).
Incompatibility with various substances/Hazardous Reactions	Reactive or incompatible with the following materials: oxidizing materials.
Hazardous decomposition products	Decomposition products may include the following materials: carbon dioxide carbon monoxide other hazardous substances.

11 . Toxicological information

Effects and symptoms

Eyes	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs. Vapour, mist or fume may cause eye irritation. Exposure to vapour, mist or fume may cause stinging, redness and watering of the eyes.
Skin	Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis.
Inhalation	May cause irritation of respiratory tract, coughing, shortness of breath.
Ingestion	Aspiration hazard if swallowed -- harmful or fatal if liquid is aspirated into lungs. Ingestion may cause gastrointestinal irritation and diarrhoea.

Chronic toxicity

Carcinogenic effects	POSSIBLE CANCER HAZARD - CONTAINS MATERIAL WHICH MAY CAUSE CANCER, BASED ON ANIMAL DATA. -- Carcinogenic Category 3 Risk of cancer depends on duration and level of exposure.
Mutagenic effects	No known significant effects or critical hazards.

12 . Ecological information

Ecotoxicity	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
<u>Biodegradability</u>	
Persistence/degradability	This product is inherently biodegradable.
Mobility	Spillages may penetrate the soil causing ground water contamination. This material may accumulate in sediments.
Bioaccumulative potential	This product is not expected to bioaccumulate through food chains in the environment.
Other ecological information	Spills may form a film on water surfaces causing physical damage to organisms. Oxygen transfer could also be impaired.

13 . Disposal considerations

Disposal considerations / Waste information	The generation of waste should be avoided or minimised wherever possible. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe way. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.
Special Precautions for Landfill or Incineration	Empty packages may contain some remaining product. Hazard warning labels are a guide to the safe handling of empty packaging and should not be removed.

14 . Transport information

International transport regulations

Regulatory information	UN number	Proper shipping name	Class	PG*	Label	Additional information
ADG Classification	Not regulated.	-	-	-	-----	**<u>Remarks</u>** Combustible liquid Class C1 (AS 1940).
IMDG Classification	UN 1202	DIESEL FUEL. Marine pollutant	3	III	 	Marine pollutant

Regulatory information	UN number	Proper shipping name	Class	PG*	Label	Additional information
IATA/ICAO Classification	UN 1202	DIESEL FUEL	3	III	 	**Remarks** Environmentally hazardous substance mark.

PG* : Packing group

Special precautions for user No known special precautions required. See Section: "Handling and storage" for additional information.

15 . Regulatory information

Standard for the Uniform Scheduling of Drugs and Poisons

5

Control of Scheduled Carcinogenic Substances

Ingredient name	Schedule
No Listed Substance	

Australia Regulations Labelling requirements for SUSDP do not apply to a poison that is packed and sold solely for industrial, laboratory or manufacturing use. However, this product is labelled in accordance with NOSHC National Code of Practice for labelling of workplace substances.

Other regulations

Europe inventory	Not determined.
United States inventory (TSCA 8b)	Not determined.
Australia inventory (AICS)	All components are listed or exempted.
Canada inventory	Not determined.
China inventory (IECSC)	Not determined.
Japan inventory (ENCS)	Not determined.
Korea inventory (KECI)	Not determined.
Philippines inventory (PICCS)	At least one component is not listed.

16 . Other information

Key to abbreviations

AMP = Acceptable Maximum Peak
ACGIH = American Conference of Governmental Industrial Hygienists, an agency that promulgates exposure standards.
ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail
ADG Code = Australian Code for the Transport of Dangerous Goods by Road and Rail
CAS Number = Chemical Abstracts Service Registry Number
HAZCHEM Code = Emergency action code of numbers and letters which gives information to emergency services. Its use is required by the ADG Code for Dangerous Goods in bulk.
ICAO = International Civil Aviation Organization.
IATA = International Air Transport Association, the organization promulgating rules governing shipment of goods by air.
IMDG = International Maritime Organization Rules, rules governing shipment of goods by water.
IP 346 = A chemical screening assay for dermal toxicity. The European Commission has recommended that Method IP 346 be used as the basis for labelling certain lubricant oil base stocks for carcinogenicity. The EU Commission has stipulated that the classification as a carcinogen need not apply if it can be shown that the substance contains less than 3% DMSO extract as measured by IP 346. (See Note L, European Commission Directive 67/548/EEC as amended and adapted.) DMSO is a solvent.
NOHSC = National Occupational Health & Safety Commission, Australia
TWA = Time weighted average
STEL = Short term exposure limit
UN Number = United Nations Number, a four digit number assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods.

History

Date of issue	19/08/2010.
Date of previous issue	29/05/2007.
Prepared by	Product Stewardship

Notice to reader

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.

The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from us.

It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken.

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SAFETY DATA SHEET

Issuing Date January 5, 2015 **Revision Date** June 12, 2015 **Revision Number** 1

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product identifier

Product Name	**Clorox® Regular-Bleach$_1$**

Other means of identification

EPA Registration Number	5813-100

Recommended use of the chemical and restrictions on use

Recommended use	Household disinfecting, sanitizing, and laundry bleach
Uses advised against	No information available

Details of the supplier of the safety data sheet

Supplier Address
The Clorox Company
1221 Broadway
Oakland, CA 94612

Phone: 1-510-271-7000

Emergency telephone number

Emergency Phone Numbers	For Medical Emergencies, call: 1-800-446-1014 For Transportation Emergencies, call Chemtrec: 1-800-424-9300

2. HAZARDS IDENTIFICATION

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

Skin corrosion/irritation	Category 1
Serious eye damage/eye irritation	Category 1

GHS Label elements, including precautionary statements

Emergency Overview

Signal word **Danger**

Hazard Statements
Causes severe skin burns and eye damage
Causes serious eye damage

Appearance Clear, pale yellow **Physical State** Thin liquid **Odor** Bleach

Precautionary Statements - Prevention

Wash face, hands and any exposed skin thoroughly after handling.
Wear protective gloves, protective clothing, face protection, and eye protection such as safety glasses.

Precautionary Statements - Response

Immediately call a poison center or doctor.
If swallowed: Rinse mouth. Do NOT induce vomiting.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
Wash contaminated clothing before reuse.
If inhaled: Remove person to fresh air and keep comfortable for breathing.
Specific treatment (see supplemental first aid instructions on this label).
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Precautionary Statements - Storage

Store locked up.

Precautionary Statements - Disposal

Dispose of contents in accordance with all applicable federal, state, and local regulations.

Hazards not otherwise classified (HNOC)

Although not expected, heart conditions or chronic respiratory problems such as asthma, chronic bronchitis, or obstructive lung disease may be aggravated by exposure to high concentrations of vapor or mist.

Product contains a strong oxidizer. Always flush drains before and after use.

Unknown Toxicity
Not applicable.

Other information
Very toxic to aquatic life with long lasting effects.

Interactions with Other Chemicals
Reacts with other household chemicals such as toilet bowl cleaners, rust removers, acids, or products containing ammonia to produce hazardous irritating gases, such as chlorine and other chlorinated compounds.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No	Weight %	Trade Secret
Sodium hypochlorite	7681-52-9	5 - 10	*

* The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

First aid measures

General Advice	Call a poison control center or doctor immediately for treatment advice. Show this safety data sheet to the doctor in attendance.
Eye Contact	Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Skin Contact	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
Inhalation	Move to fresh air. If breathing is affected, call a doctor.
Ingestion	Have person sip a glassful of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person. Call a poison control center or doctor immediately for treatment advice.
Protection of First-aiders	Avoid contact with skin, eyes, and clothing. Use personal protective equipment as required. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed

Most Important Symptoms and Effects	Burning of eyes and skin.

Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically. Probable mucosal damage may contraindicate the use of gastric lavage.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
CAUTION: Use of water spray when fighting fire may be inefficient.

Specific Hazards Arising from the Chemical
This product causes burns to eyes, skin, and mucous membranes. Thermal decomposition can release sodium chlorate and irritating gases and vapors.

Explosion Data

Sensitivity to Mechanical Impact	None.
Sensitivity to Static Discharge	None.

Protective equipment and precautions for firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal Precautions	Avoid contact with eyes, skin, and clothing. Ensure adequate ventilation. Use personal protective equipment as required. For spills of multiple products, responders should evaluate the MSDSs of the products for incompatibility with sodium hypochlorite. Breathing protection should be worn in enclosed and/or poorly-ventilated areas until hazard assessment is complete.
Other Information	Refer to protective measures listed in Sections 7 and 8.

Environmental precautions

Environmental Precautions	This product is toxic to fish, aquatic invertebrates, oysters, and shrimp. Do not allow product to enter storm drains, lakes, or streams. See Section 12 for ecological Information.

Methods and material for containment and cleaning up

Methods for Containment	Prevent further leakage or spillage if safe to do so.
Methods for Cleaning Up	Absorb and containerize. Wash residual down to sanitary sewer. Contact the sanitary treatment facility in advance to assure ability to process washed-down material.

7. HANDLING AND STORAGE

Precautions for safe handling

Handling Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes, and clothing. Do not eat, drink, or smoke when using this product.

Conditions for safe storage, including any incompatibilities

Storage Store away from children. Reclose cap tightly after each use. Store this product upright in a cool, dry area, away from direct sunlight and heat to avoid deterioration. Do not contaminate food or feed by storage of this product.

Incompatible Products Toilet bowl cleaners, rust removers, acids, and products containing ammonia.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Sodium hypochlorite 7681-52-9	None	None	None

ACGIH TLV: American Conference of Governmental Industrial Hygienists - Threshold Limit Value. OSHA PEL: Occupational Safety and Health Administration - Permissible Exposure Limits. NIOSH IDLH: Immediately Dangerous to Life or Health.

Appropriate engineering controls

Engineering Measures

- Showers
- Eyewash stations
- Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/Face Protection If splashes are likely to occur: Wear safety glasses with side shields (or goggles) or face shield.

Skin and Body Protection Wear rubber or neoprene gloves and protective clothing such as long-sleeved shirt.

Respiratory Protection If irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice. Wash hands after direct contact. Do not wear product-contaminated clothing for prolonged periods. Remove and wash contaminated clothing before re-use. Do not eat, drink, or smoke when using this product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical and Chemical Properties

Physical State	Thin liquid		
Appearance	Clear	**Odor**	Bleach
Color	Pale yellow	**Odor Threshold**	No information available

Property	**Values**	**Remarks/ Method**
pH	~12	None known
Melting/freezing point	No data available	None known
Boiling point / boiling range	No data available	None known
Flash Point	Not flammable	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limits in Air		
Upper flammability limit	No data available	None known
Lower flammability limit	No data available	None known
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Specific Gravity	~1.1	None known
Water Solubility	Soluble	None known
Solubility in other solvents	No data available	None known
Partition coefficient: n-octanol/water	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known
Explosive Properties	Not explosive	
Oxidizing Properties	No data available	

Other Information

Softening Point	No data available
VOC Content (%)	No data available
Particle Size	No data available
Particle Size Distribution	No data available

10. STABILITY AND REACTIVITY

Reactivity

Reacts with other household chemicals such as toilet bowl cleaners, rust removers, acids, or products containing ammonia to produce hazardous irritating gases, such as chlorine and other chlorinated compounds.

Chemical stability

Stable under recommended storage conditions.

Possibility of Hazardous Reactions

None under normal processing.

Conditions to avoid

None known based on information supplied.

Incompatible materials

Toilet bowl cleaners, rust removers, acids, and products containing ammonia.

Hazardous Decomposition Products

None known based on information supplied.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Product Information .

Inhalation Exposure to vapor or mist may irritate respiratory tract and cause coughing. Inhalation of high concentrations may cause pulmonary edema.

Eye Contact Corrosive. May cause severe damage to eyes.

Skin Contact May cause severe irritation to skin. Prolonged contact may cause burns to skin.

Ingestion Ingestion may cause burns to gastrointestinal tract and respiratory tract, nausea, vomiting, and diarrhea.

Component Information

Chemical Name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium hypochlorite 7681-52-9	8200 mg/kg (Rat)	>10000 mg/kg (Rabbit)	-

Information on toxicological effects

Symptoms May cause redness and tearing of the eyes. May cause burns to eyes. May cause redness or burns to skin. Inhalation may cause coughing.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization No information available.

Mutagenic Effects No information available.

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
Sodium hypochlorite 7681-52-9	-	Group 3	-	-

IARC (International Agency for Research on Cancer)
Group 3 - Not Classifiable as to Carcinogenicity in Humans

Reproductive Toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.
Chronic Toxicity Carcinogenic potential is unknown.
Target Organ Effects Respiratory system, eyes, skin, gastrointestinal tract (GI).

Aspiration Hazard No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)
54 g/kg
ATEmix (inhalation-dust/mist)
58 mg/L

12. ECOLOGICAL INFORMATION

Ecotoxicity
Very toxic to aquatic life with long lasting effects.

This product is toxic to fish, aquatic invertebrates, oysters, and shrimp. Do not allow product to enter storm drains, lakes, or streams.

Persistence and Degradability
No information available.

Bioaccumulation
No information available.

Other adverse effects
No information available.

13. DISPOSAL CONSIDERATIONS

Disposal methods
Dispose of in accordance with all applicable federal, state, and local regulations. Do not contaminate food or feed by disposal of this product.

Contaminated Packaging
Do not reuse empty containers. Dispose of in accordance with all applicable federal, state, and local regulations.

14. TRANSPORT INFORMATION

DOT	Not restricted.
TDG	Not restricted for road or rail.
ICAO	Not restricted, as per Special Provision A197, Environmentally Hazardous Substance exception.
IATA	Not restricted, as per Special Provision A197, Environmentally Hazardous Substance exception.
IMDG/IMO	Not restricted, as per IMDG Code 2.10.2.7, Marine Pollutant exception.

15. REGULATORY INFORMATION

Chemical Inventories

TSCA	All components of this product are either on the TSCA 8(b) Inventory or otherwise exempt from listing.
DSL/NDSL	All components are on the DSL or NDSL.

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

U.S. Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
This product contains the following substances which are regulated pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

Chemical Name	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants	CWA - Hazardous Substances
Sodium hypochlorite 7681-52-9	100 lb			X

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Chemical Name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	RQ
Sodium hypochlorite 7681-52-9	100 lb	-	RQ 100 lb final RQ RQ 45.4 kg final RQ

EPA Statement
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets and for workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

> **DANGER: CORROSIVE.** Causes irreversible eye damage and skin burns. Harmful if swallowed. Do not get in eyes, on skin, or on clothing. Wear protective eyewear and rubber gloves when handling this product. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the restroom. Avoid breathing vapors and use only in a well-ventilated area.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical Name	New Jersey	Massachusetts	Pennsylvania	Rhode Island	Illinois
Sodium hypochlorite 7681-52-9	X	X	X	X	
Sodium chlorate 7775-09-9	X	X	X		

International Regulations

Canada
WHMIS Hazard Class
E - Corrosive material

16. OTHER INFORMATION

NFPA	**Health Hazard** 3	**Flammability** 0	**Instability** 0	**Physical and Chemical Hazards** -
HMIS	**Health Hazard** 3	**Flammability** 0	**Physical Hazard** 0	**Personal Protection** B

Prepared By

Product Stewardship
23 British American Blvd.
Latham, NY 12110
1-800-572-6501

Revision Date June 12, 2015

Revision Note Revision Section 14.

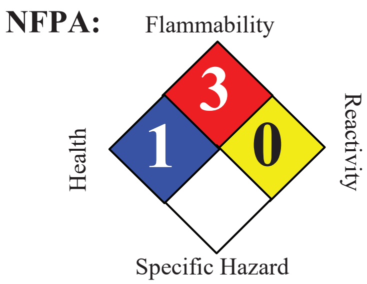
Reference 1096036/164964.159

General Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal, and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

Safety Data Sheet
Gasoline, Unleaded



TESORO

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Gasoline, Unleaded

Synonyms : Blend of Highly Flammable Petroleum Distillates, Regular, Mid-Grade, Premium, 888100008809

SDS Number : 888100008809 **Version** : 1.1

Product Use Description : Fuel

Company : For: Tesoro Refining & Marketing Co.
19100 Ridgewood Parkway, San Antonio, TX 78259

Tesoro Call Center : (877) 783-7676 **Chemtrec (Emergency Contact)** : (800) 424-9300

SECTION 2. HAZARDS IDENTIFICATION

Classifications : Flammable Liquid – Category 1 or 2 depending on formulation.
Aspiration Hazard – Category 1
Carcinogenicity – Category 2
Specific Target Organ Toxicity (Repeated Exposure) – Category 2
Specific Target Organ Toxicity (Single Exposure) – Category 3
Skin Irritation – Category 2
Eye Irritation – Category 2B
Chronic Aquatic Toxicity – Category 2

Pictograms :

Signal Word : **Danger**

Hazard Statements

Extremely flammable liquid and vapor.
May be fatal if swallowed and enters airways – do not siphon gasoline by mouth.
Suspected of causing blood cancer if repeated over-exposure by inhalation and/or skin contact occurs.
May cause damage to liver, kidneys and nervous system by repeated and prolonged inhalation or skin contact. Causes eye irritation. Can be absorbed through skin.
May cause drowsiness or dizziness. Extreme exposure such as intentional inhalation may cause unconsciousness, asphyxiation and death.
Repeated or prolonged skin contact can cause irritation and dermatitis.

Harmful to aquatic life.

Precautionary statements

Prevention : Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep away from heat, sparks, open flames, welding and hot surfaces.
No smoking.
Keep container tightly closed.
Ground and/or bond container and receiving equipment.
Use explosion-proof electrical equipment.
Use only non-sparking tools (if tools are used in flammable atmosphere).
Take precautionary measures against static discharge.
Wear gloves, eye protection and face protection (as needed to prevent skin and eye contact with liquid).
Wash hands or liquid-contacted skin thoroughly after handling.
Do not eat, drink or smoke when using this product.
Do not breathe vapors.
Use only outdoors or in a well-ventilated area.

Response : In case of fire: Use dry chemical, CO2, water spray or fire fighting foam to extinguish.
If swallowed: Immediately call a poison center, doctor, hospital emergency room, medical clinic or 911. Do NOT induce vomiting. Rinse mouth.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
If in eye: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
If skin or eye irritation persists, get medical attention.
If inhaled: Remove person to fresh air and keep comfortable for breathing.
Get medical attention if you feel unwell.

Storage : Store in a well ventilated place. Keep cool. Store locked up. Keep container tightly closed . Use only approved containers. Some containers not approved for gasoline may dissolve and release flammable gasoline liquid and vapors.

Disposal : Dispose of contents/containers to approved disposal site in accordance with local, regional, national, and/or international regulations.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No.	Weight %
Gasoline, natural; Low boiling point naphtha	8006-61-9	10 - 30%
Toluene	108-88-3	10 - 30%
Xylene	1330-20-7	10 - 30%
Ethanol; ethyl alcohol	64-17-5	0-8.2%
Trimethylbenzene	25551-13-7	1 - 5%
Isopentane; 2-methylbutane	78-78-4	1 - 5%

Naphthalene	91-20-3	1 - 5%
Benzene	71-43-2	Less than 1.3%
Pentane	109-66-0	1 - 5%
Cyclohexane	110-82-7	1 - 5%
Ethylbenzene	100-41-4	1 - 5%
Butane	106-97-8	1 - 20%
Heptane [and isomers]	142-82-5	0.5 - 0.75%
N-hexane	110-54-3	0.5 - 0.75%

SECTION 4. FIRST AID MEASURES

Inhalation	:	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical attention immediately.
Skin contact	:	In case of contact, immediately flush skin with plenty of water. Take off contaminated clothing and shoes immediately. Wash contaminated clothing before re-use. Contaminated leather, particularly footwear, must be discarded. Note that contaminated clothing may be a fire hazard. Seek medical advice if symptoms persist or develop.
Eye contact	:	Remove contact lenses. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Seek medical advice if symptoms persist or develop.
Ingestion	:	Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Obtain medical attention.
Notes to physician	:	Symptoms: Dizziness, Discomfort, Headache, Nausea, Kidney disorders, Liver disorders. Aspiration may cause pulmonary edema and pneumonitis. Swallowing gasoline is more likely to be fatal for small children than adults, even if aspiration does not occur.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray or fire fighting foam. LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers. Keep containers and surroundings cool with water spray.
Specific hazards during fire fighting	:	Extremely flammable liquid and vapor. This material is combustible/flammable and is sensitive to fire, heat, and static discharge.
Special protective equipment for fire-fighters	:	Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Further information	:	Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam. Exposure to decomposition products may be a hazard to health. Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Use water spray to cool unopened containers. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Evacuate personnel to safe areas. Ventilate the area. Remove all sources of ignition. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).
Environmental precautions	:	Discharge into the environment must be avoided. If the product contaminates rivers and lakes or drains inform respective authorities.
Methods for cleaning up	:	Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations.

SECTION 7. HANDLING AND STORAGE

Precautions for safe handling	:	Keep away from fire, sparks and heated surfaces. No smoking near areas where material is stored or handled. The product should only be stored and handled in areas with intrinsically safe electrical classification. Hydrocarbon liquids including this product can act as a non-conductive flammable liquid (or static accumulators), and may form ignitable vapor-air mixtures in storage tanks or other containers. Precautions to prevent static-initated fire or explosion during transfer, storage or handling, include but are not limited to these examples: (1) Ground and bond containers during product transfers. Grounding and bonding may not be adequate protection to prevent ignition or explosion of hydrocarbon liquids and vapors that are static accumulators. (2) Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil or diesel) is loaded into tanks previously containing low flash point products (such gasoline or naphtha). (3) Storage tank level floats must be effectively bonded. For more information on precautions to prevent static-initated fire or explosion, see NFPA 77, Recommended Practice on Static Electricity (2007), and API Recommended Practice 2003, Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents (2008).
Conditions for safe storage, including incompatibilities	:	Keep away from flame, sparks, excessive temperatures and open flame. Use approved containers. Keep containers closed and clearly labeled. Empty or partially full product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose containers to sources of ignition. Store in a well-ventilated area. The storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

Reports suggest that government-mandated ethanol, if present, may not be compatible with fiberglass gasoline tanks. Ethanol may dissolve fiberglass resin, causing engine damage and possibly allow leakage of explosive gasoline.

Keep away from food, drink and animal feed. Incompatible with oxidizing agents. Incompatible with acids.

No decomposition if stored and applied as directed. Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Store only in containers approved and labeled for gasoline.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

List	Components	CAS-No.	Type:	Value
OSHA	Benzene	71-43-2	TWA	1 ppm
		71-43-2	STEL	5 ppm
		71-43-2	OSHA_ACT	0.5 ppm
OSHA Z1	Xylene	1330-20-7	PEL	100 ppm 435 mg/m3
	Ethanol; Ethyl alcohol	64-17-5	PEL	1,000 ppm 1,900 mg/m3
	Naphthalene	91-20-3	PEL	10 ppm 50 mg/m3
	Cyclohexane	110-82-7	PEL	300 ppm 1,050 mg/m3
	Ethylbenzene	100-41-4	PEL	100 ppm 435 mg/m3
	Heptane [and isomers]	142-82-5	PEL	500 ppm 2,000 mg/m3
	N-hexane	110-54-3	PEL	500 ppm 1,800 mg/m3
ACGIH	Toluene	108-88-3	TWA	50 ppm
	Xylene	1330-20-7	TWA	100 ppm
		1330-20-7	STEL	150 ppm
	Ethanol; Ethyl alcohol	64-17-5	TWA	1,000 ppm
	Trimethylbenzene	25551-13-7	TWA	25 ppm
	Isopentane; 2-Methylbutane	78-78-4	TWA	600 ppm
	Naphthalene	91-20-3	TWA	10 ppm
		91-20-3	STEL	15 ppm
	Benzene	71-43-2	TWA	0.5 ppm
		71-43-2	STEL	2.5 ppm
	Pentane	109-66-0	TWA	600 ppm
	Cyclohexane	110-82-7	TWA	100 ppm
	Ethylbenzene	100-41-4	TWA	100 ppm
		100-41-4	STEL	125 ppm
	Heptane [and isomers]	142-82-5	TWA	400 ppm
		142-82-5	STEL	500 ppm

	N-hexane	110-54-3	TWA	50 ppm

Engineering measures : Use adequate ventilation to keep gas and vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces. Use only intrinsically safe electrical equipment approved for use in classified areas.

Eye protection : Safety glasses or goggles are recommended where there is a possibility of splashing or spraying. Ensure that eyewash stations and safety showers are close to the workstation location.

Hand protection : Gloves constructed of nitrile or neoprene are recommended. Consult manufacturer specifications for further information.

Skin and body protection : If needed to prevent skin contact, chemical protective clothing such as of DuPont TyChem®, Saranex or equivalent recommended based on degree of exposure. Flame resistant clothing such as Nomex ® is recommended in areas where material is stored or handled.

Respiratory protection : A NIOSH/ MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection. Use a NIOSH/ MSHA-approved positive-pressure supplied-air respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Work / Hygiene practices : Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : Clear to straw colored liquid

Odor : Characteristic hydrocarbon-like

Odor threshold 0.5 - 1.1 ppm

pH : Not applicable

Melting point/freezing point About -101°C (-150°F)

Initial boiling point & range Boiling point varies: 30 – 200°C (85 – 392°F)

Flash point < -21°C (-5.8°F)

Evaporation rate : Higher initially and declining as lighter components evaporate

Flammability (solid, gas) : Flammable vapor released by liquid

Upper explosive limit	7.6 %(V)
Lower explosive limit	1.3 %(V)
Vapor pressure	345 - 1,034 hPa at 37.8 °C (100.0 °F)
Vapor density (air = 1)	Approximately 3 to 4
Relative density (water = 1)	0.8 g/mL
Solubility (in water)	Negligible
Partition coefficient (n-octanol/water)	2 – 7 as log Pow
Auto-ignition temperature	Approximately 250°C (480°F)
Decomposition temperature	Will evaporate or boil and possibly ignite before decomposition occurs.
Kinematic viscosity	0.64 to 0.88 mm²/s range reported for gasoline
Conductivity (conductivity can be reduced by environmental factors such as a decrease in temperature)	: Hydrocarbon liquids without static dissipater additive may have conductivity below 1 picoSiemens per meter (pS/m). The highest electro-static ignition risks are associated with ”ultra-low conductivities” below 5 pS/m. See Section 7 for sources of information on defining safe loading and handling procedures for low conductivity products.

SECTION 10. STABILITY AND REACTIVITY

Reactivity	: Vapors may form explosive mixture with air. Hazardous polymerization does not occur.
Chemical stability	: Stable under normal conditions.
Possibility of hazardous reactions	Can react with strong oxidizing agents, peroxides, alkaline products and strong acids. Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.
Conditions to avoid	: Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources. Avoid static charge accumulation and discharge (see Section 7).
Hazardous decomposition products	: Ignition and burning can release carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

SECTION 11. TOXICOLOGICAL INFORMATION

Skin contact	: Irritating to skin. Can be partially absorbed through skin.
Eye contact	: Irritating to eyes.
Ingestion	: Aspiration hazard if liquid is inhaled into lungs, particularly from vomiting after ingestion. Aspiration may result in chemical pneumonia, severe lung damage, respiratory failure and even death. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest and death may occur.

Inhalation and further information

Acute toxicity of benzene results primarily from depression of the central nervous system (CNS). Inhalation of concentrations over 50 ppm can produce headache, lassitude, weariness, dizziness, drowsiness, over excitation. Exposure to very high levels can result in unconsciousness and death.

Repeated over-exposure may cause liver and kidney injuries.
Components of the product may affect the nervous system.

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.
This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

Component:

Gasoline, natural; Low boiling point naphtha	8006-61-9	Acute oral toxicity: LD50 rat Dose: 18.8 mg/kg Acute inhalation toxicity: LC50 rat Dose: 20.7 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Eye irritation: Classification: Irritating to eyes. Result: Moderate eye irritation
Toluene	108-88-3	Acute oral toxicity: LD50 rat Dose: 636 mg/kg Acute dermal toxicity: LD50 rabbit Dose: 12,124 mg/kg Acute inhalation toxicity: LC50 rat Dose: 49 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Prolonged skin contact may defat the skin and produce dermatitis. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
Xylene	1330-20-7	Acute oral toxicity: LD50 rat Dose: 2,840 mg/kg Acute dermal toxicity: LD50 rabbit Dose: ca. 4,500 mg/kg Acute inhalation toxicity: LC50 rat Dose: 6,350 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation

		Repeated or prolonged exposure may cause skin irritation and dermatitis, due to degreasing properties of the product. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
Ethanol; Ethyl alcohol	64-17-5	Acute oral toxicity: LD50 rat Dose: 6,200 mg/kg Acute dermal toxicity: LD50 rabbit Dose: 19,999 mg/kg Acute inhalation toxicity: LC50 rat Dose: 8,001 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Prolonged skin contact may cause skin irritation and/or dermatitis. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation Mild eye irritation
Naphthalene	91-20-3	Acute oral toxicity: LD50 rat Dose: 2,001 mg/kg Acute dermal toxicity: LD50 rat Dose: 2,501 mg/kg Acute inhalation toxicity: LC50 rat Dose: 101 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation Carcinogenicity: N11.00422130
Benzene	71-43-2	Acute oral toxicity: LD50 rat Dose: 930 mg/kg Acute inhalation toxicity: LC50 rat Dose: 44 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Repeated or prolonged exposure may cause skin irritation and dermatitis, due to degreasing properties of the product. Eye irritation: Classification: Irritating to eyes. Result: Risk of serious damage to eyes.
Pentane	109-66-0	Acute oral toxicity: LD50 rat Dose: 2,001 mg/kg Acute inhalation toxicity: LC50 rat Dose: 364 mg/l Exposure time: 4 h Skin irritation: Repeated or prolonged exposure may cause skin irritation and dermatitis, due to degreasing properties of the product. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
Cyclohexane	110-82-7	Acute dermal toxicity: LD50 rabbit Dose: 2,001 mg/kg Acute inhalation toxicity: LC50 rat Dose: 14 mg/l Exposure time: 4 h

		Skin irritation: Classification: Irritating to skin. Result: Skin irritation Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
Ethylbenzene	100-41-4	Acute oral toxicity: LD50 rat Dose: 3,500 mg/kg Acute dermal toxicity: LD50 rabbit Dose: 15,500 mg/kg Acute inhalation toxicity: LC50 rat Dose: 18 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Eye irritation: Classification: Irritating to eyes. Result: Risk of serious damage to eyes.
Heptane [and isomers]	142-82-5	Acute oral toxicity: LD50 rat Dose: 15,001 mg/kg Acute inhalation toxicity: LC50 rat Dose: 103 g/m3 Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Skin irritation Repeated or prolonged exposure may cause skin irritation and dermatitis, due to degreasing properties of the product. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
N-hexane	110-54-3	Acute oral toxicity: LD50 rat Dose: 25,000 mg/kg Acute dermal toxicity: LD50 rabbit Dose: 2,001 mg/kg Acute inhalation toxicity: LC50 rat Dose: 171.6 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Skin irritation Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation Teratogenicity: N11.00418960

Carcinogenicity

NTP : Naphthalene (CAS-No.: 91-20-3)
Benzene (CAS-No.: 71-43-2)

IARC : Gasoline, natural; Low boiling point naphtha (CAS-No.: 8006-61-9)
Naphthalene (CAS-No.: 91-20-3)
Benzene (CAS-No.: 71-43-2)
Ethylbenzene (CAS-No.: 100-41-4)

OSHA : Benzene (CAS-No.: 71-43-2)

CA Prop 65 : WARNING! This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.
Toluene (CAS-No.: 108-88-3)

Benzene (CAS-No.: 71-43-2)

SECTION 12. ECOLOGICAL INFORMATION

Additional ecological information : Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federal and State regulations.

Component:

Toluene	108-88-3	Toxicity to fish: LC50 Species: Carassius auratus (goldfish) Dose: 13 mg/l Exposure time: 96 h Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 11.5 mg/l Exposure time: 48 h Toxicity to algae: IC50 Species: Selenastrum capricornutum (green algae) Dose: 12 mg/l Exposure time: 72 h
Ethanol; Ethyl alcohol	64-17-5	Toxicity to fish: LC50 Species: Leuciscus idus (Golden orfe) Dose: 8,140 mg/l Exposure time: 48 h Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 9,268 - 14,221 mg/l Exposure time: 48 h
Isopentane; 2-Methylbutane	78-78-4	Toxicity to fish: LC50 Species: Oncorhynchus mykiss (rainbow trout) Dose: 3.1 mg/l Exposure time: 96 h Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 2.3 mg/l Exposure time: 96 h
Naphthalene	91-20-3	Toxicity to algae: EC50 Species: Dose: 33 mg/l Exposure time: 24 h
Pentane	109-66-0	Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 9.74 mg/l Exposure time: 48 h
Cyclohexane	110-82-7	Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 3.78 mg/l Exposure time: 48 h

Heptane [and isomers]	142-82-5	Toxicity to fish: LC50 Species: Carassius auratus (goldfish) Dose: 4 mg/l Exposure time: 24 h Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 1.5 mg/l Exposure time: 48 h
N-hexane	110-54-3	Toxicity to fish: LC50 Species: Pimephales promelas (fathead minnow) Dose: 2.5 mg/l Exposure time: 96 h Acute and prolonged toxicity for aquatic invertebrates: EC50 Species: Daphnia magna (Water flea) Dose: 2.1 mg/l Exposure time: 48 h

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal : Dispose of container and unused contents in accordance with federal, state and local requirements.

SECTION 14. TRANSPORT INFORMATION

CFR

Proper shipping name : Petrol
UN-No. : 1203
Class : 3
Packing group : II

TDG

Proper shipping name : Gasoline
UN-No. : UN1203
Class : 3
Packing group : II

IATA Cargo Transport

UN UN-No. : UN1203
Description of the goods : Gasoline
Class : 3
Packaging group : II
ICAO-Labels : 3
Packing instruction (cargo aircraft) : 364
Packing instruction (cargo aircraft) : Y341

IATA Passenger Transport

UN UN-No. : UN1203
Description of the goods : Gasoline
Class : 3

Packaging group : II
ICAO-Labels : 3
Packing instruction (passenger aircraft) : 353
Packing instruction (passenger aircraft) : Y341

IMDG-Code

UN-No. : UN 1203
Description of the goods : Gasoline
Class : 3
Packaging group : II
IMDG-Labels : 3
EmS Number : F-E S-E
Marine pollutant : No

SECTION 15. REGULATORY INFORMATION

OSHA Hazards : Flammable liquid
Highly toxic by ingestion
Moderate skin irritant
Severe eye irritant
Carcinogen

TSCA Status : On TSCA Inventory

DSL Status : . All components are on the Canadian DSL list.

SARA 311/312 Hazards : Fire Hazard
Acute Health Hazard
Chronic Health Hazard

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIROMENT)

The CERCLA definition of hazardous substances contains a “petroleum exclusion” clause which exempts crude oil. Fractions of crude oil, and products (both finished and intermediate) from the crude oil refining process and any indigenous components of such from the CERCLA Section 103 reporting requirements. However, other federal reporting requirements, including SARA Section 304, as well as the Clean Water Act may still apply.

California Prop. 65 : WARNING! This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

Toluene	108-88-3
Benzene	71-43-2

SECTION 16. OTHER INFORMATION

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

6, 8, 10, 12, 14, 16, 64, 68, 91, 112, 306, 1092, 1106, 1500, 1570, 1571, 1651, 1652, 1654, 1700, 1701, 1702, 1710, 1711, 1714, 1726, 1729, 1730, 1732, 1733, 1826, 1848, 1880, 1950

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 05/17/2017 **Revision** : 05/17/2017

Trade Name: Liquinox

1 Identification of the substance/mixture and of the supplier

1.1 Product identifier

Trade Name: Liquinox
Synonyms:
Product number: 1232-1, 1232, 1201-1, 1201, 1205, 1215, 1255

1.2 Application of the substance / the mixture : Cleaning material/Detergent

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer **Supplier**
Alconox, Inc.
30 Glenn Street
White Plains, NY 10603
1-914-948-4040

Emergency telephone number:
ChemTel Inc
North America: 1-800-255-3924
International: 01-813-248-0585

2 Hazards identification

2.1 Classification of the substance or mixture:

In compliance with EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments.

Hazard-determining components of labeling:

Alcohol ethoxylate
Sodium alkylbenzene sulfonate
Sodium xylenesulphonate
Lauramine oxide

2.2 Label elements:

Eye irritation, category 2A.
Skin irritation, category 2.

Hazard pictograms:

Signal word: Warning

Hazard statements:

H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Additional information: None.

Hazard description

Hazards Not Otherwise Classified (HNOC): None

Information concerning particular hazards for humans and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments, and extended by company and literature data. The classification is in accordance with the latest editions of international substances lists, and is supplemented by information from technical literature and by information provided by the company.

3 Composition/information on ingredients

3.1 Chemical characterization : None

3.2 Description : None

3.3 Hazardous components (percentages by weight)

Identification	Chemical Name	Classification	Wt. %
CAS number: 68081-81-2	Sodium Alkylbenzene Sulfonate	Acute Tox. 4; H303 Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	10-25
CAS number: 1300-72-7	Sodium Xylenesulphonate	Eye Irrit. 2; H319	2.5-10
CAS number: 84133-50-6	Alcohol Ethoxylate	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	2.5-10
CAS number: 1643-20-5	Lauramine oxide	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	1-2

3.4 Additional Information: None.

4 First aid measures

4.1 Description of first aid measures

General information: None.

After inhalation:

Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:

Wash affected area with soap and water.
Seek medical attention if symptoms develop or persist.

After eye contact:

Rinse/flush exposed eye(s) gently using water for 15-20 minutes.

Remove contact lens(es) if able to do so during rinsing.
Seek medical attention if irritation persists or if concerned.

After swallowing:

Rinse mouth thoroughly.
Seek medical attention if irritation, discomfort, or vomiting persists.

4.2 Most important symptoms and effects, both acute and delayed

None

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information.

5 Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:

Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition.

For safety reasons unsuitable extinguishing agents : None

5.2 Special hazards arising from the substance or mixture :

Thermal decomposition can lead to release of irritating gases and vapors.

5.3 Advice for firefighters

Protective equipment:

Wear protective eye wear, gloves and clothing.
Refer to Section 8.

5.4 Additional information :

Avoid inhaling gases, fumes, dust, mist, vapor and aerosols.
Avoid contact with skin, eyes and clothing.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures :

Ensure adequate ventilation.
Ensure air handling systems are operational.

6.2 Environmental precautions :

Should not be released into the environment.
Prevent from reaching drains, sewer or waterway.

6.3 Methods and material for containment and cleaning up :

Wear protective eye wear, gloves and clothing.

6.4 Reference to other sections : None

7 Handling and storage

7.1 Precautions for safe handling :

Avoid breathing mist or vapor.
Do not eat, drink, smoke or use personal products when handling chemical substances.

Conditions for safe storage, including any incompatibilities:

Store closed upright and in a cool dry place, should be 15 - 30 deg C or 60 - 90 deg F.

7.2 Specific end use(s):

No additional information.

8 Exposure controls/personal protection

8.1 Control parameters :

No applicable occupational exposure limits

8.2 Exposure controls

Appropriate engineering controls:

Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling.

Respiratory protection:

Not needed under normal conditions.

Protection of skin:

Select glove material impermeable and resistant to the substance.

Eye protection:

Safety goggles or glasses, or appropriate eye protection.

General hygienic measures:

Wash hands before breaks and at the end of work.
Avoid contact with skin, eyes and clothing.

9 Physical and chemical properties

Appearance (physical state, color):	Pale yellow liquid	**Explosion limit lower**: **Explosion limit upper**:	Not determined or not available. Not determined or not available.
Odor:	Not determined or not available.	**Vapor pressure at 20°C**:	Not determined or not available.
Odor threshold:	Not determined or not available.	**Vapor density**:	Not determined or not available.
pH-value:	8.5 as is	**Relative density**:	Not determined or not available.
Melting/Freezing point:	Not determined or not available.	**Solubilities**:	Not determined or not available.
Boiling point/Boiling range:	Not determined or not available.	**Partition coefficient (n-octanol/water)**:	Not determined or not available.
Flash point (closed cup):	Not determined or not available.	**Auto/Self-ignition temperature**:	Not determined or not available.
Evaporation rate:	Not determined or not available.	**Decomposition temperature**:	Not determined or not available.
Flammability (solid, gaseous):	Not determined or not available.	**Viscosity**:	a. Kinematic: Not determined or not available. b. Dynamic: Not determined or not available.

Trade Name: Liquinox	
Density at 20°C:	Not determined or not available.

10 Stability and reactivity

10.1 Reactivity : None

10.2 Chemical stability : None

10.3 Possibility hazardous reactions : None

10.4 Conditions to avoid : None

10.5 Incompatible materials : None

10.6 Hazardous decomposition products : None

11 Toxicological information

11.1 Information on toxicological effects :

Acute Toxicity:

Oral:

: LD50 >5000 mg per kg Rat, Oral) - product .

Chronic Toxicity: No additional information.

Skin corrosion/irritation:

Alcohol Ethoxylate: May cause mild to moderate skin irritation.

Sodium Alkylbenzene Sulfonate: Causes skin irritation.

Lauramine oxide: Causes skin irritation.

Serious eye damage/irritation:

Sodium Alkylbenzene Sulfonate: Causes serious eye irritation.

Alcohol Ethoxylate: Causes moderate to severe eye irritation and conjunctivitis.

Sodium xylenesulphonate: Rabbit: irritating to eyes.

Lauramine oxide: Causes serious eye damage.

Respiratory or skin sensitization: No additional information.

Carcinogenicity: No additional information.

IARC (International Agency for Research on Cancer): None of the ingredients are listed.

NTP (National Toxicology Program): None of the ingredients are listed.

Germ cell mutagenicity: No additional information.

Reproductive toxicity: No additional information.

STOT-single and repeated exposure: No additional information.

Additional toxicological information: No additional information.

12 Ecological information

12.1 Toxicity:

Sodium Alkylbenzene Sulfonate: Fish, LC50 1.67 mg/l, 96 hours.

Sodium Alkylbenzene Sulfonate: Aquatic invertebrates, EC50 Daphnia 2.4 mg/l, 48 hours.
Sodium Alkylbenzene Sulfonate: Aquatic Plants, EC50 Algae 29 mg/l, 96 hours.
Lauramine oxide: Fish, LC0 24.3 mg/l, 96h [Killifish (Cyprinodontidae)]
Lauramine oxide: Aquatic invertebrates, (LC50): 3.6 mg/l 96 hours [Daphnia (Daphnia)].
Lauramine oxide: Aquatic plants, EC50 Algae 0.31 mg/l 72 hours [Algae]
Alcohol Ethoxylate: Aquatic invertebrates, (LC50): 4.01 mg/l 48 hours [Daphnia (daphnia)].

12.2 Persistence and degradability: No additional information.

12.3 Bioaccumulative potential: No additional information.

12.4 Mobility in soil: No additional information.

General notes: No additional information.

12.5 Results of PBT and vPvB assessment:

PBT: No additional information.

vPvB: No additional information.

12.6 Other adverse effects: No additional information.

13 Disposal considerations

13.1 Waste treatment methods (consult local, regional and national authorities for proper disposal)

Relevant Information:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities. (US 40CFR262.11).

14 Transport information

14.1 UN Number: ADR, ADN, DOT, IMDG, IATA	None
14.2 UN Proper shipping name: ADR, ADN, DOT, IMDG, IATA	None
14.3 Transport hazard classes: ADR, ADN, DOT, IMDG, IATA	**Class:** None **Label:** None **LTD. QTY:** None

US DOT
Limited Quantity Exception: None

Bulk:	**Non Bulk:**
RQ (if applicable): None	**RQ (if applicable):** None
Proper shipping Name: None	**Proper shipping Name:** None
Hazard Class: None	**Hazard Class:** None
Packing Group: None	**Packing Group:** None
Marine Pollutant (if applicable): No additional information.	**Marine Pollutant (if applicable):** No additional information.
Comments: None	**Comments:** None

Trade Name: Liquinox

14.4 Packing group: None
ADR, ADN, DOT, IMDG, IATA

14.5 Environmental hazards : None

14.6 Special precautions for user: None

Danger code (Kemler): None
EMS number: None
Segregation groups: None

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.

14.8 Transport/Additional information:

Transport category: None
Tunnel restriction code: None
UN "Model Regulation": None

15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture.

North American

SARA

Section 313 (specific toxic chemical listings): None of the ingredients are listed.
Section 302 (extremely hazardous substances): None of the ingredients are listed.

CERCLA (Comprehensive Environmental Response, Clean up and Liability Act) Reportable Spill Quantity: None of the ingredients are listed.

TSCA (Toxic Substances Control Act):

Inventory: All ingredients are listed.
Rules and Orders: Not applicable.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients are listed.

Chemicals known to cause developmental toxicity: None of the ingredients are listed.

Canadian

Canadian Domestic Substances List (DSL):
All ingredients are listed.

EU

REACH Article 57 (SVHC): None of the ingredients are listed.

Germany MAK: Not classified.

Asia Pacific

Australia

Australian Inventory of Chemical Substances (AICS): All ingredients are listed.

China

Inventory of Existing Chemical Substances in China (IECSC): All ingredients are listed.

Japan

Inventory of Existing and New Chemical Substances (ENCS): All ingredients are listed.

Korea

Existing Chemicals List (ECL): All ingredients are listed.

New Zealand

New Zealand Inventory of Chemicals (NZOIC): All ingredients are listed.

Philippines

Philippine Inventory of Chemicals and Chemical Substances (PICCS): All ingredients are listed.

Taiwan

Taiwan Chemical Substance Inventory (TSCI): All ingredients are listed.

16 Other information

Abbreviations and Acronyms: None

Summary of Phrases

Hazard statements:

H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Manufacturer Statement:

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling,

use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

NFPA: 1-0-0

HMIS: 1-0-0

Safety Data Sheet Portland Cement

Section 1. Identification

GHS product identifier:	Portland Cement
Chemical name:	Calcium compounds, calcium silicate compounds, and other calcium compounds containing iron and aluminum make up the majority of this product.
Other means of identification:	Cement, ASTM Type I, II, III, V, Portland Limestone Cement, Plastic Cement, Hydraulic Cement, Oilwell Cement, Well Cement, Class G Cement, InterCem, Type L, CSA Type GU, GUb, GUL, MS, MH, MHL, HE, HEL, LH, LHL, HS
Relevant identified uses of the substance or mixture and uses advised against:	Building materials, construction, a basic ingredient in concrete.
Supplier's details:	300 E. John Carpenter Freeway, Suite 1645 Irving, TX 75062 (972) 653-5500
Emergency telephone number (24 hours):	**CHEMTREC: (800) 424-9300**

Section 2. Hazards Identification

Overexposure to portland cement can cause serious, potentially irreversible skin or eye damage in the form of chemical (caustic) burns, including third degree burns. The same serious injury can occur if wet or moist skin has prolonged contact exposure to dry portland cement.

OSHA/HCS status:	This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture:	SKIN CORROSION/IRRITATION – Category 1 SERIOUS EYE DAMAGE/EYE IRRITATION – Category 1 SKIN SENSITIZATION – Category 1 CARCINOGENICITY/INHALATION – Category 1A SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) [Respiratory tract irritation] – Category 3

GHS label elements

Hazard pictograms:

Signal word:	Danger
Hazard statements:	Causes severe skin burns and eye damage. May cause an allergic skin reaction. May cause respiratory irritation. May cause cancer.

Precautionary statements:

Prevention:	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust. Use outdoors in a well ventilated area. Wash any exposed body parts thouroughly after handling. Wear protective gloves/protective clothing/eye protection/face protection.Contaminated clothing must not be allowed out of the workplace.
Response:	If exposed or concerned: Immediately get medical advice/attention if you feel unwell or irritation or rash occurs.If on skin: Wash with plenty of water. Take off contaminated clothing and wash it before reuse. If in eyes: Rinse continuously with water for several minutes. Remove contact lenses, if present and easy to do.If inhaled: Remove person to fresh air and keep comfortable for breathing. If swallowed: Rinse mouth. Do not induce vomiting.
Storage:	Restrict or control access to stockpile areas (store locked up). Engulfment hazard: To prevent burial or suffocation, do not enter a confined space, such as a silo, bulk truck or other storage container or vessel that stores or contains cement without an effective procedure for assuring

safety. Store in a well ventilated area. Keep container tightly closed.

Disposal:	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazards not otherwise classified (HNOC):	None known
Supplemental Information:	Respirable Crystalline Silica (RCS) may cause cancer. Repeated inhalation of respirable crystalline silica (quartz) may cause lung cancer according to IARC and NTP; ACGIH states that it is a suspected cause of cancer. Other forms of RCS (e.g., tridymite and cristobalite) may also be present or formed under certain industrial processes.

Section 3. Composition/information on ingredients

Substance/mixture:	Mixture
Chemical Name:	Calcium compounds, calcium silicate compounds, and other calcium compounds containing iron and aluminum make up the majority of this product.

CAS number/other identifiers

Ingredient name	%	CAS number
Portland Cement	100%	65997-15-1
The structure of Portland cement may contain the following in some concentration ranges:		
Calcium oxide	A-B	1305-78-8
Quartz	C-D	14808-60-7
Hexavalent chromium*	E-F	18450-29-9
Portland cement also contains gypsum, limestone and magnesium oxide in various concentrations. However, because these components are not classifiable as a hazard under Title 29 Code of Federal Regulations 1910.1200, they are not required to be listed in this section.		
Gypsum	G-H	13397-24-5
Limestone	I-J	1317-65-3
Magnesium oxide	K-L	1309-48-4

Any concentration shown as a range is to protect confidentiality or is due to process variation.
*Hexavalent chromium is included due to dermal sensitivity associated with the component.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye Contact:	Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 20 minutes. Chemical burns must be treated promptly by a physician.
Inhalation:	Seek medical help if coughing or other symptoms persist. Inhalation of large amounts of portland cement requires immediate medical attention. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If the individual is not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in a recovery position and get medical attention immediately. Maintain an open airway.
Skin Contact:	Get medical attention immediately. Heavy exposure to portland cement dust, wet concrete or associated water requires prompt attention. Quickly remove contaminated clothing, shoes, and leather goods such as watchbands and belts. Quickly and gently blot or brush away excess portland cement. Immediately wash thoroughly with lukewarm, gently flowing water and non-abrasive pH natural soap. Seek medical attention for rashes, burns, irritation, dermatitis and prolonged unprotected exposure to wet cement, cement mixtures or liquids from wet cement. Burns should be treated as caustic burns. Portland cement causes skin burns with little warning. Discomfort or pain cannot be relied upon to alert a person to

	a serious injury. You may not feel pain or the severity of the burn until hours after the exposure Chemical burns must be treated promptly by a physician. In the event of any complaints or symptoms, avoid further exposure.
Ingestion:	Get medical attention immediately. Call a poison center or physician. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING unless directed to do so by medical personnel. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Have victim drink 60 to 240 mL (2 to 8 oz.) of water. Stop giving water if the exposed person feels sick as vomiting may be dangerous. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Chemical burns must be treated promptly by a physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway.

Most important symptoms/effects, acute and delayed potential acute health effects

Eye contact:	Causes serious eye damage.
Inhalation:	May cause respiratory irritation.
Skin contact:	Causes severe burns. May cause an allergic skin reaction.
Ingestion:	May cause burns to mouth, throat and stomach.

Over-exposure signs/symptoms

Eye contact:	Adverse symptoms may include the following: pain, watering and redness.
Inhalation:	Adverse symptoms may include the following: respiratory tract irritation and coughing.
Skin contact:	Adverse symptoms may include the following: pain or irritation, redness and blistering may occur, skin burns, ulceration and necrosis may occur.
Ingestion:	Adverse symptoms may include the following: stomach pains.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician:	Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.
Specific treatments:	Not applicable.
Protection of first-aiders:	No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media:	Use an extinguishing agent suitable for the surrounding fire.
Unsuitable extinguishing media:	Do not use water jet or water-based fire extinguishers.
Specific hazards arising from the chemical:	No specific fire or explosion hazard.
Hazardous thermal decomposition Products:	Decomposition products may include the following materials: carbon dioxide, carbon monoxide, sulfur oxides and metal oxide/oxides.
Special protective actions for fire-fighters:	Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.
Special protective equipment for fire-fighters:	Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel:	No action shall be taken involving any personal risk or without suitable training. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Do not

	breathe dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
For emergency responders:	For personal protective clothing requirements, please see Section 8.
Environmental precautions:	Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has entered the environment, including waterways, soil or air. Materials can enter waterways through drainage systems.

Methods and materials for containment and cleaning up

Small spill:	Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Place spilled material in a designated, labeled waste container. Dispose of waste material by using a licensed waste disposal contractor.
Large spill:	Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place dust in a closed, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Large spills to waterways may be hazardous due to alkalinity of the product. Dispose of waste material using a licensed waste disposal contractor. Note: see section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures:	Put on appropriate personal protective equipment (see Section 8). Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure by obtaining and following special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not breathe dust. Do not ingest. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material and keep the container tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.
Advice on general occupational hygiene:	Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
Conditions for safe storage, including any incompatibilities:	A key to using the product safely requires the user to recognize that portland cement reacts chemically with water to produce calcium hydroxide which can cause severe chemical burns. Every attempt should be made to avoid skin and eye contact with cement. Do not get portland cement inside boots, shoes or gloves. Do not allow wet, saturated clothing to remain against the skin. Promptly remove clothing and shoes that are dusty or wet with cement mixtures. Launder/clean clothing and shoes before reuse. Do not enter a confined space that stores or contains portland cement unless appropriate procedures and protection are available. Portland cement can build up or adhere to the walls of a confined space and then release or fall suddenly (engulfment).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Cement, portland, chemicals	**ACGIH TLV (United States, 3/2012)** TWA: 1 mg/m^3 8hours. Form: Respirable fraction **NIOSH REL (United States, 6/2009)** TWA: 5 mg/m^3 10 hours. Form: Respirable fraction TWA: 10 mg/m^3 10 hours. Form: Total **OSHA PEL (United States, 6/2010)** TWA: 5mg/m^3. 8 hours. Form: Respirable fraction TWA: 15 mg/m^3. 8 hours. Form: Total dust
Calcium oxide	**ACGIH TLV (United States, 3/2012)** TWA: 2 mg/m^3 8 hours **NIOSH REL (United States, 6/2009)** TWA: 2mg/m^3 10 hours. **OSHA PEL (United States, 6/2010)** TWA: 5 mg/m^3 8 hours.
Limestone	**NIOSH REL (United States, 6/2009)** TWA: 5 mg/m^3 10 hours. Form: Respirable fraction TWA: 10 mg/m^3 10 hours. Form: Total **OSHA PEL (United States, 6/2010)** TWA: 5 mg/m^3 8 hours. Form: Respirable fraction TWA: 15 mg/m^3 8 hours. Form: Total dust
Magnesium oxide	**ACGIH TLV (United States, 3/2012)** TWA: 10 mg/m^3 8 hours. Form: Inhalable fraction **OSHA PEL (United States, 6/2010)** TWA: 15 mg/m^3 8 hours. Form: Total particulates
Crystalline Silica (Quartz) (CAS 14808-60-7)	**OSHA PEL (United States, 9/2017)** TWA: 0.3 mg/m^3. Form: Total dust (1,2) TWA: 0.05 mg/m^3. Form: Respirable (1,2,3) **ACGIH TLV (United States, 3/2012)** TWA: 0.025 mg/m^3. Form: Respirable fraction **NIOSH REL (United States, 6/2009)** TWA: 0.05 mg/m^3. Form: Respirable dust
Calcium sulfate (gypsum)	**ACGIH TLV (United States, 3/2012)** TWA: 10 mg/m^3 8 hours. Form: Respirable fraction **NIOSH REL (United States, 6/2009)** TWA: 5 mg/m^3 8 hours. Form: Respirable fraction TWA: 10 mg/m^3 8 hours. Form: Total dust **OSHA PEL Z-1 (United States, 2/2006)** TWA: 5 mg/m^3 8 hours. Form: Respirable fraction TWA: 15 mg/m^3 8 hours. Form: Total dust

Appropriate engineering controls:	Use only with adequate ventilation. If user operations generate dust, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.
Environmental exposure controls:	Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation.

Individual protection measures

Hygiene measures:	Clean water should always be readily available for skin and (emergency) eye washing. Periodically wash areas contacted by portland cement with a pH neutral soap and clean, uncontaminated water. If clothing becomes saturated with portland cement, garments should be removed and replaced with clean, dry clothing.
Eye/face protection:	To prevent eye contact, wear safety glasses with side shields, safety goggles or face shields when handling dust or wet cement. Wearing contact lenses when working with cement is not recommended.

Skin protection

Hand protection:	Use impervious, waterproof, abrasion and alkali-resistant gloves. Do not rely on barrier creams in place of impervious gloves. Do not get portland cement inside gloves.
Body protection:	Use impervious, waterproof, abrasion and alkali-resistant boots and protective long-sleeved and long-legged clothing to protect the skin from contact with wet portland cement. To reduce foot and ankle exposure, wear impervious boots that are high enough to prevent portland cement from getting inside them. Do not get portland cement inside boots, shoes, or gloves. Remove clothing and protective equipment that becomes saturated with cement and immediately wash exposed areas of the body.
Other skin protection:	Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved. .
Respiratory protection:	Use properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product, and assigned protection factor of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical State:	Solid. [Powder]	**Lower and Upper explosive flammable limits**	Not applicable
Color:	Gray or white	**Vapor pressure:**	Not applicable
Odor:	Odorless	**Vapor density:**	Not applicable
Odor threshold:	Not available	**Relative density:**	2.3 to 3.1
pH:	>11.5 [Conc. (% w/w): 1%]	**Solubility:**	Slightly soluble in water
Melting point:	Not available	**Solubility in water:**	0.1 to 1%
Boiling point:	>1000°C (>1832°F)	**Partition coefficient: n-octanol/water:**	Not applicable
Flash point:	Not flammable. Not combustible	**Auto-ignition temperature:**	Not applicable
Burning time:	Not available	**Decomposition temperature:**	Not available
Burning rate:	Not available	**SADT:**	Not available
Evaporation Rate:	Not applicable	**Viscosity:**	Not applicable
Flammability (solid, gas):	Not applicable		

Section 10. Stability and reactivity

Reactivity:	Reacts slowly with water forming hydrated compounds, releasing heat and producing a strong alkaline solution until reaction is substantially complete.
Chemical Stability:	The product is stable.
Possibility of hazardous reactions:	Under normal circumstances of storage and use, hazardous reactions will not occur.
Conditions to avoid:	No specific data.
Incompatible materials:	Reactive or incompatible with the following materials: oxidizing materials, acids, aluminum and ammonium salt. Portland cement is highly alkaline and will react with acids to produce a violent, heat-generating reaction. Toxic gases or vapors may be given off depending on the acid involved. Reacts with acids, aluminum metals and ammonium salts. Aluminum powder and other alkali and alkaline earth elements will react in wet mortar or concrete, liberating hydrogen gas. Limestone ignites on contact with fluorine and is incompatible with acids, alum, ammonium salts, and magnesium. Silica reacts violently with powerful oxidizing agents such as fluorine, boron trifluoride, chlorine trifluoride, manganese trifluoride, and oxygen difluoride yielding possible fire and/or explosions. Silicates dissolve readily in hydrofluoric acid producing a corrosive gas-silicon tetrafluoride.

Hazardous decomposition products: Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity: Portland Cement LD50/LC50 = Not available

Irritation/Corrosion:
Skin: May cause skin irritation. May cause serious burns in the presence of moisture.
Eyes: Causes serious eye damage. May cause burns in the presence of moisture.
Respiratory: May cause respiratory tract irritation.

Sensitization: May cause sensitization due to the potential presence of trace amounts of hexavalent chromium.

Mutagenicity: There are no data available.

Carcinogenicity:
Classification below:

Product/ingredient name	OSHA	IARC	ACGIH	NTP
Cement, portland, chemicals	-	-	A4	-
Crystalline Silica (Quartz) (CAS 14808-60-7)	-	1	A2	Known to be a human carcinogen.

Reproductive toxicity: There are no data available.

Teratogenicity: There are no data available.

Specific target organ toxicity (single exposure)

Name	Category	Route of Exposure	Target Organs
Calcium oxide	Category 3	Inhalation and skin contact	Respiratory tract irritation, skin irritation
Cement, portland, chemicals	Category 3	Inhalation and skin contact	Respiratory tract irritation, skin irritation

Specific target organ toxicity (repeated exposure)

Name	Category	Route of Exposure	Target Organs
Crystalline Silica (Quartz) (CAS 14808-60-7)	Category 1	Inhalation	Respiratory tract and kidneys

Aspiration hazard: There are no data available.

Information on the likely routes of exposure

Potential acute health effects:
Eye contact: Causes serious eye damage.
Inhalation: May cause respiratory irritation.
Skin contact: Causes severe burns. May cause an allergic skin reaction.
Ingestion: May cause burns to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics:
Eye contact: Adverse symptoms may include the following: pain, watering, redness.
Inhalation: Adverse symptoms may include the following: respiratory tract irritation, coughing
Skin contact: Adverse symptoms may include the following: pain or irritation, redness, blistering may occur, skin burns, ulcerations and necrosis may occur
Ingestion: Adverse symptoms may include the following: stomach pains

Delayed and immediate effects and also chronic effects from short and long term exposure:
Short term exposure
Potential immediate effects: No known significant effects or critical hazards.
Potential delayed effects: No known significant effects or critical hazards.

Long term exposure
Potential immediate effects: No known significant effects or critical hazards.
Potential delayed effects: No known significant effects or critical hazards.

Potential chronic health effects: **General:** Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. If sensitized to hexavalent chromium, a severe allergic dermal reaction may occur when subsequently exposed to very low levels.

Carcinogenicity: Portland cement is not classifiable as a human carcinogen. Crystalline silica is considered a hazard by inhalation. IARC has classified crystalline silica as a Group 1 substance, carcinogenic to humans. This classification is based on the findings of laboratory animal studies (inhalation and implantation) and epidemiology studies that were considered sufficient for carcinogenicity. Excessive exposure to crystalline silica can cause silicosis, a non-cancerous lung disease.

Mutagenicity: No known significant effects or critical hazards.

Teratogenicity: No known significant effects or critical hazards.

Developmental effects: No known significant effects or critical hazards.

Fertility effects: No known significant effects or critical hazards.

Numerical measures of toxicity: Acute toxicity estimates: There are no data available.

Section 12. Ecological Information

Toxicity

Product/ingredient name	Result	Species	Exposure
Calcium oxide	Chronic NOEC 100 mg/L Fresh water	Fish-Oreochromis niloticus-Juvenile (Fledgling, Hatchling, Weanling)	46 days

Persistence and degradability:	There are not data available.
Bioaccumulative potential:	There are not data available.
Mobility in soil:	Soil/water partition coefficient (Koc): Not available.
Other adverse effects:	No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods: The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Untreated waste should not be released to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe manner. Care should be taken when handling empty containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff, and contact with soil, waterways, drains and sewers.

Section 14. Transportation information

	DOT Classification	IMDG	IATA
UN number	Not regulated	Not regulated	Not regulated
UN proper shipping name	-	-	-
Transport hazard class(es)	-	-	-
Packing group	-	-	-
Environmental hazards	None	None	None
Additional information	-	-	-

Special precautions for user:	Transport within user's premises: always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code:	Not available.

Section 15. Regulatory Information

TSCA 6 final risk management: Chromium, ion (Cr6+)
United States inventory (TSCA 8b): Cements are considered to be statutory mixtures under TSCA. CAS 65997-15-1 is included on the TSCA inventory.
CERCLA: This product is not listed as a CERCLA substance
Clean Air Act Section 112 (b): Hazardous Air Pollutants (HAPs) – Not listed
Clean Air Act Section 602: Class I Substances - Not listed
Clean Air Act Section 602: Class II Substances - Not listed
DEA List I Chemicals: (Precursor Chemicals) – Not listed
DEA List II Chemicals: (Essential Chemicals) – Not listed

SARA 311/312

Classification:	Immediate (acute) health hazard Delayed (chronic) health hazard

Composition/information on ingredients

Name	%	Fire Hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
Calcium oxide	A-B	No	No	No	Yes	No
Quartz	>0.1	No	No	No	No	Yes
Chromium, ion (Cr6+)	<0.1	No	No	No	Yes	Yes

SARA 313

	Product name	CAS number	%
Form R-Report requirements	Chromium, ion (Cr6+)	8540-29-9	<0.1

State regulations

Massachusetts:	The following components are listed: cement, portland, chemicals, limestone
New York:	None of the components are listed.
New Jersey:	The following components are listed: cement, portland, chemicals, gypsum, limestone
Pennsylvania:	The following components are listed: cement, portland, chemicals, gypsum, limestone

California Prop. 65

WARNING: This product contains crystalline silica and chemicals (trace metals) known to the State of California to cause cancer, birth defects or other reproductive harm. California law requires the above warning in the absence of definitive testing to prove the defined risks do not exist.

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
Quartz	Yes	No	No	No
Chromium, ion (Cr6+)	Yes	Yes	0.001µg/day (inhalation)	8.2 micrograms/day (ingestion)

International regulations

International lists: **Canadian Domestic Substances List (DSL):** Portland cement is included on the DSL.
Mexico Inventory (INSQ): All components are listed or exempted.

Section 16. Other Information

Date of issue: 07/01/2018
Replaces: 06/01/2015
Revised Section(s): Section 8

Notice to reader

While the information provided in this safety data sheet is believed to provide a useful summary of the hazards of portland cement as it is commonly used, the sheet cannot anticipate and provide all of the information that might be needed in every situation. Inexperienced product users should obtain proper training before using this product. In particular, the data furnished in this sheet do not address hazards that may be posed by other materials mixed with portland cement to produce portland cement products. Users should review other relevant material safety data sheets before working with this portland cement or working on portland cement products, for example, portland cement concrete.

SELLER MAKES NO WARRANTY, EXPRESS OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY Lehigh Hanson, except that the product shall conform to contracted specifications. The information provided herein was believed by the Lehigh Hanson to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information to comply with all laws and procedures applicable to the safe handling and use of product and to determine the suitability of the product for its intended use. Buyer's exclusive remedy shall be for damages and no claim of any kind, whether as to product delivered or for non-delivery of product, and whether based on contract, breach of warranty, negligence, or otherwise shall be greater in amount than the purchase price of the quantity of product in respect of which damages are claimed. In no event shall Seller be liable for incidental or consequential damages, whether Buyer's claim is based on contract, breach of warranty, negligence or otherwise.

Abbreviations

ACGIH — American Conference of Governmental Industrial Hygienists
CAS — Chemical Abstract Service
CERCLA — Comprehensive Emergency Response and Comprehensive Liability Act
CFR — Code of Federal Regulations
DOT — Department of Transportation
GHS — Globally Harmonized System
HEPA — High Efficiency Particulate Air
IATA — International Air Transport Association
IARC — International Agency for Research on Cancer
IMDG — International Maritime Dangerous Goods
NIOSH — National Institute of Occupational Safety and Health
NOEC — No Observed Effect Concentration
NTP — National Toxicology Program
OSHA — Occupational Safety and Health Administration
PEL — Permissible Exposure Limit
REL — Recommended Exposure Limit
RQ — Reportable Quantity
SARA — Superfund Amendments and Reauthorization Act
SDS — Safety Data Sheet
TLV — Threshold Limit Value
TPQ — Threshold Planning Quantity
TSCA — Toxic Substances Control Act
TWA — Time-Weighted Average
UN — United Nations

Safety Data Sheet

RUST-OLEUM
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1. Identification

Product Name:	PRO LSPR 6PK MARK FLUORESCENT ORANGE	**Revision Date:**	5/12/2017
Product Identifier:	2554838	**Supercedes Date:**	6/5/2015
Product Use/Class:	Marking Paint/Aerosols		
Supplier:	Rust-Oleum Corporation 11 Hawthorn Parkway Vernon Hills, IL 60061 USA	**Manufacturer:**	Rust-Oleum Corporation 11 Hawthorn Parkway Vernon Hills, IL 60061 USA
Preparer:	Regulatory Department		
Emergency Telephone:	24 Hour Hotline: 847-367-7700		

2. Hazard Identification

Classification

Symbol(s) of Product

Signal Word
Danger

Possible Hazards
27% of the mixture consists of ingredient(s) of unknown acute toxicity.

GHS HAZARD STATEMENTS

Carcinogenicity, category 2	H351	Suspected of causing cancer.
Compressed Gas	H280	Contains gas under pressure; may explode if heated.
Flammable Aerosol, category 1	H222	Extremely flammable aerosol.
STOT, repeated exposure, category 2	H373	May cause damage to organs through prolonged or repeated exposure.

GHS LABEL PRECAUTIONARY STATEMENTS

P201	Obtain special instructions before use.
P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P211	Do not spray on an open flame or other ignition source.
P251	Do not pierce or burn, even after use.
P260	Do not breathe dust/fume/gas/mist/vapors/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P308+P313	IF exposed or concerned: Get medical advice/attention.
P314	Get medical advice/attention if you feel unwell.
P405	Store locked up.
P410+P403	Protect from sunlight. Store in a well-ventilated place.
P410+P412	Protect from sunlight. Do no expose to temperatures exceeding 50°C/ 122°F.

P501 Dispose of contents/container in accordance with local, regional and national regulations.

3. Composition/Information On Ingredients

HAZARDOUS SUBSTANCES

Chemical Name	CAS-No.	Wt.% Range	GHS Symbols	GHS Statements
Propane	74-98-6	10-25	GHS04	H280
Naphtha, Petroleum, Hydrotreated Light	64742-49-0	2.5-10	GHS08	H304
n-Butane	106-97-8	2.5-10	GHS04	H280
Hydrotreated Light Distillate	64742-47-8	2.5-10	GHS08	H304
Xylenes (o-, m-, p- isomers)	1330-20-7	2.5-10	GHS02-GHS07	H226-315-319-332
Barium Sulfate	7727-43-7	2.5-10	Not Available	Not Available
Ethylbenzene	100-41-4	1.0-2.5	GHS02-GHS07-GHS08	H225-304-332-351-373
Stoddard Solvent	8052-41-3	0.1-1.0	GHS08	H304-372
Pigment Orange 13	3520-72-7	0.1-1.0	Not Available	Not Available
Crystalline Silica / Quartz	14808-60-7	0.1-1.0	Not Available	Not Available

4. First-aid Measures

FIRST AID - EYE CONTACT: Immediately flush eyes with plenty of water for at least 15 minutes holding eyelids open. Get medical attention. Do NOT allow rubbing of eyes or keeping eyes closed.

FIRST AID - SKIN CONTACT: Wash skin with soap and water. Remove contaminated clothing. Get medical attention if irritation develops or persists.

FIRST AID - INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get immediate medical attention. Do NOT use mouth-to-mouth resuscitation. If you experience difficulty in breathing, leave the area to obtain fresh air. If continued difficulty is experienced, get medical assistance immediately.

FIRST AID - INGESTION: Aspiration hazard: Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. Get immediate medical attention. If swallowed, get medical attention.

5. Fire-fighting Measures

EXTINGUISHING MEDIA: Alcohol Film Forming Foam, Carbon Dioxide, Dry Chemical, Dry Sand, Water Fog

UNUSUAL FIRE AND EXPLOSION HAZARDS: FLASH POINT IS LESS THAN 20°F. EXTREMELY FLAMMABLE LIQUID AND VAPOR!Water spray may be ineffective. Closed containers may explode when exposed to extreme heat due to buildup of steam. Closed containers may explode when exposed to extreme heat. Vapors may form explosive mixtures with air. Vapors can travel to a source of ignition and flash back. Keep containers tightly closed. Isolate from heat, electrical equipment, sparks and open flame. Perforation of the pressurized container may cause bursting of the can. No unusual fire or explosion hazards noted.

SPECIAL FIREFIGHTING PROCEDURES: Water may be used to cool closed containers to prevent pressure buildup and possible autoignition or explosion. Full protective equipment including self-contained breathing apparatus should be used. Evacuate area and fight fire from a safe distance. Use water spray to keep fire-exposed containers cool. Containers may explode when heated.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Contain spilled liquid with sand or earth. DO NOT use combustible materials such as sawdust. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Remove all sources of ignition, ventilate area and remove with inert absorbent and non-sparking tools. Dispose of according to local, state (provincial) and federal regulations. Do not incinerate closed containers. Ventilate area, isolate spilled material, and remove with inert absorbent. Dispose of contaminated absorbent, container, and unused contents in accordance with local, state, and federal regulations.

7. Handling and Storage

HANDLING: Wash thoroughly after handling. Wash hands before eating. Remove contaminated clothing and launder before reuse. Use only in a well-ventilated area. Use only with adequate ventilation. Follow all MSDS/label precautions even after container is emptied because it may retain product residues. Avoid breathing fumes, vapors, or mist. Avoid contact with eyes, skin and clothing.

STORAGE: Store in a dry, well ventilated place. Keep container tightly closed when not in use. Keep containers tightly closed. Isolate from heat, electrical equipment, sparks and open flame. Contents under pressure. Do not store above 120 ° F. Store large quantities in buildings designed and protected for storage of flammable aerosols. Keep away from heat, sparks, flame and sources of ignition. Contents under pressure. Do not expose to heat or store above 120 ° F. Avoid excess heat. Product should be stored in tightly sealed containers and protected from heat, moisture, and foreign materials.

8. Exposure Controls/Personal Protection

Chemical Name	CAS-No.	Weight % Less Than	ACGIH TLV-TWA	ACGIH TLV-STEL	OSHA PEL-TWA	OSHA PEL-CEILING
Propane	74-98-6	20.0	N.E.	N.E.	1000 ppm	N.E.
Naphtha, Petroleum, Hydrotreated Light	64742-49-0	10.0	N.E.	N.E.	N.E.	N.E.
n-Butane	106-97-8	10.0	N.E.	1000 ppm	N.E.	N.E.
Hydrotreated Light Distillate	64742-47-8	10.0	N.E.	N.E.	N.E.	N.E.
Xylenes (o-, m-, p- isomers)	1330-20-7	5.0	100 ppm	150 ppm	100 ppm	N.E.
Barium Sulfate	7727-43-7	5.0	5 mg/m3	N.E.	15 mg/m3	N.E.
Ethylbenzene	100-41-4	5.0	20 ppm	N.E.	100 ppm	N.E.
Stoddard Solvent	8052-41-3	1.0	100 ppm	N.E.	500 ppm	N.E.
Pigment Orange 13	3520-72-7	1.0	N.E.	N.E.	N.E.	N.E.
Crystalline Silica / Quartz	14808-60-7	1.0	0.025 mg/m3	N.E.	50 µg/m3	N.E.

PERSONAL PROTECTION

ENGINEERING CONTROLS: Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof ventilation equipment. Provide general dilution of local exhaust ventilation in volume and pattern to keep TLV of hazardous ingredients below acceptable limits. Prevent build-up of vapors by opening all doors and windows to achieve cross-ventilation.

RESPIRATORY PROTECTION: A respiratory protection program that meets OSHA 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. A NIOSH/MSHA approved air purifying respirator with organic vapor cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits.

SKIN PROTECTION: Use gloves to prevent prolonged skin contact. Use impervious gloves to prevent skin contact and absorption of this material through the skin. Nitrile or Neoprene gloves may afford adequate skin protection.

EYE PROTECTION: Use safety eyewear designed to protect against splash of liquids.

OTHER PROTECTIVE EQUIPMENT: Refer to safety supervisor or industrial hygienist for further guidance regarding types of personal protective equipment and their applications. Refer to safety supervisor or industrial hygienist for further information regarding personal protective equipment and its application.

HYGIENIC PRACTICES: Wash thoroughly with soap and water before eating, drinking or smoking. Remove contaminated clothing immediately and launder before reuse.

9. Physical and Chemical Properties

Appearance:	Aerosolized Mist	**Physical State:**	Liquid
Odor:	Solvent Like	**Odor Threshold:**	N.E.
Relative Density:	0.857	**pH:**	N.A.
Freeze Point, °C:	N.D.	**Viscosity:**	N.D.
Solubility in Water:	Slight	**Partition Coefficient, n-octanol/water:**	N.D.
Decompostion Temp., °C:	N.D.		
Boiling Range, °C:	-37 - 537	**Explosive Limits, vol%:**	0.9 - 12.6
Flammability:	Supports Combustion	**Flash Point, °C:**	-96
Evaporation Rate:	Faster than Ether	**Auto-ignition Temp., °C:**	N.D.
Vapor Density:	Heavier than Air	**Vapor Pressure:**	N.D.

(See "Other information" Section for abbreviation legend)

10. Stability and Reactivity

CONDITIONS TO AVOID: Avoid temperatures above 120°F (49°C). Avoid contact with strong acid and strong bases. Avoid all possible sources of ignition.

INCOMPATIBILITY: Incompatible with strong oxidizing agents, strong acids and strong alkalies.

HAZARDOUS DECOMPOSITION: By open flame, carbon monoxide and carbon dioxide. When heated to decomposition, it emits acrid smoke and irritating fumes. Contains solvents which may form carbon monoxide, carbon dioxide, and formaldehyde.

HAZARDOUS POLYMERIZATION: Will not occur under normal conditions.

STABILITY: This product is stable under normal storage conditions.

11. Toxicological information

EFFECTS OF OVEREXPOSURE - EYE CONTACT: Causes Serious Eye Irritation

EFFECTS OF OVEREXPOSURE - SKIN CONTACT: Substance may cause slight skin irritation. May cause skin irritation. Allergic reactions are possible. Prolonged or repeated contact may cause skin irritation.

EFFECTS OF OVEREXPOSURE - INHALATION: Harmful if inhaled. High gas, vapor, mist or dust concentrations may be harmful if inhaled. Avoid breathing fumes, spray, vapors, or mist. High vapor concentrations are irritating to the eyes, nose, throat and lungs. Prolonged or excessive inhalation may cause respiratory tract irritation.

EFFECTS OF OVEREXPOSURE - INGESTION: Harmful if swallowed. Aspiration hazard if swallowed; can enter lungs and cause damage.

EFFECTS OF OVEREXPOSURE - CHRONIC HAZARDS: May cause central nervous system disorder (e.g., narcosis involving a loss of coordination, weakness, fatigue, mental confusion, and blurred vision) and/or damage. High concentrations may lead to central nervous system effects (drowsiness, dizziness, nausea, headaches, paralysis, and blurred vision) and/or damage. Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Overexposure to xylene in laboratory animals has been associated with liver abnormalities, kidney, lung, spleen, eye and blood damage as well as reproductive disorders. Effects in humans, due to chronic overexposure, have included liver, cardiac abnormalities and nervous system damage. IARC lists Ethylbenzene as a possible human carcinogen (group 2B).

PRIMARY ROUTE(S) OF ENTRY: Eye Contact, Ingestion, Inhalation, Skin Absorption, Skin Contact

ACUTE TOXICITY VALUES

The acute effects of this product have not been tested. Data on individual components are tabulated below:

CAS-No.	Chemical Name	Oral LD50	Dermal LD50	Vapor LC50
74-98-6	Propane	N.I.	N.I.	658 mg/L Rat
64742-49-0	Naphtha, Petroleum, Hydrotreated Light	>5000 mg/kg Rat	>3160 mg/kg Rabbit	>4951 mg/L Rat
106-97-8	n-Butane	N.I.	N.I.	658 mg/L Rat
64742-47-8	Hydrotreated Light Distillate	>5000 mg/kg Rat	>2000 mg/kg Rabbit	>5000 mg/L Rat
1330-20-7	Xylenes (o-, m-, p- isomers)	3500 mg/kg Rat	>4350 mg/kg Rabbit	29.08 mg/L Rat
100-41-4	Ethylbenzene	3500 mg/kg Rat	15400 mg/kg Rabbit	17.4 mg/L Rat
3520-72-7	Pigment Orange 13	>5000 mg/kg Rat	N.I.	N.I.
14808-60-7	Crystalline Silica / Quartz	5500 mg/kg Rat	5500	100 mg/L

N.I. - No Information

12. Ecological Information

ECOLOGICAL INFORMATION: Product is a mixture of listed components. Product is a mixture of listed components.

13. Disposal Information

DISPOSAL INFORMATION: Dispose of material in accordance to local, state, and federal regulations and ordinances. Do not allow to enter waterways, wastewater, soil, storm drains or sewer systems.

14. Transport Information

	Domestic (USDOT)	International (IMDG)	Air (IATA)	TDG (Canada)
UN Number:	N.A.	1950	1950	N.A.
Proper Shipping Name:	Paint Products in Limited Quantities	Aerosols	Aerosols	Paint Products in Limited Quantities
Hazard Class:	N.A.	2.1	2.1	N.A.
Packing Group:	N.A.	N.A.	N.A.	N.A.
Limited Quantity:	Yes	Yes	Yes	Yes

15. Regulatory Information

U.S. Federal Regulations:

CERCLA - SARA Hazard Category

This product has been reviewed according to the EPA 'Hazard Categories' promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

Fire Hazard, Pressure Hazard, Acute Health Hazard, Chronic Health Hazard

Sara Section 313:

This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR part 372:

Chemical Name	CAS-No.
Xylenes (o-, m-, p- isomers)	1330-20-7
Ethylbenzene	100-41-4

Toxic Substances Control Act:

This product contains the following chemical substances subject to the reporting requirements of TSCA 12(b) if exported from the United States:

Chemical Name	CAS-No.
Castor oil, sulfated, sodium salt	68187-76-8

16. Other Information

HMIS RATINGS

Health:	2*	**Flammability:**	4	**Physical Hazard:**	0	**Personal Protection:**	X

NFPA RATINGS

Health:	2	**Flammability:**	4	**Instability**	0

VOLATILE ORGANIC COMPOUNDS, g/L: 551

SDS REVISION DATE: 5/12/2017

REASON FOR REVISION:
Product Composition Changed
Substance and/or Product Properties Changed in Section(s):
02 - Hazard Identification
05 - Fire-fighting Measures
16 - Other Information
Statement(s) Changed

Legend: N.A. - Not Applicable, N.E. - Not Established, N.D. - Not Determined

Rust-Oleum Corporation believes, to the best of its knowledge, information and belief, the information contained herein to be accurate and reliable as of the date of this safety data sheet. However, because the conditions of handling, use, and storage of these materials are beyond our control, we assume no responsibility or liability for personal injury or property damage incurred by the use of these materials. Rust-Oleum Corporation makes no warranty, expressed or implied, regarding the accuracy or reliability of the data or results obtained from their use. All materials may present unknown hazards and should be used with caution. The information and recommendations in this material safety data sheet are offered for the users' consideration and examination. It is the responsibility of the user to determine the final suitability of this information and to comply with all applicable international, federal, state, and local laws and regulations.

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Appendix E

Waste Management Plan

APPENDIX E
WASTE MANAGEMENT PLAN

UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN FOR PHASE I REMEDIAL INVESTIGATION OF PER- AND POLYFLUOROALKYL SUBSTANCES, NIAGARA FALLS AIR RESERVE STATION NIAGARA FALLS, NEW YORK

PREPARED FOR:

UNITED STATES ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
2 Hopkins Plaza
Baltimore, Maryland 21201

PREPARED BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
EA Engineering, P.C. and Its Affiliate
EA Science and Technology*
269 W. Jefferson Street
Syracuse, New York 13202

DoD Contract Number: W912DR19D0005/Delivery Order: W912DR22F0247

September 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per Liter
AFFF	Aqueous film-forming foam
ASD	Assistant Secretary of Defense
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
EPA	U.S. Environmental Protection Agency
HQ	Hazard Quotient
HFPO-DA	hexafluoropropylene oxide dimer acid
IBC	Intermediate Bulk Container
ID	Identification
IDW	Investigation-derived waste
ILCR	Incremental Lifetime Cancer Risk
mg/kg	Milligram(s) per kilogram
NA	Not Available/Applicable
NFARS	Niagara Falls Air Reserve Station
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutane sulfonate
PFHxS	Perfluorohexane sulfonate
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanioic acid
PFOS	Perfluorooctane sulfonate
ppb	Part(s) per billion
PPE	Personal protective equipment
ppm	Part(s) per million
ppt	Part(s) per trillion
QAPP	Quality Assurance Project Plan
RfD	Reference dose
RI	Remedial Investigation
RPM	Restoration Program Manager
RSL	Regional Screening Level
SF	Slope Factor
TO	Task Order
UFP	Uniform Federal Policy

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

USACE	U.S. Army Corps of Engineers
WMP	Waste Management Plan

1. INTRODUCTION

This document presents the Waste Management Plan (WMP) for investigation-derived waste (IDW) generated during the Phase I Remedial Investigation (RI) of Per- and Polyfluoroalkyl Substances (PFAS) at the Niagara Falls Air Reserve Station (NFARS). This WMP was prepared by EA Engineering, P.C. and its affiliate EA Science and Technology (EA) for the U.S. Army Corps of Engineers (USACE) - Baltimore District under Contract Number W912DR-19-D-0005/ Delivery Order: W912DR22F0247.

The WMP applies to all IDW generated from the activities performed as part of the RI, including soil sampling, groundwater sampling, surface water sampling, soil boring advancement, monitoring well installation and development, and lysimeter installation and sampling, and includes associated secondary waste streams and management of waste during mobilization and demobilization phases of the project. The IDW and subsidiary waste management will be in accordance with federal regulations and applicable state regulations. This IDW and subsidiary waste plan has been developed using a logical and systematic framework for waste identification, characterization, and decision pathway for media treatment and disposal of PFAS-contaminated media.

1.1 PURPOSE AND SCOPE

The purpose of this WMP is to provide a systemic approach to the management of IDW generated during the RI that is designed to protect the health and safety of the worker, the public, and the environment. The WMP provides an overall strategy for how waste management activities will be implemented for all primary and secondary wastes generated by RI activities as described in the UFP-QAPP for the Phase I RI of PFAS at NFARS. This WMP will also cover management responsibilities, record keeping, document management, waste characterization and disposal of IDW. These procedures may be modified during project execution in response to unanticipated or changing conditions or updated guidance.

1.2 REGULATORY GUIDANCE

This Phase I RI will be performed per the Office of the Assistant Secretary of Defense (ASD) Memorandum, *Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program* signed into use on 6 July 2022 (ASD 2022). The most recent 2022 EPA SLs, as presented in the memorandum, will be used for delineating and evaluating detected constituents, including perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorobutane sulfonate (PFBS), hexafluoropropylene oxide dimer acid (HFPO-DA, or GenX), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS). These screening values and anticipated treatment and final disposition methods are presented in Section 3.

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2. TYPES OF INVESTIGATION DERIVED WASTE

There are several different potential IDW generating activities during the RI. A general discussion regarding the generation, sampling, and disposal of IDW is presented in the following sections.

To determine the ultimate disposition of IDW, the waste is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or by subsequent analysis.

2.1 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) waste generated during RI activities (including used disposable masks, gloves, and single use samplers) will be placed in plastic bags and then disposed of at an approved disposal facility.

2.2 SAMPLING WASTE

For the purposes of this plan, sample wastes are those materials that are generated during sampling activities. As outlined in the UFP-QAPP, each waste stream will be sampled to verify compliance with the approved Subtitle D disposal facility waste acceptance requirements. The sampled material will be handled, packaged, stored, and transported in accordance with all applicable regulations. Sampling wastes includes, but is not limited to, the following:

- Disposable equipment and items such as plastic single use samplers, aluminum foil, polyvinyl chloride pipe, composite liquid waste sampling, tubing, broken or unused sample containers, sample container packaging, gloves, masks, and tape.
- Soil cuttings from direct-push and sonic drilling activities.
- Drilling mud or water used for drilling activities.
- Groundwater from well purging and well development activities.
- Cleaning fluids and decontaminants as well as wash water.
- Unused or excess packaging and shipping materials.

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3. INVESTIGATION-DERIVED WASTE MANAGEMENT PLAN

This section provides instructions for handling, packaging, transporting, and disposing of IDW generated during the field activities of the RI through the 4-step process summarized below. The 4-step process outlined in this WMP provides a logical and systematic framework for waste identification and characterization, and a decision pathway for media treatment and disposal of PFAS-contaminated IDW.

3.1 STEP 1: WASTE MEDIA IDENTIFICATION

This project will include liquid, soil, and other solid IDW media as described in Section 2. Potential liquid IDW will include groundwater samples, surface water samples, rinse water, groundwater from well purging and development, and from accidental releases. Potential soil IDW will include soil boring cuttings, cuttings from monitoring well installation, and from accidental releases. Other solid media can include PPE (e.g., disposable gloves), construction waste (e.g., plastic sheeting, paper, rags, grout), and single use sampling equipment (e.g., used and unused sample containers, samplers, tubing).

3.2 STEP 2: CONTAINERIZE, SAMPLE, AND CHARACTERIZE WASTE

IDW will be containerized and isolated to minimize cross contamination. Liquid IDW will be stored in Department of Transportation approved 55-gallon drums while on-site. Soil IDW will be stored in lined roll off containers or 55-gallon drums. Soil and liquid IDW will be characterized for final treatment and disposal. The decision points for disposal methods for liquid and soil IDW are described in Step 3.

Other solids (e.g., PPE, construction waste, and sampling equipment) will be placed in trash bags and disposed as non-hazardous solid waste in an appropriate off-base Subtitle D landfill.

3.3 STEP 3: MEDIA SPECIFIC TREATMENT AND DISPOSAL DECISION POINTS

Representative samples of liquid and soil IDW will be collected, and lab tested to determine if the IDW is non-detect or detected at less than or equal to applicable screening levels. EPA screening criteria as presented in the ASD Memorandum, *Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program*, shall be used to delineate PFOS, PFOA, PFBS, PFNA, and PFHxS for this RI (ASD 2022). These screening values are presented in **Table 3-1**.

**Table 3-1.
EPA Regional Screening Levels**

Chemical	EPA RSLs[1]	
	Residential RSL (µg/kg)	Tapwater RSL (ng/L)
PFOS	13	4
PFOA	19	6
PFBS	1,900	601
PFNA	19	5.9
PFHxS	130	39
HFPO-DA	23	6

1) EPA RSL for tapwater (TR=1E-06, HQ=0.1). November 2022

3.4 STEP 4: MEDIA SPECIFIC TREATMENT TECHNOLOGY FOR FINAL DISPOSAL

For liquid IDW, if laboratory PFOS, PFOA, PFBS, PFNA, and/or PFHxS are less than the screening criteria presented in **Table 3-1**, no other contamination is present, and no state or local regulation prohibits it, the water may be discharged to the sanitary sewer after disclosing the nature and concentrations of PFAS constituents to the local wastewater authority and obtaining a recordable authorization to discharge. Liquid IDW with PFOS, PFOA, PFBS, PFNA, and/or PFHxS greater than or equal to the screening criteria presented in **Table 3-1** will be treated on-site via a portable ion exchange treatment system prior to disposal and coordinated for on-site disposal to the sanitary sewer system, or transported to an approved, permitted treatment plant for disposal by an EA waste subcontractor.

For soil IDW, if laboratory PFOS, PFOA, PFBS, PFNA, and/or PFHxS is less than the screening criteria presented in **Table 3-1**, and no other contamination is laboratory-confirmed, the soil IDW will be transported by an EA waste subcontractor and disposed of as non-hazardous waste at an EPA-approved Subtitle D Landfill. EA will coordinate with the USACE Project Manager and NFARS, and written authorization and acceptance will be obtained prior to off-site disposal.

If soil IDW is laboratory confirmed to be greater than or equal to the screening criteria for PFOS, PFOA, PFBS, PFNA, and/or PFHxS presented in **Table 3-1**, then the waste will be transported by an EA waste subcontractor and disposed of as hazardous solid waste at an EPA-approved RCRA Subtitle C Landfill. EA will coordinate with the USACE Project Manager and NFARS, and written authorization and acceptance will be obtained prior to off-site disposal.
If soil IDW is laboratory confirmed to be less than the screening criteria for PFOS, PFOA, PFBS, PFNA, and/or PFHxS presented in **Table 3-1**, but laboratory confirmed to be contaminated with another chemical of concern where concentrations exceeding regulatory standards and regulated hazardous waste were identified and properly managed for disposal, then the waste will be transported by an EA waste subcontractor and disposed of as hazardous solid waste at an EPA-approved RCRA Subtitle C Landfill. EA will coordinate with the USACE Project Manager and NFARS, and written authorization and acceptance will be obtained prior to off-site disposal.

PPE and other debris (e.g., rags, booms, containers, and construction debris) will be disposed of at a Subtitle D landfill.

4. OFF-SITE TRANSPORTATION AND DISPOSAL

4.1 SHIPPING DOCUMENTATION

Prior to any necessary off-site waste disposal, characterization information will be documented on a waste profile form provided by the off-site treatment and/or disposal facility as part of the waste acceptance process. The profile will be reviewed and approved by EA, the USACE Project Manager, and NFARS. EA will provide any required generator certification and/or signatures. Signed profile(s) will then be submitted to the disposal facility for acceptance.

The profile typically requires the following information, including but not limited to:

- Generator information, including name, mailing address, contact, and phone number
- Site name, including street address
- Process generating waste (for example, well development, well water sample collection, etc.)
- Source of contamination
- Historical use for area
- Waste composition
- Physical state of waste
- Applicable hazardous waste codes.

Once the approved profile or approval letter is received from the disposal facility, transportation can be scheduled. Each load of waste will be manifested prior to leaving the site. At a minimum, the manifest form will include the following information:

- Generator contact information including name, address, and phone number, and USACE/NFARS identification (ID) number
- Transporter contact information including name, address, and phone number, and USACE/NFARS ID number
- Facility information including name, address, phone number, and USACE/NFARS ID number
- Site name including street/mailing address
- Department of Transportation Proper Shipping Name
- Type and number of container(s)
- Quantity of waste (volumetric estimate)
- Contract TO number or job number
- Profile number
- 24-hour emergency phone number.

The generator and the transporter must sign the manifest before the load of waste leaves the site. The original signed manifest will be returned to the address of the generator. EA anticipates that the facility will provide a copy of the facility-signed manifest to EA.

4.2 TRANSPORTATION

A contractor licensed for commercial transportation will transport non-hazardous wastes. If wastes are hazardous, the transporter selected will have the appropriate credentials and licenses to comply with all required regulations.

4.3 DISPOSAL AND WASTE STREAMS

Disposal facilities with proper permits and in good standing with the state and federal agencies will be used.

Off-site treatment and disposal facilities will use the waste profile and supporting documentation (e.g., analytical data) to determine whether they will accept the waste. Hazardous and non-hazardous wastes will be disposed of at facilities permitted to receive such wastes.

The treatment and disposal facility will be responsible for providing a copy of the final facility-signed waste manifest and a certificate of treatment or disposal for each load of waste received.

4.4 WASTE MANAGEMENT RECORDKEEPING

The following records and documents shall be maintained:

- Waste profiles and associated characterization data
- Manifests and bills of lading

5. DOCUMENT MANAGEMENT

This section provides the project filing requirements.

5.1 DOCUMENT CONTROL

EA has implemented control procedures for project documents prepared by EA, by our team subcontractors, non-team subcontractors, vendors, and by our clients for each project. Project documents will be stored electronically in a dedicated project folder located on EA's corporate server and file or paper copies will be maintained in the project manager's office in order to provide control and confidentiality of documents and reports. Quality records and related documents will be stored in a dedicated section of the project file. Each draft or obsolete document will be discarded or destroyed after the final or next revised draft version is completed.

5.2 DOCUMENT DISTRIBUTION

In general, documents will be distributed as needed to EA, NFARS, and USACE personnel associated with the project. The project manager will distribute this WMP and any revisions to this plan to project team members.

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6. REFERENCES

Assistant Secretary of Defense (ASD). 2022. *Investigating Per- and Polyfluoroalkyl Substances with the Department of Defense Cleanup Program.* United States Department of Defense. 6 July.

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Appendix F

Quality Control Plan

APPENDIX F
QUALITY CONTROL PLAN

UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN FOR PHASE I REMEDIAL INVESTIGATION OF PER- AND POLYFLUOROALKYL SUBSTANCES, NIAGARA FALLS AIR RESERVE STATION NIAGARA FALLS, NEW YORK

PREPARED FOR:

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Baltimore, Maryland 21201

PREPARED BY:

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EA Engineering, P.C. and Its Affiliate
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DoD Contract Number: W912DR19D0005/Delivery Order: W912DR22F0247

September 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
AFFF	Aqueous film-forming foam
APP	Accident Prevention Plan
ASL	Aerostar SES LLC
CQCS	Contractor Quality Control Supervisor
DFW	Definable Feature of Work
DoD	Department of Defense
DQCR	Daily Quality Control Report
EA	EA Engineering, P.C. and its affiliate EA Science and Technology
EPA	U.S. Environmental Protection Agency
ITR	Independent Technical Review
NFARS	Niagara Falls Air Reserve Station
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PM	Project Manager
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QCP	Quality Control Plan
QMP	Quality Management Plan
QSM	Quality Systems Manual
RI	Remedial Investigation
RML	Regional Management Level
RPM	Restoration Program Manager
RSL	Regional Screening Level
SI	Site Investigation
SL	Screening Level
SOP	Standard Operating Procedure
STR	Senior Technical Reviewer

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TO	Task Order
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers

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1. INTRODUCTION

This document presents the Quality Control Plan (QCP) for the Phase I Remedial Investigation (RI) of Per- and Polyfluoroalkyl Substances (PFAS) at the Niagara Falls Air Reserve Station (NFARS).

1.1 AUTHORITY

This QCP was prepared by EA Engineering, P.C. and its affiliate EA Science and Technology (EA). EA is the prime contractor under U.S. Army Corps of Engineers (USACE) - Baltimore District, Contract Number W912DR-19-D-0005/ Delivery Order: W912DR22F0247.

1.2 PURPOSE AND SCOPE

The purpose of this QCP is to ensure quality control (QC) during execution of the defined Scope of Work, as described in the Statement of Work issued with Task Order (TO) award, over the duration of the TO. This QCP describes procedures for control, verification, and acceptance testing for each definable feature of work. The Three Phases of Control (Preparation, Initial, and Follow-up) will be used to prevent problems and deficiencies in implementation of the required work elements and to achieve the project performance objectives.

1.3 BACKGROUND

PFAS are classified as emerging environmental contaminants based on increasing regulatory interest, potential risk to human health and the environment, and evolving regulatory standards. In 2014, the U.S. Environmental Protection Agency (EPA) added the first PFAS compound, perfluorobutane sulfonate (PFBS), to the Regional Screening Level and Regional Management Level lists. EPA subsequently issued Drinking Water Health Advisories for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in May 2016 (EPA 2016a and 2016b). In May 2022, EPA added five additional compounds to the RSL and RML including PFOS, PFOA, hexafluoropropylene oxide dimer acid (HFPO-DA, or GenX), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS)

Aerostar SES LLC (ASL), under contract to USACE, conducted screening-level site inspections at known or suspected aqueous film-forming foam (AFFF) release areas at NFARS in 2017 under the site investigation (SI). The 2018 SI Report identified historical AFFF releases which have resulted in PFAS compounds (specifically PFOA, PFOS, and PFBS) present in on-site and downgradient environmental media (ASL 2018). Based on the results of SI, seven areas of interest (Figure 1-2 of the Uniform Federal Policy [UFP]- Quality Assurance Project Plan [QAPP]) are being carried forward to the next phase (RIs) following the Comprehensive Environmental Response, Compensation, and Liability Act process:

- FT007P – AFFF Area 1: Former Fire Training Area (Site 9) and Outfall 007
- SS850P – AFFF Area 2: Hanger 850
- SS706P – AFFF Area 3: Building 706

- SS700P – AFFF Area 4: Building 700 and Outfall 004
- SS015P – AFFF Area 5: Blue Angels Crash Site
- SS101P – AFFF Area 6: Fox Row/Taxiway Alpha and Outfalls 005 and 009
- SS316P – AFFF Area 8: Hulby Street

In 2019, subsequent to the SIs, DoD adopted SLs for soil and groundwater, as described in a memorandum from the ASD titled *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* and signed into use on 15 September 2021 (ASD 2021). The ASD SLs applied to three compounds: PFOS, PFOA, and PFBS. In July 2022, DoD issued a revised memorandum from the ASD clarifying technical guidance on the investigation of PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA (GenX) accounting for the May 2022 EPA screening levels (ASD 2022).

This Phase I RI will be performed following the DoD policy. In addition, the most recent EPA SLs will be used for evaluating detected constituents. SLs to be used during the RI are provided in UFP-QAPP Worksheet #15.

2. QUALITY MANAGEMENT

2.1 OVERALL APPROACH

EA follows and implements a Corporate Quality Management Program. The mission of the program is to establish, maintain, and continually improve the efficiency of quality assurance(QA)/QC procedures that are developed with contract- and project-specific requirements. EA's Quality Management Program provides an integrated approach to advance a total quality system. EA's quality management approach involves the following:

- Use of a systematic planning process to develop acceptance or performance criteria for the collection, evaluation, or use of data and other information. This includes selection of project staff with the technical skills and knowledge to complete the work and preparation of project planning documentation.

- Ensuring that all work is conducted in accordance with approved plans and QC steps. This includes the use of Standard Operating Procedures (SOPs) as a means of performing technical work consistently and use of status reporting and tracking methods to maintain management oversight and control of work.

- Use of assessment tools to monitor and ensure that all work meets internal and external quality standards. These include Senior Technical Review (STR), engineering design reviews, data validation, data quality assessment, project/program reviews, and audits.

- Continuously striving for improvement, utilizing assessment tools to identify components that are functioning properly and those that may require corrective action.

2.2 ROLES AND RESPONSIBILITES

EA's quality management personnel, roles, and responsibilities for this TO are identified and described below.

2.2.1 Program Manager

The Program Manager provides program-level management oversight, supports the Project Manager with TO execution, and oversees coordination between USACE, EA, and subcontractors. The Program Manager participates in project reviews, including with USACE as required, and works to resolve contractual matters.

2.2.2 Contractor Quality Control Supervisor

The Contractor Quality Control Supervisor (CQCS) communicates with the Program Manager on quality-related matters and works to ensure that work is conducted in accordance with quality standards and that quality products are delivered to USACE. The CQCS or designee is independent of EA project management responsibilities and has the authority to review all aspects of project completion and has the authority to stop work if deficiencies in the work are noted. Duties of the CQCS or designee include:

- Overall implementation of the QCP;
- Identifying and reporting all nonconforming items;
- Making recommendations for any corrective actions;
- Inspecting, and documenting sampling activities;
- Assisting in monitoring site safety activities;
- Conducting training to ensure that all staff are cognizant of site QC objectives;
- Monitoring site activities for overall compliance including work (field and reporting) conducted by subcontractors;
- Ensuring that all analytical tests are in accordance with project requirements; and
- Interfacing with the Project Manager (PM) to keep him abreast of overall project quality.

2.2.3 Project Manager

The PM is responsible for coordinating with the CQCS to ensure QC procedures are being implemented as proposed in this QCP. In the event of non-compliance, the PM will work with the CQCS on how the issue can be corrected. The PM will be responsible for overseeing the implementation of QC activities and corrective actions as they occur. The PM will also coordinate with the Program Manager and USACE as QC issues arise.

2.2.4 Field Manager/Field Geologist

The Field Manager and/or Field Geologist will be responsible for QC procedures during sampling/testing at NFARS. The Field Manager/Field Geologist will ensure that sampling collection and sample shipping is completed in accordance with SOPs presented in the UFP–QAPP. The Field Manager/Field Geologist will oversee instrument calibration, health and safety compliance, and sample collection handling and shipment procedures.

2.2.5 Senior Technical Reviewer(s)

The designated STR will be assigned and involved in project planning and remain engaged throughout project execution, offering advice and providing technical direction. The STR is responsible for reviewing deliverables, independent of day-to-day work. The STR spot checks data and serves as a mentor for project staff.

2.3 QUALITY CONTROL PROCESS

All members of the project team are responsible for QC related to their work assignment. Individual team members are expected to employ QC procedures during execution of their normal duties. The EA QC program includes detail checking and independent/STR. Detail checking is used to verify information in project deliverables for correctness, completeness, and technical accuracy. Independent technical review is an evaluation of the significant opinions, conclusions, and recommendations that are produced during the project work and presented in deliverables. The procedures used to develop project results are reviewed to confirm the validity and suitability of results. Independent technical reviews are completed by senior EA personnel that are pre-qualified, including annual re-certification.

On-site QC will be performed by the Field Manager and/or Field Geologist to ensure that project processes and systems meet the project QC requirements. Through a continual improvement process, project staff at all levels will be encouraged to provide recommendations for improvements in established work processes and techniques. Where the improvement would necessitate a change to the work plan, a field change request will be initiated and approved by USACE prior to implementation.

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3. PRODUCT DEVELOPMENT

3.1 PRODUCT REVIEWS

Project document checks (e.g., for work plans, reports, tables, drawings, and appendices) will be performed by each discipline as an extension of the document preparation process. An individual qualified in the appropriate discipline will perform such checks. Checked computations, analyses, and drawings will be annotated to show the initials of the designer/originator and the checker. It is the responsibility of the product developer to coordinate the checks and to select a checker with the concurrence of the EA PM. The experience level of the checker will be commensurate with the level of complexity and risk.

3.2 INTERDISCIPLINARY REVIEWS

This process encompasses the day-to-day coordination between the product development team members throughout the product development process. The interdisciplinary check ensures that the portion of the product developed by one discipline does not conflict or interfere with the portion developed by another discipline. In addition, these checks provide an opportunity for each member of the product development team to review the entire product. Project documents that are included in the review process are presented in **Table 3-1**:

Table 3-1. Quality Control of Documents

Document	Prepared By	Reviewed By
Planning Documents	PM	STR
Field Documentation	Field Manager/Field Geologist	CQCS/PM
Daily Quality Control Reports (DQCRs)	Field Manager/Field Geologist	CQCS/PM
RI Report	PM	STR

3.3 INDEPENDENT TECHNICAL REVIEW

The independent technical review (ITR) is a formally conducted and documented review at the completion of various stages of product development. The ITR process assigns senior staff with significant experience in technical, managerial, and client activities to review specific portions of a product as the STR. The STRs are not involved with the day-to-day direction of the work product, however, input is solicited from these individuals at critical points in the development and performance of an assignment to ensure the product meets the client's needs and expectations. A signed certification will be provided that has the signatures of the ITR team and states that an ITR was accomplished and all comments resulting from that review have been incorporated into the documents.

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4. FIELD SAMPLING AND ANALYSIS QUALITY CONTROL

4.1 FIELD SAMPLING AND ANALYSIS

Sample collection will be performed using procedures outlined in the UFP-QAPP for the Phase I RI of PFAS at NFARS. Procedures for standard activities including sample collection are included in the field sampling portion(s) of the UFP-QAPP.

The UFP-QAPP also contains information concerning the sample analyses procedures and QA/QC that will be used during the project. EA will subcontract to Pace Analytical as the primary laboratory for analysis by liquid chromatography/tandem mass spectroscopy compliant with DoD Quality Systems Manual (QSM) Version 5.4 (DoD 2021) (or more recent), Table B-15. A list of analyses, respective analytical method references, and detection limits will be provided in the UFP-QAPP.

The following are to be completed daily during each sampling event by EA's Field Manager and/or Field Geologist:

- Sample collection field sheet(s) (Appendix B of the UFP-QAPP)
- Required Safety field form(s) (Attachment D of the Accident Prevention Plan [APP])
- Field Notes

At the conclusion of the sampling event, the Field Manager and/or Field Geologist will complete and sign the field notes and appropriate forms. Sampling procedures shall be in accordance with the instructions contained in the UFP-QAPP, including the SOPs.

4.2 SAMPLING LOCATIONS AND FREQUENCY

Sampling location, frequency, and analyses shall be in accordance with the UFP-QAPP.

4.3 FIELD QUALITY CONTROL

EA's Field Manager and/or Field Geologist will be responsible for QC procedures during sampling events. The Field Manager and/or Field Geologist will ensure that;

- Depth to groundwater measurements are being collected from the appropriate wells and using the appropriate reference point on the well casing.
- Stratigraphic changes are being appropriately logged during drilling and sampling activities and recorded at the correct depths.
- Equipment calibrations are being completed according to manufacturer's instructions.

- Multi-parameter water quality measurements are being determined and documented correctly by the field crew.

- Health and safety requirements from the APP are being followed and adhered to by all field crew members.

- Sample collection, handling, QA/QC, and shipment procedures are being followed.

The following field forms are to be completed daily during each sampling event:

- DQCR – To be completed daily by the Field Manager and/or Field Geologist and provided to the EA PM via e-mail that same night. The EA PM will review and edit the DQCR in consultation with the CQCS, and forward the final DQCR to the USACE PM and the NFARS RPM by the following day (an example of a DQCR is included in **Attachment A**).

- Chain-of-Custody Form (provided by the laboratory).

- Field Notes.

4.4 DATA EVALUATION

The laboratory will analyze samples for the analytes designated in the UFP-QAPP. The laboratory will provide analytical results to EA within 14 business days of receipt of the last field sample. If any delay occurs, EA shall notify the USACE PM and NFARS Restoration Program Manager (RPM) immediately followed by written confirmation in two working days stating the problem, cause, impact, and proposed remedy.

Laboratory analysis shall be performed in accordance with EPA or other industry standard analytical methodologies and laboratory standard operating procedures as appropriate and as specified in the UFP-QAPP. Variances from the procedures and protocols specified in these methods shall be documented and reported. The laboratory shall maintain DoD Environmental Laboratory Accreditation Program certification as well as any required state level certification, as appropriate.

The data generated during this project will be in accordance with the DoD QSM for Environmental Laboratories Version 5.4 (or higher), Table B-15. Data deliverables from the laboratory will be provided in both hard copy data packages and electronic data deliverable format. Electronic data will be maintained in an EQuIS® Environmental Data Management system and final validated data will be uploaded to the Environmental Resource Program Information Management System and NYSDEC's Environmental Information Management System in the standardized electronic data deliverable format. The data packages from the laboratory will be Level IV and meet DoD QSM Version 5.4 (or higher), Table-15 requirements to support data validation. Validation shall be performed to a 90 percent (%) Stage 2b and 10% Stage 4 standard, including DoD QSM Appendix B (DoD 2021) table requirements.

Data validation results will be further verified by the program chemist for accuracy and completeness. The data evaluation procedures discussed above will ensure that the data are of sufficient quality for use in the RIs. Any validation issues noted for the data will be evaluated by the project team during the data usability assessment.

4.5 QUALITY CONTROL SUMMARY

The analytical data shall be assessed, validated and the results of the validation will be summarized in the RI reports. The QC summary shall include, among other items as listed below, summary tables of analytes measured above detection limits (i.e., positive detections) as well as other required items. The QC summary will contain:

- A sample detail table per laboratory data package (sample delivery group), which relates field sample identifications to laboratory sample identifications, sampling date, analysis date, and analytical batch. This type of table may include more than one sample delivery group, listed sequentially
- A summary table of detected analytes per method, matrix, and sampling location, with final qualifiers
- A table of all analytical results (including non-detects) per method, matrix, and sampling location, with final qualifiers
- A table of laboratory QC elements per method and matrix
- A table of QC element outliers per method and matrix
- A table summarizing qualified analytes per sample, method, and matrix, with rationales for final qualifiers
- A data qualification scheme table.

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5. CONSTRUCTION QUALITY CONTROL

5.1 THREE PHASE CONTROL SYSTEM

The three phases of control (i.e., preparatory phase, initial phase, and follow-up phase) will be used for QC of construction activities (e.g., water treatment system) for definable features of work (DFW). The PM will oversee the implementation and documentation process. Worksheets for each phase of QC inspection are contained in **Attachment A**.

5.1.1 Preparatory Phase Inspection

The preparatory phase comprises the planning and design process leading up to the actual field activities. The Field Supervisor will perform a preparatory phase inspection before constructing each DFW. The purposes of this inspection are to review applicable specifications and plans to verify that the necessary resources, conditions, and controls are in place and compliant before work activities start. The preparatory phase inspection will also verify that the APP adequately identifies all hazards associated with actual field conditions and that the APP promulgates the appropriate safe work practices. Upon completion of the inspection, the Field Supervisor will complete the preparatory phase inspection checklist.

To perform the inspection, the Field Supervisor will review work plan documents and operating procedures. The Field Supervisor will verify that required plans and procedures have been approved and are available to the field staff; field equipment is appropriate, available, functional, and properly calibrated for its intended/stated use; staff responsibilities have been assigned and communicated; staff have the necessary knowledge, expertise, and information to perform their jobs; arrangements for support services have been made; training in accordance with the requirements of the work plan has occurred; and the prerequisite mobilization tasks have been completed. As part of the preparatory phase inspection, the Field Supervisor will verify that lessons learned during previous similar work have been incorporated, as appropriate, into the project procedures to prevent recurrence of past challenges. Project staff must correct or resolve discrepancies between existing conditions and the approved plans/procedures identified by the PM during the preparatory phase inspection. The Field Supervisor will verify that unsatisfactory and/or nonconforming conditions have been corrected in the work plan before beginning work.

5.1.2 Initial Phase Inspection

The initial phase occurs at the startup of construction activities associated with a DFW. At the onset of the operation, the PM will perform an initial phase inspection and complete the initial phase inspection checklist. The main objectives of the inspection are to check preliminary work for compliance with procedures and specifications, establish an acceptable level of workmanship, check for omissions, and resolve differences of interpretation. Should results of the inspection be unsatisfactory, the initial phase inspection will be rescheduled and performed again.

During the initial phase inspection, the Field Supervisor will ensure that discrepancies between site practices and approved plans or specifications are identified and resolved. The resolution of discrepancies is a critical step in the initial phase inspection. As applicable, the appropriate senior technical consultant (e.g., CQCS, Corporate Health and Safety Supervisor) will guide the PM and project team members in resolving discrepancies. If discrepancies arise in establishing the baseline quality for a project task, the responsibility for resolution falls to the PM. If the discrepancy cannot be resolved in a manner that satisfies the project requirements, it will be elevated to the program level (i.e., to the program manager) and a nonconformance report will be issued. With concurrence of the project team, the appropriate senior technical consultant may direct a cessation of work activity if an unresolved discrepancy jeopardizes the results of the task or puts the project at risk of non-conformance.

5.1.3 Follow-Up Phase Inspection

Completion of the initial phase inspection of QC activity leads directly into the follow-up phase, which is used to verify continuity of work quality through completion of a DFW. The Field Supervisor will remotely perform a follow-up phase inspection at regular intervals while a particular task is performed. This inspection ensures continuous compliance and verifies an acceptable level of workmanship. To conduct and document these inspections, the Field Supervisor will complete the follow-up phase inspection checklist. The Field Supervisor will remotely monitor on-site practices and operations taking place and verify continued compliance with the specifications and requirements of the work plan and approved amendments. The Field Supervisor will verify that daily health and safety inspections are performed and documented as prescribed in the APP. Discrepancies between site practices and approved plans/procedures will be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices will be resolved by the Field Supervisor before continuing work.

5.2 NON-CONFORMANCE AND CORRECTIVE ACTIONS

The EA PM or his designee will be responsible for identification of any project non-conformance and implementation of corrective action. Upon identification of any non-conformance, the non-conformance form contained in **Attachment B** will be completed and provided to the EA PM; the USACE PM and NFARS RPM will also be provided with an electronic copy of the non-conformance form within 24 hours.

Corrective actions arising from identification of non-conformances will be rectified by first completing a corrective action request form (**Attachment B**); the form will be completed according to its contained instructions on sheet number 2 of the form. A corrective action plan form (**Attachment B**) will also be completed according to the contained instructions. Both forms will be supplied to the recipients noted within their respective instructions; in addition, a copy of the forms will be provided to the USACE PM and NFARS RPM within 24 hours.

After sufficient time has passed for implementation of the corrective action for the non-conformance, a follow-up inspection will be made by the Field Supervisor to ensure that corrective actions have been undertaken. If corrective actions have not been undertaken, the Field Supervisor has the authority to stop work until such corrective actions have been made. At any time, if non-conformance results in a potential threat to on-site or off-site personnel, the Field Supervisor may stop work until the non-conformance has been corrected.

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6. SUBCONTRACTOR QUALITY CONTROL

Subcontractors will report to EA, which is responsible for overall project quality. The EA PM and Field Supervisor and/or Field Geologist will ensure that activities completed by EA field subcontractors will be in conformance with project requirements. The EA CQCS and Program Chemist will ensure that laboratory analytical services conducted in support of the project meet all project quality objectives in accordance with the UFP-QAPP. Field subcontractors will provide employees who will be properly trained before being allowed to complete any work on-site. Subcontractors are responsible for completing work in a professional, timely, and ethical manner. EA assumes responsibility for the services of subcontractors on-site and will maintain a close working relationship with the subcontractors utilized.

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7. REERENCES

Assistant Secretary of Defense (ASD). 2021. *Investigation Per- and Polyfluoroalkyl Substances within The Department of Defense Cleanup Program*. United States Department of Defense. 15 September.

Aerostar SES LLC (ASL). 2018. *Site Inspections Report of Fire Fighting Foam Usage at Niagara Falls Air Reserve Station*. Oak Ridge, Tennessee.

Department of Defense (DoD). 2021. *Department of Defense (DoD) Department of Energy (DoE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.4.* October.

U.S. Environmental Protection Agency (EPA). 2016a. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)*. Office of Water, EPA 822-R-16-005. May.

———. 2016b. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).* Office of Water, EPA 822-R-16-004. May.

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Attachment A

Phase Inspection Forms and Daily QC Report

EA Engineering, Science,
and Technology, Inc., PBC

PREPARATORY PHASE INSPECTION CHECKLIST

PROJECT: ____ DATE:___________________

TITLE AND NO. OF THE TECHNICIAL SECTION:

____

____

____

WORK PLAN REFERENCE:____

A. ATTENDANTS:

NAME **POSITION** **COMPANY**

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

8. ____

9. ____

10. ____

11. ____

12. ____

B. Submittals required to begin work:

	Item	Submittal No.	Action Code
1.			
2.			
3.			
4.			
5.			
6.			

C. Equipment to be used in executing work:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

D. Work Areas examined to ascertain that all preliminary work has been completed:

____
____
____

E. Methods and procedures for performing Quality Control, including specific testing requirements:

____
____
____

PART II

A. PERSONS IN ATTENDANCE: SEE MEETING ATTENDANCE SHEET (ATTACHED)

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

7. ______________________________

8. ______________________________

9. ______________________________

10. ______________________________

11. ______________________________

12. ______________________________

I HEREBY CERTIFY, THAT TO THE BEST OF MY KNOWLEDGE AND BELIEF, THAT THE ABOVE REQUIRED MATERIALS DELIVERED TO THE JOB SITE ARE THE SAME AS THOSE SUBMITTED AND APPROVED.

NAME OF PROJECT QC INSPECTOR: ______________________________

DATE:______________________________

SIGNATURE OF PROJECT QC INSPECTOR:______________________________

EA Engineering, Science,
and Technology, Inc., PBC

INITIAL PHASE INSPECTION CHECKLIST

PROJECT: ____ DATE:___________________

TITLE AND NO. OF THE TECHNICAL SECTION:

____

____

____

DESCRIPTION AND LOCATION OF WORK INSPECTION

____

____

A. KEY PERSONNEL PRESENT:

NAME	POSITION	COMPANY
1.		
2.		
3.		
4.		
5.		
6.		

B. MATERIALS BEING USED ARE IN STRICT COMPLIANCE WITH THE CONTRACT SPECIFICATIONS: YES ☐ NO ☐

IF NOT EXPLAIN BELOW:

____

____

____

____

C. PROCEDURES AND/OR WORK WITNESSED ARE IN STRICT COMPLIANCE WITH THE CONTRACT SPECIFICATIONS: YES ☐ NO ☐

IF NOT EXPLAIN BELOW:

____

____

____

____

D. WORKMANSHIP IS ACCEPTABLE : YES ☐ NO ☐

STATE WHERE IMPROVEMENT IS NEEDED:

____

____

____

____

E. WORKMANSHIP IS FREE OF SAFETY VIOLATIONS : YES ☐ NO ☐

IF NO, CORRECTIVE ACTION TAKEN:

____

____

____

____

NAME OF PROJECT QC INSPECTOR: ____

DATE:____________________________

SIGNATURE OF PROJECT QC INSPECTOR:____

EA Engineering, Science, and Technology, Inc., PBC

FOLLOW-UP PHASE INSPECTION CHECKLIST

DATE:_______________________________________

COMPANY/CONTRACTOR:____

PROJECT:____

Y=YES; N=NO; SEE REMARKS BLANK=NOT APPLICABLE	
WORK COMPLIES WITH WORK PLAN AS APPROVED IN INITIAL PHASE	

IDENTIFY DEFINABLE FEATURE OF WORK, LOCATION, AND LIST PERSONNEL PRESENT

INSPECTION PERFORMED & WHO PERFORMED TEST

NAME OF PROJECT QC INSPECTOR: ____

DATE:___________________________

SIGNATURE OF PROJECT QC INSPECTOR:____

EA Engineering, Science,
and Technology, Inc., PBC

FINAL INSPECTION CHECKLIST

PROJECT____ DATE:____________________

AREA OF INSPECTION :

____

____

____

____

A. TASK: STATUS OF

INSPECTION:____

____

____

____

____

____

____

____

I HEREBY CERTIFY, THAT TO THE BEST OF MY KNOWLEDGE AND BELIEF, THAT THE WORK INSPECTED IS COMPLETE AND ALL MATERIALS AND EQUIPMENT USED AND WORK PERFORMED WERE COMPLETED IN ACCORDANCE WITH THE APPROVED PLANS.

NAME OF PROJECT QC INSPECTOR: ____

DATE:__________________________

SIGNATURE OF PROJECT QC INSPECTOR:____

EA Engineering, Science,
and Technology, Inc., PBC

FINAL INSPECTION CHECKLIST
MEETING ATTENDANCE LIST

MEETING:		**DATE:**
NAME	**ORGANIZATION**	**PHONE NUMBER**

INSPECTION SCHEDULE AND TRACKING FORM

Project:

Project Manager:

Project QC Inspector/Staff:

Reference Number	Definable Feature of Work/Task	Preparatory		Initial		Follow-Up		Completion		Status
		Date Planned	Actual Date	Date Planned	Actual Date	Planned Begin/End	Actual Date	Planned Begin/End	Actual Date	

Remarks:

RIs for PFAS at Niagara Falls Air Reserve Station

Daily Quality Control Report (DQCR)

SITE: NFARS

DATE:

Contract No.: W912DR-19-D-0005

EA Project No.: 634250247

Delivery Order: W912DR22F0247

Weather:

Work Performed:

Other Notes:

Safety Meeting Issues:

Certification: I certify that the above report is complete and correct and that I, or my authorized representative, have inspected all work performed this day by the Prime Contractor and each subcontractor and have determined that all materials, equipment, and workmanship are in strict compliance with the plans and specification, except as may be noted above.

Signature: ______________________________ **Date:** ____________________

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Attachment B

Field Change and Corrective Action Forms

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NON-CONFORMANCE REPORT

PROJECT: **NCR NO.** **DATE:**

TO:

ORIGINAL TO EA CORPORATE QC MANAGER

ITEM: ____

WORK PLAN REFERENCE

REQUIREMENT:____

NONCONFORMANCE:

ISSUED BY: NAME: **TITLE:** **ORGANIZATION:**

DATE:

DISPOSITION: _________**ACCEPT** ________**REJECT**

DISPOSITION APPROVALS:

TASK MANAGER DATE	FCR REQUIRED? ☐ YES ☐ NO
PROJECT MANAGER DATE	DISTRIBUTION

REMARKS:

EA Engineering, Science,
and Technology, Inc., PBC

CORRECTIVE ACTION REQUEST (CAR)

PART A: TO BE COMPLETED BY PROJECT MANAGER OR DESIGNEE

(1) **PROJECT:**	
(2) **PROJECT MGR:**	(3) **QC MGR/STAFF:**
(4) **CAR NO (S)AND DATE (S) ISSUED**	
(5) **DEFICIENCY DESCRIPTION AND LOCATION**	

(6) **PLANNED ACTIONS**	(7) **ASSIGNED RESPONSIBILITY**	(8) **COMPLETION DUE DATE**

(9) **PROJECT MANAGER SIGNATURE:** **DATE:**

PART B TO BE COMPLETED BY CQCS OR DESIGNEE

(10) **CAP REVIEWED BY** **DATE**

(11) **REVIEWER COMMENTS**

(12) **CAP DISPOSITION: (CHECK ONLY ONE AND EXPLAIN STIPULATIONS, IF ANY.**

☐ **APPROVED WITHOUT STIPULATIONS**
☐ **APPROVED WITH STIPULATIONS**
☐ **APPROVED DELAYED, FURTHER PLANNING REQUIRED**

COMMENTS:

(13) **CQCS SIGNATURE** **DATE**

CORRECTIVE ACTION REQUEST (CAR) INSTRUCTION SHEET

(1) Task Manager: Verify that the total number of pages includes all attachments.

(2) Task Manager: Fill in CAR number from CAR log.

(3) CQCS: Fill in appropriate priority category. High priority indicates resolution of deficiency requires expediting corrective action plan and correction of deficient conditions noted in the CAR and extraordinary resources may be required due to the deficiencies impact on continuing operations. Normal priority indicates that the deficiency resolution process may be accomplished without further impacting continuing operations.

(4) CAR Requestor: Fill in date CAR is initiated.

(5) CAR Requestor: Identify project name, number, CTO, and WAD.

(6) CAR Requestor: Identify Project Manager

(7) CAR Requestor: Identify CQC System Manager.

(8) CAR Requestor: Identify project organization, group, or discrete work environment where deficiency was first discovered.

(9) CAR Requestor: Identify line manager responsible for work unit where deficiency was discovered.

(10) Task Manager: Identify responsible manager designated to resolve deficiency (this may not be work unit manager).

(11) CAR Requestor: Identify source of requirement violated in contract, work planning document, procedure, instruction, etc; use exact reference to page and, when applicable, paragraph.

(12) CAR Requestor: Identify problem as it relates to requirement previously stated. Identify location of work activities impacted by deficiency.

(13) Task Manager: Identify if Corrective Action Plan (CAP) is required. CAP is typically required where one or more of the following conditions apply: CAR priority is High; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent future recurrence.

(14) Task Manager: Identify date by which proposed corrective action is due to QC for concurrence.

(15) Task Manager: Sign and date CAR and forward to responsible manager identified in (10) above.

(16) Responsible Manager: Initial to acknowledge receipt of CAR.

(17) Responsible Manager: Complete corrective action plan and identify date of correction. Typical corrective action response will include statement regarding how the condition occurred, what the extent of the problem is (if not readily apparent by the problem description statement in [12]), methods to be used to correct the condition, and actions to be taken to prevent the condition from recurring. If a CAP is required, refer to CAP only in this section.

(18) Responsible Manager: Sign and date corrective action response.

(19) Task Manager: Initial to identify concurrence with corrective action response from responsible manager.

(20) Task Manager: Check appropriate block to identify if corrective action process is complete so that CAR may be closed. Add close-out comments relevant to block checked.

(21) Task Manager: Indicate document closeout by signing and dating.

EA Engineering, Science,
and Technology, Inc., PBC

CORRECTIVE ACTION PLAN

(2) CAR#	(3) Priority: High ☐ Normal ☐	(4) Date Prepared:

Part A: Notice of Deficiency

(5) Project:	
(6) Project Mgr:	(7) QC Mgr/Staff:
(8) Construction Mgr:	(9) Task Manager:
(10) Issued to (Individual & Organization)	
(11) Requirement & Reference	
(12) Problem Description & Location: (13) CAP Required? Yes ☐ No ☐ (14) Response Due:	
(15) Issued by (Printed Name & Title) Signature: Date:	(16) Management Concurrence:

Part B Corrective Action

(17) Proposed Corrective Action/Action Taken	
(18) Part B Completed By (Name & Title) Date	(19) QC Concurrence

Part C

(20) CAR Verification and Close Out: (Check only one & and Explain Stipulations, If any)

☐ Approved for Closure without Stipulations

☐ Approved for Closure with following stipulations

Comments/Stipulations:

(21) Closed by (Printed name and Title)

Signature: Date:

CORRECTIVE ACTION PLAN INSTRUCTION SHEET

(1) Task Manager: Verify that the total number of pages includes all attachments.

(2) Task Manager: Fill in CAR number from CAR log.

(3) CQCS: Fill in appropriate priority category. High priority indicates resolution of deficiency requires expediting corrective action plan and correction of deficient conditions noted in the CAR and extraordinary resources may be required due to the deficiencies impact on continuing operations. Normal priority indicates that the deficiency resolution process may be accomplished without further impacting continuing operations.

(4) CAR Requestor: Fill in date CAR is initiated.

(5) CAR Requestor: Identify project name, number, CTO, and WAD.

(6) CAR Requestor: Identify Project Manager

(7) CAR Requestor: Identify CQC System Manager.

(8) CAR Requestor: Identify project organization, group, or discrete work environment where deficiency was first discovered.

(9) CAR Requestor: Identify line manager responsible for work unit where deficiency was discovered.

(10) Task Manager: Identify responsible manager designated to resolve deficiency (this may not be work unit manager).

(11) CAR Requestor: Identify source of requirement violated in contract, work planning document, procedure, instruction, etc; use exact reference to page and, when applicable, paragraph.

(12) CAR Requestor: Identify problem as it relates to requirement previously stated. Identify location of work activities impacted by deficiency.

(13) Task Manager: Identify if Corrective Action Plan (CAP) is required. CAP is typically required where one or more of the following conditions apply: CAR priority is High; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent future recurrence.

(14) Task Manager: Identify date by which proposed corrective action is due to QC for concurrence.

(15) Task Manager: Sign and date CAR and forward to responsible manager identified in (10) above.

(16) Responsible Manager: Initial to acknowledge receipt of CAR.

(17) Responsible Manager: Complete corrective action plan and identify date of correction. Typical corrective action response will include statement regarding how the condition occurred, what the extent of the problem is (if not readily apparent by the problem description statement in [12]), methods to be used to correct the condition, and actions to be taken to prevent the condition from recurring. If a CAP is required, refer to CAP only in this section.

(18) Responsible Manager: Sign and date corrective action response.

(19) Task Manager: Initial to identify concurrence with corrective action response from responsible manager.

(20) Task Manager: Check appropriate block to identify if corrective action process is complete so that CAR may be closed. Add close-out comments relevant to block checked.

(21) Task Manager: Indicate document closeout by signing and dating.

Field Change Request (FCR) Form

FCR #:	**DATE:**
PROJECT NAME:	**TASK MANAGER:**

1. Description (Items involved, submit sketch, if applicable): (Use continuation sheet if necessary)

2. Reason for Change (Use continuation sheet if necessary)

3. Recommended Disposition (Submit sketch, if applicable): (Use continuation sheet if necessary)

Preparer of FCR (Print name and sign)	Preparer’s Title	Date
PM- Reviewed (Print name and sign)	Accepted (Y/N)	Date
QC – Reviewed (Print name and sign)	Accepted (Y/N)	Date
Field Manager – Reviewed (Print name and sign)	Accepted (Y/N)	Date
USACE – Reviewed (Print name and sign)	Accepted (Y/N)	Date
NBG/A4VR – Reviewed (Print name and sign)	Accepted (Y/N)	Date

Field Change Form

Project Name and Location	**Project/Task Order Number**	**Client Name**
Date prepared		**Prepared by**

Title and version of work plan

Reason for action

Existing plan or procedure

Proposed change

External Review

Regulatory or contractual conditions:

Signatures

The proposed change, with the stated conditions if applicable, is hereby approved.

Regulatory PM	NFARS RPM	USACE PM
Date	Date	Date

Appendix G

Laboratory Standard Operating Procedures and Certifications

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ANAB
ANSI National Accreditation Board

CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Pace Analytical – South Carolina

106 Vantage Point Drive
West Columbia, SC 29172

Fulfills the requirements of

ISO/IEC 17025:2017

and the

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.3)

In the field of

TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 18 November 2024
Certificate Number: L2224.01

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017 AND U.S. DEPARTMENT OF DEFENSE (DOD) QUALITY SYSTEMS MANUAL FOR ENVIRONMENTAL LABORATORIES (DOD QSM V5.3)

Pace Analytical – South Carolina

106 Vantage Point Drive
West Columbia, SC 29172
Kelly Nance
803-227-2702

TESTING

Valid to: **November 18, 2024**

Certificate Number: **L2224**

Environmental

Non-Potable Water

Technology	Method	Analyte
GC	EPA 8151A	2,4,5-T
GC	EPA 8151A	2,4D
GC	EPA 8151A	2,4DB
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	Dichloroprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	Silvex(2,4,5 TP)
GC/MS	EPA 8270E	0,0,0-Triethylphosphorothioate
GC/MS	EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270E	1,2-Dichlorobenzene
GC/MS	EPA 8270E	1,3-Dichlorobenzene
GC/MS	EPA 8270E	1,3,5-Trinitrobenzene
GC/MS	EPA 8270E	1,4-Benzoquinone
GC/MS	EPA 8270E	1,4-Dichlorobenzene
GC/MS	EPA 8270E	1,4-Dinitrobenzene
GC/MS	EPA 8270E	1,4-Naphthoquinone

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270E	1-Chloronaphthalene
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	1-Naphthylamine
GC/MS	EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,3,5,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 8270E	2,4-Dinitrotoluene
GC/MS	EPA 8270E	2,6-Dichlorophenol
GC/MS	EPA 8270E	2,6-Dinitrotoluene
GC/MS	EPA 8270E	2-Acetylaminofluorene
GC/MS	EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 8270E	2-Chlorophenol
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylphenol
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 8270E	2-Nitroaniline
GC/MS	EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	2-Picoline
GC/MS	EPA 8270E	3,3’-Dichlorobenzidine
GC/MS	EPA 8270E	3,3’-Dimethylbenzidine
GC/MS	EPA 8270E	3-Methylcholanthrene
GC/MS	EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4,4’-Methylene-bis-chloroaniline
GC/MS	EPA 8270E	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 8270E	4-Bromophenylphenylether
GC/MS	EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 8270E	4-Chloroaniline
GC/MS	EPA 8270E	4-Chlorophenylphenylether
GC/MS	EPA 8270E	4-Nitroaniline
GC/MS	EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	5-Nitro-o-toluidine

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270E	7,12-Dimethylbenzo(a)anthracene
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Acetophenone
GC/MS	EPA 8270E	Aniline
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Aramite
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Azobenzene
GC/MS	EPA 8270E	Benzaldhyde
GC/MS	EPA 8270E	Benzidine
GC/MS	EPA 8270E	Benzo(a)Anthracene
GC/MS	EPA 8270E	Benzo(a)pyrene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Benzoic acid
GC/MS	EPA 8270E	Benzyl alcohol
GC/MS	EPA 8270E	Biphenyl
GC/MS	EPA 8270E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270E	bis(2-Chloroethyl)ether
GCMS	EPA 8270E	Bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 8270E	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 8270E	Butylbenzylphthalate
GC/MS	EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Carbazole
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	Chlorobenzilate
GC/MS	EPA 8270E	DEET
GC/MS	EPA 8270E	Diallate
GC/MS	EPA 8270E	Dibenzo(a,h)acridine
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzo(a,e)pyrene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Diethylphthalate
GC/MS	EPA 8270E	Dimethoate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Dimethylphthalate
GC/MS	EPA 8270E	Di-n-butylphthalate
GC/MS	EPA 8270E	Di-n-octylphthalate
GC/MS	EPA 8270E	Dinoseb
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Ethyl methacrylate
GC/MS	EPA 8270E	Ethyl methanesulfonate
GC/MS	EPA 8270E	Famphur
GC/MS	EPA 8270E	Fluoranthene
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Hexachloropropene
GC/MS	EPA 8270E	Indene
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Isodrin
GC/MS	EPA 8270E	Isophorone
GC/MS	EPA 8270E	Isosafrole
GC/MS	EPA 8270E	Kepone
GC/MS	EPA 8270E	m+p-Cresol
GC/MS	EPA 8270E	m-Dinitrobenzene
GC/MS	EPA 8270E	Methyl methacrylate
GC/MS	EPA 8270E	Methyl methanesulfonate
GC/MS	EPA 8270E	Methyl parathion
GC/MS	EPA 8270E	Mirex
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	N-Nitrosodiethylamine
GC/MS	EPA 8270E	N-Nitrosodimethylamine
GC/MS	EPA 8270E	N-Nitrosodi-n-butylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	N-Nitrosomethylethylamine
GC/MS	EPA 8270E	N-Nitrosomorpholine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	N-Nitrosopiperidine
GC/MS	EPA 8270E	N-Nitrosopyrrolidine
GC/MS	EPA 8270E	o-Cresol
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	p-(Dimethylamino)azobenzene
GC/MS	EPA 8270E	Parathion
GC/MS	EPA 8270E	Pentachlorobenzene
GC/MS	EPA 8270E	Pentachloroethane
GC/MS	EPA 8270E	Pentachloronitrobenzene
GC/MS	EPA 8270E	Pentachlorophenol
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 8270E	Phenanthrene
GC/MS	EPA 8270E	Phenol
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	Pronamide
GC/MS	EPA 8270E	Pyrene
GC/MS	EPA 8270E	Pyridine
GC/MS	EPA 8270E	Quinoline
GC/MS	EPA 8270E	Safrole
GC/MS	EPA 8270E	Tetraethyl dithiopyrophosphate
GC/MS	EPA 8270E	Thionazine
GC/MS	EPA 8270E	Tributyl phosphate
GC/MS	EPA 8270E	p-Phenylenediamine
GC/MS	EPA 8270E SIM	Acenaphthene
GC/MS	EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 8270E SIM	Anthracene
GC/MS	EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 8270E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E SIM	1,4-Dioxane
GC/MS	EPA 8270E SIM	Fluoranthene
GC/MS	EPA 8270E SIM	Fluorene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270E SIM	1-Methylphenol
GC/MS	EPA 8270E SIM	2-Methylphenol
GC/MS	EPA 8270E SIM	Naphthalene
GC/MS	EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E SIM	Phenanthrene
GC/MS	EPA 8270E SIM	Pyrene
GC/MS	EPA 625.1	Acenaphthene
GC/MS	EPA 625.1	Acenaphthylene
GC/MS	EPA 625.1	Aniline
GC/MS	EPA 625.1	Anthracene
GC/MS	EPA 625.1	Benzidine
GC/MS	EPA 625.1	Benzo(a)anthracene
GC/MS	EPA 625.1	Benzo(a)pyrene
GC/MS	EPA 625.1	Benzo(b)fluoranthene
GC/MS	EPA 625.1	Benzo(g,h,i)perylene
GC/MS	EPA 625.1	Benzo(k)fluoranthene
GC/MS	EPA 625.1	Benzoic acid
GC/MS	EPA 625.1	Benzyl alcohol
GC/MS	EPA 625.1	4-Bromophenyl phenyl ether
GC/MS	EPA 625.1	Butyl benzyl phthalate
GC/MS	EPA 625.1	Carbazole
GC/MS	EPA 625.1	bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 625.1	4-Chloro-3-methyl phenol
GC/MS	EPA 625.1	4-Chloroaniline
GC/MS	EPA 625.1	bis(2-Chloroethoxy)methane
GC/MS	EPA 625.1	bis(2-Chloroethyl)ether
GC/MS	EPA 625.1	2-Chloronaphthalene
GC/MS	EPA 625.1	2-Chlorophenol
GC/MS	EPA 625.1	4-Chlorophenyl phenyl ether
GC/MS	EPA 625.1	Chrysene
GC/MS	EPA 625.1	n-Decane
GC/MS	EPA 625.1	Dibenzo(a,h)anthracene
GC/MS	EPA 625.1	Dibenzofuran
GC/MS	EPA 625.1	2,3-Dichloroaniline
GC/MS	EPA 625.1	1,2-Dichlorobenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 625.1	1,3-Dichlorobenzene
GC/MS	EPA 625.1	1,4-Dichlorobenzene
GC/MS	EPA 625.1	3,3'-Dichlorobenzidine
GC/MS	EPA 625.1	2,4-Dichlorophenol
GC/MS	EPA 625.1	2,6-Dichlorophenol
GC/MS	EPA 625.1	Diethylphthalate
GC/MS	EPA 625.1	Dimethyl phthalate
GC/MS	EPA 625.1	3,3'-Dimethylbenzidine
GC/MS	EPA 625.1	2,4-Dimethylphenol
GC/MS	EPA 625.1	Di-n-butyl phthalate
GC/MS	EPA 625.1	4,6-Dinitro-2-methylphenol
GC/MS	EPA 625.1	2,4-Dinitrophenol
GC/MS	EPA 625.1	2,4-Dinitrotoluene
GC/MS	EPA 625.1	2,6-Dinitrotoluene
GC/MS	EPA 625.1	Di-n-octylphthalate
GC/MS	EPA 625.1	1,2-Diphenylhydrazine(as azobenzene)
GC/MS	EPA 625.1	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 625.1	Fluoranthene
GC/MS	EPA 625.1	Fluorene
GC/MS	EPA 625.1	Hexachlorobenzene
GC/MS	EPA 625.1	Hexachlorobutadiene
GC/MS	EPA 625.1	Hexachlorocyclopentadiene
GC/MS	EPA 625.1	Hexachloroethane
GC/MS	EPA 625.1	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 625.1	Isophorone
GC/MS	EPA 625.1	1-Methylnaphthalene
GC/MS	EPA 625.1	2-Methylnaphthalene
GC/MS	EPA 625.1	2-Methylphenol
GC/MS	EPA 625.1	3+4-Methylphenol
GC/MS	EPA 625.1	N,N-Diethyl-m-toluamide (DEET)
GC/MS	EPA 625.1	Naphthalene
GC/MS	EPA 625.1	Nitrobenzene
GC/MS	EPA 625.1	2-Nitrophenol
GC/MS	EPA 625.1	4-Nitrophenol
GC/MS	EPA 625.1	N-Nitrosodimethylamine
GC/MS	EPA 625.1	N-Nitrosodi-n-propylamine

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 625.1	N-Nitrosodiphenylamine (Diphenylamine)
GC/MS	EPA 625.1	n-Octadecane
GC/MS	EPA 625.1	Pentachlorophenol
GC/MS	EPA 625.1	Phenanthrene
GC/MS	EPA 625.1	Phenol
GC/MS	EPA 625.1	Piperonyl butoxide (PIP)
GC/MS	EPA 625.1	Pyrene
GC/MS	EPA 625.1	alpha-Terpineol
GC/MS	EPA 625.1	1,2,4-Trichlorobenzene
GC/MS	EPA 625.1	2,4,6-Trichlorophenol
GC/MS	EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 8260D	1,1,2,2-Tetrachloroethene
GC/MS	EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethene
GC/MS	EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 8260D	1,2,3-Trichlorobenzene
GC/MS	EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260D	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260D	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260D	1,2-Dichlorobenzene
GC/MS	EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 8260D	1,2-Dichloropropane
GC/MS	EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260D	1,3-Dichlorobenzene
GC/MS	EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 8260D	1,4-Dichlorobenzene
GC/MS	EPA 8260D	1,4-Dioxane
GC/MS	EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 8260D	2-Butanone (MEK)
GC/MS	EPA 8260D	2-Chloroethylvinyl ether
GC/MS	EPA 8260D	2-Chlorotoluene
GC/MS	EPA 8260D	2-Hexanone

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	3,3-Dimethyl-1-butanol
GC/MS	EPA 8260D	4-Chlorotoluene
GC/MS	EPA 8260D	4-Methyl-2-pentanone
GC/MS	EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 8260D	Acrolein
GC/MS	EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride
GC/MS	EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl chloride
GC/MS	EPA 8260D	Bromobenzene
GC/MS	EPA 8260D	Bromochloromethane
GC/MS	EPA 8260D	Bromodichloromethane
GC/MS	EPA 8260D	Bromoform
GC/MS	EPA 8260D	Bromomethane
GC/MS	EPA 8260D	Carbon disulfide
GC/MS	EPA 8260D	Carbon tetrachloride
GC/MS	EPA 8260D	Chlorobenzene
GC/MS	EPA 8260D	Chloroethane
GC/MS	EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloromethane
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 8260D	cis-1,2-Dichloroethene
GC/MS	EPA 8260D	cis-1,3-Dichloropropene
GC/MS	EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 8260D	Dibromochloromethane
GC/MS	EPA 8260D	Dibromomethane
GC/MS	EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diisopropyl ether (IPE)
GC/MS	EPA 8260D	Ethanol
GC/MS	EPA 8260D	Ethyl ether
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260D	Ethylbenzene
GC/MS	EPA 8260D	Ethyl-Tert-Butyl Ether
GC/MS	EPA 8260D	Freon 113

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Isobutyl alcohol
GC/MS	EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	m+p-Xylenes
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 8260D	Methyl Acetate
GC/MS	EPA 8260D	Methyl iodide
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 8260D	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 8260D	Methylcyclohexane
GC/MS	EPA 8260D	Methylene chloride
GC/MS	EPA 8260D	Naphthalene
GC/MS	EPA 8260D	n-Butylbenzene
GC/MS	EPA 8260D	n-Propylbenzene
GC/MS	EPA 8260D	o-Xylene
GC/MS	EPA 8260D	Pentachloroethane
GC/MS	EPA 8260D	p-Isopropyltoluene
GC/MS	EPA 8260D	Propionitrile
GC/MS	EPA 8260D	sec-Butylbenzene
GC/MS	EPA 8260D	Styrene
GC/MS	EPA 8260D	Tert-Amyl Alcohol (TAA)
GC/MS	EPA 8260D	Tert-Amyl Methyl Ether (TAME)
GC/MS	EPA 8260D	Tert-Butyl Alcohol (TBA)
GC/MS	EPA 8260D	Tert-Butyl Formate (TBF)
GC/MS	EPA 8260D	tert-Butylbenzene
GC/MS	EPA 8260D	Tetrachloroethene
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 8260D	Toluene
GC/MS	EPA 8260D	Total Xylenes
GC/MS	EPA 8260D	trans-1,2-Dichloroethene
GC/MS	EPA 8260D	trans-1,3-Dichloropropene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	Trichloroethene
GC/MS	EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 8260D	Vinyl acetate
GC/MS	EPA 8260D	Vinyl chloride

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D SIM	1,4-Dioxane
GC/MS	EPA 624.1	Acetone
GC/MS	EPA 624.1	Acetonitrile
GC/MS	EPA 624.1	Acrolein
GC/MS	EPA 624.1	Acrylonitrile
GC/MS	EPA 624.1	Benzene
GC/MS	EPA 624.1	Bromochloromethane
GC/MS	EPA 624.1	Bromodichloromethane
GC/MS	EPA 624.1	Bromoform
GC/MS	EPA 624.1	Bromomethane (Methyl bromide)
GC/MS	EPA 624.1	2-Butanone (MEK)
GC/MS	EPA 624.1	Carbon disulfide
GC/MS	EPA 624.1	Carbon tetrachloride
GC/MS	EPA 624.1	Chlorobenzene
GC/MS	EPA 624.1	Chloroethane
GC/MS	EPA 624.1	2-Chloroethylvinylether
GC/MS	EPA 624.1	Chloroform
GC/MS	EPA 624.1	Chloromethane (Methyl chloride)
GC/MS	EPA 624.1	Dibromochloromethane
GC/MS	EPA 624.1	1,2-Dibromoethane (EDB)
GC/MS	EPA 624.1	1,2-Dichlorobenzene
GC/MS	EPA 624.1	1,3-Dichlorobenzene
GC/MS	EPA 624.1	1,4-Dichlorobenzene
GC/MS	EPA 624.1	Dichlorodifluoromethane
GC/MS	EPA 624.1	1,1-Dichloroethane
GC/MS	EPA 624.1	1,2-Dichloroethane
GC/MS	EPA 624.1	1,1-Dichloroethene
GC/MS	EPA 624.1	cis-1,2-Dichloroethene
GC/MS	EPA 624.1	trans-1,2-Dichloroethene
GC/MS	EPA 624.1	1,2-Dichloropropane
GC/MS	EPA 624.1	cis-1,3-Dichloropropene
GC/MS	EPA 624.1	trans-1,3-Dichloropropene
GC/MS	EPA 624.1	Diisopropyl ether (IPE)
GC/MS	EPA 624.1	1,4-Dioxane
GC/MS	EPA 624.1	Ethylbenzene
GC/MS	EPA 624.1	Methyl methacrylate

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 624.1	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 624.1	Methylene chloride
GC/MS	EPA 624.1	Naphthalene
GC/MS	EPA 624.1	Styrene
GC/MS	EPA 624.1	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624.1	Tetrachloroethene
GC/MS	EPA 624.1	Toluene
GC/MS	EPA 624.1	1,2,4-Trichlorobenzene
GC/MS	EPA 624.1	1,1,1-Trichloroethane
GC/MS	EPA 624.1	1,1,2-Trichloroethane
GC/MS	EPA 624.1	Trichloroethene
GC/MS	EPA 624.1	Trichlorofluoromethane
GC/MS	EPA 624.1	1,2,4-Trimethylbenzene
GC/MS	EPA 624.1	1,3,5-Trimethylbenzene
GC/MS	EPA 624.1	Vinyl acetate
GC/MS	EPA 624.1	Vinyl chloride
GC/MS	EPA 624.1	Xylenes (total)
GC/MS	SM 6200B-2011	Benzene
GC/MS	SM 6200B-2011	Bromobenzene
GC/MS	SM 6200B-2011	Bromochloromethane
GC/MS	SM 6200B-2011	Bromodichloromethane
GC/MS	SM 6200B-2011	Bromoform
GC/MS	SM 6200B-2011	Bromomethane (Methyl bromide)
GC/MS	SM 6200B-2011	n-Butylbenzene
GC/MS	SM 6200B-2011	sec-Butylbenzene
GC/MS	SM 6200B-2011	tert-Butylbenzene
GC/MS	SM 6200B-2011	Carbon tetrachloride
GC/MS	SM 6200B-2011	Chlorobenzene
GC/MS	SM 6200B-2011	Chloroethane
GC/MS	SM 6200B-2011	Chloroform
GC/MS	SM 6200B-2011	Chloromethane (Methyl chloride)
GC/MS	SM 6200B-2011	2-Chlorotoluene
GC/MS	SM 6200B-2011	4-Chlorotoluene
GC/MS	SM 6200B-2011	Dibromochloromethane
GC/MS	SM 6200B-2011	1,2-Dibromoethane (EDB)
GC/MS	SM 6200B-2011	Dibromomethane (Methylene bromide)

Non-Potable Water

Technology	Method	Analyte
GC/MS	SM 6200B-2011	1,2-Dichlorobenzene
GC/MS	SM 6200B-2011	1,3-Dichlorobenzene
GC/MS	SM 6200B-2011	1,4-Dichlorobenzene
GC/MS	SM 6200B-2011	Dichlorodifluoromethane
GC/MS	SM 6200B-2011	1,1-Dichloroethane
GC/MS	SM 6200B-2011	1,2-Dichloroethane
GC/MS	SM 6200B-2011	1,1-Dichloroethene
GC/MS	SM 6200B-2011	cis-1,2-Dichloroethene
GC/MS	SM 6200B-2011	trans-1,2-Dichloroethene
GC/MS	SM 6200B-2011	1,2-Dichloropropane
GC/MS	SM 6200B-2011	1,3-Dichloropropane
GC/MS	SM 6200B-2011	2,2-Dichloropropane
GC/MS	SM 6200B-2011	1,1-Dichloropropene
GC/MS	SM 6200B-2011	cis-1,3-Dichloropropene
GC/MS	SM 6200B-2011	trans-1,3-Dichloropropene
GC/MS	SM 6200B-2011	Diisopropyl ether (IPE)
GC/MS	SM 6200B-2011	Ethylbenzene
GC/MS	SM 6200B-2011	Hexachlorobutadiene
GC/MS	SM 6200B-2011	Isopropylbenzene (Cumene)
GC/MS	SM 6200B-2011	p-Isopropyltoluene (p-Cymene)
GC/MS	SM 6200B-2011	Methyl tertiary butyl ether (MTBE)
GC/MS	SM 6200B-2011	4-Methyl-2-pentanone
GC/MS	SM 6200B-2011	Methylene chloride
GC/MS	SM 6200B-2011	Naphthalene
GC/MS	SM 6200B-2011	n-Propylbenzene
GC/MS	SM 6200B-2011	Styrene
GC/MS	SM 6200B-2011	1,1,1,2-Tetrachloroethane
GC/MS	SM 6200B-2011	1,1,2,2-Tetrachloroethane
GC/MS	SM 6200B-2011	Tetrachloroethene
GC/MS	SM 6200B-2011	Toluene
GC/MS	SM 6200B-2011	1,1,2-Trichloro-1,2,2-Trifluoroethane
GC/MS	SM 6200B-2011	1,2,3-Trichlorobenzene
GC/MS	SM 6200B-2011	1,2,4-Trichlorobenzene
GC/MS	SM 6200B-2011	1,1,1-Trichloroethane
GC/MS	SM 6200B-2011	1,1,2-Trichloroethane
GC/MS	SM 6200B-2011	Trichloroethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	SM 6200B-2011	Trichlorofluoromethane
GC/MS	SM 6200B-2011	1,2,3-Trichloropropane
GC/MS	SM 6200B-2011	1,3,5-Trimethylbenzene (Mesitylene)
GC/MS	SM 6200B-2011	1,2,4-Trimethylbenzene
GC/MS	SM 6200B-2011	Vinyl chloride
GC/MS	SM 6200B-2011	m+p - Xylenes
GC/MS	SM 6200B-2011	o-Xylene
GC	EPA 8081B	4,4'-DDD
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Mirex
GC	EPA 8081B	Toxaphene
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268
GC	EPA 608.3	Aldrin
GC	EPA 608.3	gamma-BHC (Lindane)
GC	EPA 608.3	alpha-BHC
GC	EPA 608.3	beta-BHC
GC	EPA 608.3	delta-BHC
GC	EPA 608.3	Chlordane
GC	EPA 608.3	cis-Chlordane
GC	EPA 608.3	trans-Chlordane
GC	EPA 608.3	4,4'-DDD
GC	EPA 608.3	4,4'-DDE
GC	EPA 608.3	4,4'-DDT
GC	EPA 608.3	Dieldrin
GC	EPA 608.3	Endosulfan I
GC	EPA 608.3	Endosulfan II
GC	EPA 608.3	Endosulfan sulfate
GC	EPA 608.3	Endrin
GC	EPA 608.3	Endrin aldehyde
GC	EPA 608.3	Endrin ketone
GC	EPA 608.3	Heptachlor
GC	EPA 608.3	Heptachlor epoxide
GC	EPA 608.3	Methoxychlor
GC	EPA 608.3	Toxaphene
GC	EPA 608.3	Aroclor 1016
GC	EPA 608.3	Aroclor 1221
GC	EPA 608.3	Aroclor 1232
GC	EPA 608.3	Aroclor 1242
GC	EPA 608.3	Aroclor 1248
GC	EPA 608.3	Aroclor 1254
GC	EPA 608.3	Aroclor 1260
HPLC	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330A	1,3-Dinitrobenzene
HPLC	EPA 8330A	2,4-Dinitrotoluene
HPLC	EPA 8330A	2,6-Dinitrotoluene

Non-Potable Water

Technology	Method	Analyte
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330B	Nitrocellulose
HPLC	EPA 8330B	Nitroguanidine
HPLC	EPA 8330B	Guanidine nitrate
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	1,3,5-Trinitrobenzene
HPLC	EPA 8330A	2,4,6-Trinitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	HMX
HPLC	EPA 8330B	Nitrobenzene
HPLC	EPA 8330B	Nitroglycerin (NG)
HPLC	EPA 8330B	2-Nitrotoluene
HPLC	EPA 8330B	3-Nitrotoluene
HPLC	EPA 8330B	4-Nitrotoluene
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	Tetryl
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 8:2 [1H,1H,2H,2H-perfluorodecane sulfonate] (8:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 4:2 [1H,1H,2H,2H-perfluorohexane sulfonate] (4:2 FTS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 6:2 [1H,1H,2H,2H-perfluorooctane sulfonate] (6:2 FTS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	GenX (HFPO-DA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-butanesulfonate (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-butanoic acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-decanesulfonate (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-decanoic acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-dodecanoic acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-heptanesulfonate (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-heptanoic acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-hexanesulfonate (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-hexanoic acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-nonanesulfonate (PFNS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-nonanoic acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorooctanesulfonate (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-octanesulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-octanoic acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-pentanoic acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-pentansulfonate (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-tetradecanoic acid (PFTeDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-tridecanoic acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-undecanoic acid (PFUDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-methylperfluoro-1-octanesulfonamide (MeFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-ethylperfluoro-1-octanesulfonamide (EtFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	1H,1H,2H,2H-perfluorododecane sulfonate (10:2FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-Ethyl Perfluorooctane sulfonamido ethanol (EtFOSE)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-Methyl Perfluorooctane sulfonamido ethanol (MeFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Sodium dodecafluoro-3H-4, 8-dioxanonanoate (NaDONA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	9Cl-PF3ONS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	11Cl-PF3OUDS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorododecanesulfonic acid (PFDOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorooctadecanoic acid (PFODA)
GC	EPA 8015C	Diesel Range Organics
GC	EPA 8015C	WI-Diesel Range Organics
GC	EPA 8015C	Gasoline Range Organics
GC	EPA 8015C	WI-Gasoline Range Organics
GC	RSK - 175	Methane, Ethane, Ethene
GC	EPA 8011	1,2-Dibromoethane (EDB)
GC	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
GC	FL-PRO	FL-PRO
ICP	EPA 6010D	Aluminum
ICP	EPA 6010D	Antimony
ICP	EPA 6010D	Arsenic
ICP	EPA 6010D	Barium
ICP	EPA 6010D	Beryllium
ICP	EPA 6010D	Cadmium
ICP	EPA 6010D	Calcium
ICP	EPA 6010D	Chromium
ICP	EPA 6010D	Cobalt
ICP	EPA 6010D	Copper

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 6010D	Iron
ICP	EPA 6010D	Lead
ICP	EPA 6010D	Magnesium
ICP	EPA 6010D	Manganese
ICP	EPA 6010D	Molybdenum
ICP	EPA 6010D	Nickel
ICP	EPA 6010D	Potassium
ICP	EPA 6010D	Selenium
ICP	EPA 6010D	Silver
ICP	EPA 6010D	Sodium
ICP	EPA 6010D	Thallium
ICP	EPA 6010D	Tin
ICP	EPA 6010D	Vanadium
ICP	EPA 6010D	Zinc
ICP/MS	EPA 200.8	Aluminum
ICP/MS	EPA 200.8	Antimony
ICP/MS	EPA 200.8	Arsenic
ICP/MS	EPA 200.8	Barium
ICP/MS	EPA 200.8	Beryllium
ICP/MS	EPA 200.8	Boron
ICP/MS	EPA 200.8	Cadmium
ICP/MS	EPA 200.8	Calcium
ICP/MS	EPA 200.8	Chromium
ICP/MS	EPA 200.8	Cobalt
ICP/MS	EPA 200.8	Copper
ICP/MS	EPA 200.8	Iron
ICP/MS	EPA 200.8	Lead
ICP/MS	EPA 200.8	Magnesium
ICP/MS	EPA 200.8	Manganese
ICP/MS	EPA 200.8	Molybdenum
ICP/MS	EPA 200.8	Nickel
ICP/MS	EPA 200.8	Potassium
ICP/MS	EPA 200.8	Selenium
ICP/MS	EPA 200.8	Silicon
ICP/MS	EPA 200.8	Silver
ICP/MS	EPA 200.8	Sodium

Non-Potable Water

Technology	Method	Analyte
ICP/MS	EPA 200.8	Thallium
ICP/MS	EPA 200.8	Tin
ICP/MS	EPA 200.8	Titanium
ICP/MS	EPA 200.8	Vanadium
ICP/MS	EPA 200.8	Zinc
ICP/MS	EPA 6020B	Aluminum
ICP/MS	EPA 6020B	Antimony
ICP/MS	EPA 6020B	Arsenic
ICP/MS	EPA 6020B	Barium
ICP/MS	EPA 6020B	Beryllium
ICP/MS	EPA 6020B	Cadmium
ICP/MS	EPA 6020B	Calcium
ICP/MS	EPA 6020B	Chromium
ICP/MS	EPA 6020B	Cobalt
ICP/MS	EPA 6020B	Copper
ICP/MS	EPA 6020B	Iron
ICP/MS	EPA 6020B	Lead
ICP/MS	EPA 6020B	Magnesium
ICP/MS	EPA 6020B	Manganese
ICP/MS	EPA 6020B	Nickel
ICP/MS	EPA 6020B	Potassium
ICP/MS	EPA 6020B	Selenium
ICP/MS	EPA 6020B	Silver
ICP/MS	EPA 6020B	Sodium
ICP/MS	EPA 6020B	Thallium
ICP/MS	EPA 6020B	Tin
ICP/MS	EPA 6020B	Vanadium
ICP/MS	EPA 6020B	Zinc
CVAA	EPA 1631E	Low Level Mercury
CVAA	EPA 7470A / EPA 245.1	Mercury
Gravimetric	EPA 1664B	Oil & Grease
Titration	SM 2320B-2011	Alkalinity
Calculation	SM 2320B-2011	Bicarbonate Alkalinity
Calculation	SM 2320B-2011	Carbonate Alkalinity
Calculation	SM 2320B-2011	Hydroxide Alkalinity
Calculation	SM 4500-CO2 D	Carbon Dioxide (CO2)

Non-Potable Water

Technology	Method	Analyte
Photometric	SM 2120F-2011	Color
Photometric	SM 2120B-2011	Platinum Cobalt Color
UV/VIS	SM 3500-Fe B-2011	Ferrous Iron
Titration	SM 4500-S2 F-2011	Sulfide
Wet Oxidation	EPA 9060A	TOC
Wet Oxidation	SM 5310C-2011	TOC
Titration	SM 2340C-2011	Total Hardness
Filtration	SM 2540C-2011	Total Dissolved Solids (TDS)
Filtration	SM 2540D-2011	Total Suspended Solids (TSS)
UV/VIS	Kelada-01	Total Cyanide
UV/VIS	SM 4500-CN E-2011	Total Cyanide
UV/VIS	EPA 9012B	Total Cyanide
UV/VIS	EPA 9065	Phenolics
UV/VIS	EPA 9066	Phenolics
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Chloride
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Bromide
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 218.6	Hexavalent chromium
IC	EPA 7199	Hexavalent chromium
UV/VIS	EPA 7196A	Hexavalent chromium
Discrete Analyzer	SM 3500-Cr B-2011	Hexavalent chromium
Pensky-Martens	EPA 1010A	Ignitability
Electrode	EPA 9040C	Corrosivity
Electrode	SM 4500-H B-2011	Corrosivity

Non-Potable Water

Technology	Method	Analyte
Electrode	EPA 120.1	Specific Conductance
Electrode	EPA 180.1	Turbidity
Photometric	Sec. 7.3.3 SW-846	Reactive Cyanide
Titration	Sec. 7.3.4 SW-846	Reactive Sulfide
UV/VIS	EPA 353.2	Nitrate
UV/VIS	EPA 353.2	Nitrite
UV/VIS	EPA 353.2	Nitrate-Nitrite
UV/VIS	EPA 365.1	Phosphorus/ Orthophosphate
Gas Diffusion / UV/VIS	EPA 350.1	Ammonia - N
UV/VIS	EPA 351.2	TKN
UV/VIS	SM 5220D-2011	COD
GC	MADEP-EPH-MOD	Extractable Petroleum Hydrocarbons (EPH) Modified
GC	MADEP-VPH-MOD	Volatile Petroleum Hydrocarbons (VPH) Modified
Preparation	**Method**	**Type**
Organic Preparation	EPA 3520C	Organic Prep. of Water by Continuous Liquid-Liquid
Organic Preparation	EPA 3535A	Solid-Phase Extraction (SPE)
Organic Cleanup	EPA 3620B	Florisil Cleanup Procedure
Organic Cleanup	EPA 3660B	Sulfur Cleanup Procedure
Organic Cleanup	EPA 3665A	Sulfuric Acid Cleanup Procedure
Waste Dilution	EPA 3580A	Waste Dilution
Volatile Organic Preparation	EPA 5030B	Purge-and-Trap for Aqueous Samples
Volatile Organic Preparation	EPA 5035	Closed-System Purge-and-Trap and extraction for Volatile Organics in Soil and Waste Samples
Volatile Organic Preparation	EPA 3585	Waste Dilution for Volatile Organics
Inorganic Preparation	EPA 3005A	Preparation of Waters by Hotblock
Inorganic Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
Inorganic Metals Preparation	EPA 3010A	Acid Digestion of Aqueous Samples and TCLP/SPLP Extracts for ICP analysis
Inorganic Metals Preparation	EPA 3030C	Acid Digestion of Aqueous Samples for ICP Spectroscopy
Organic Cleanup	EPA 3640	GPC Cleanup Procedure

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	Dichloroprop
GC	EPA 8151A	MCPP
GC	EPA 8151A	MCPA
GC	EPA 8151A	2,4D
GC	EPA 8151A	Silvex(2,4,5 TP)
GC	EPA 8151A	2,4,5-T
GC	EPA 8151A	2,4DB
GC	EPA 8151A	Dinoseb
GC/MS	EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270E	1,2-Dichlorobenzene
GC/MS	EPA 8270E	1,3-Dichlorobenzene
GC/MS	EPA 8270E	1,4-Dichlorobenzene
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 8270E	2,4-Dinitrotoluene
GC/MS	EPA 8270E	2,6-Dichlorophenol
GC/MS	EPA 8270E	2,6-Dinitrotoluene
GC/MS	EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 8270E	2-Chlorophenol
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylphenol
GC/MS	EPA 8270E	2-Nitroaniline
GC/MS	EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	3,3'-Dichlorobenzidine
GC/MS	EPA 8270E	3,3'-Dimethylbenzidine
GC/MS	EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270E	4-Bromophenylphenylether

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 8270E	4-Chloroaniline
GC/MS	EPA 8270E	4-Chlorophenylphenylether
GC/MS	EPA 8270E	4-Nitroaniline
GC/MS	EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Acetophenone
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Azobenzene
GC/MS	EPA 8270E	Benzaldhyde
GC/MS	EPA 8270E	Benzidine
GC/MS	EPA 8270E	Benzo(a)Anthracene
GC/MS	EPA 8270E	Benzo(a)pyrene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Benzoic acid
GC/MS	EPA 8270E	Benzyl alcohol
GC/MS	EPA 8270E	Biphenyl
GC/MS	EPA 8270E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270E	bis(2-Chloroethyl)ether
GCMS	EPA 8270E	Bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 8270E	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 8270E	Butylbenzylphthalate
GC/MS	EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Carbazole
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	DEET
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Diethylphthalate
GC/MS	EPA 8270E	Dimethylphthalate
GC/MS	EPA 8270E	Di-n-butylphthalate
GC/MS	EPA 8270E	Di-n-octylphthalate

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270E	Fluoranthene
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Isophorone
GC/MS	EPA 8270E	m+p-Cresol
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	N-Nitrosodimethylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	N-Nitrosopyrrolidine
GC/MS	EPA 8270E	o-Cresol
GC/MS	EPA 8270E	Pentachlorophenol
GC/MS	EPA 8270E	Phenanthrene
GC/MS	EPA 8270E	Phenol
GC/MS	EPA 8270E	Pyrene
GC/MS	EPA 8270E	Pyridine
GC/MS	EPA 8270E	n-Nitrosopiperidine
GC/MS	EPA 8270E	n-Nitrosomethylethylamine
GC/MS	EPA 8270E	p-Phenylenediamine
GC/MS	EPA 8270E	2-Picoline
GC/MS	EPA 8270E	1-Naphthylamine
GC/MS	EPA 8270E	n-Nitrosodiethylamine
GC/MS	EPA 8270E	n-Nitrosomorpholine
GC/MS	EPA 8270E	p-(Dimethylamino)azobenzene
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 8270E	Pentachloronitrobenzene (Quintozene)
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	5-Nitro-o-toluidine

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270E SIM	Acenaphthene
GC/MS	EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 8270E SIM	Anthracene
GC/MS	EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 8270E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E SIM	1,4-Dioxane
GC/MS	EPA 8270E SIM	Fluoranthene
GC/MS	EPA 8270E SIM	Fluorene
GC/MS	EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270E SIM	1-Methylphenol
GC/MS	EPA 8270E SIM	2-Methylphenol
GC/MS	EPA 8270E SIM	Naphthalene
GC/MS	EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E SIM	Phenanthrene
GC/MS	EPA 8270E SIM	Pyrene
GC/MS	EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 8260D	1,1,2,2-Tetrachloroethene
GC/MS	EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethene
GC/MS	EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 8260D	1,2,3-Trichlorobenzene
GC/MS	EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260D	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260D	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260D	1,2-Dichlorobenzene
GC/MS	EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 8260D	1,2-Dichloropropane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260D	1,3-Dichlorobenzene
GC/MS	EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 8260D	1,4-Dichlorobenzene
GC/MS	EPA 8260D	1,4-Dioxane
GC/MS	EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 8260D	2-Butanone (MEK)
GC/MS	EPA 8260D	2-Chloroethylvinyl ether
GC/MS	EPA 8260D	2-Chlorotoluene
GC/MS	EPA 8260D	2-Hexanone
GC/MS	EPA 8260D	4-Chlorotoluene
GC/MS	EPA 8260D	4-Methyl-2-pentanone
GC/MS	EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 8260D	Acrolein
GC/MS	EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride
GC/MS	EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl chloride
GC/MS	EPA 8260D	Bromobenzene
GC/MS	EPA 8260D	Bromochloromethane
GC/MS	EPA 8260D	Bromodichloromethane
GC/MS	EPA 8260D	Bromoform
GC/MS	EPA 8260D	Bromomethane
GC/MS	EPA 8260D	Carbon disulfide
GC/MS	EPA 8260D	Carbon tetrachloride
GC/MS	EPA 8260D	Chlorobenzene
GC/MS	EPA 8260D	Chloroethane
GC/MS	EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloromethane
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 8260D	cis-1,2-Dichloroethene
GC/MS	EPA 8260D	cis-1,3-Dichloropropene
GC/MS	EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 8260D	Dibromochloromethane

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260D	Dibromomethane
GC/MS	EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diisopropyl ether (IPE)
GC/MS	EPA 8260D	Ethyl ether
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260D	Ethylbenzene
GC/MS	EPA 8260D	Freon 113
GC/MS	EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Isobutyl alcohol
GC/MS	EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	m+p-Xylenes
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 8260D	Methyl Acetate
GC/MS	EPA 8260D	Methyl iodide
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 8260D	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 8260D	Methylcyclohexane
GC/MS	EPA 8260D	Methylene chloride
GC/MS	EPA 8260D	Naphthalene
GC/MS	EPA 8260D	n-Butylbenzene
GC/MS	EPA 8260D	n-Propylbenzene
GC/MS	EPA 8260D	o-Xylene
GC/MS	EPA 8260D	Pentachloroethane
GC/MS	EPA 8260D	p-Isopropyltoluene
GC/MS	EPA 8260D	Propionitrile
GC/MS	EPA 8260D	sec-Butylbenzene
GC/MS	EPA 8260D	Styrene
GC/MS	EPA 8260D	tert-Butylbenzene
GC/MS	EPA 8260D	Tetrachloroethene
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 8260D	Toluene
GC/MS	EPA 8260D	Total Xylenes
GC/MS	EPA 8260D	trans-1,2-Dichloroethene
GC/MS	EPA 8260D	trans-1,3-Dichloropropene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	Trichloroethene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 8260D	Vinyl acetate
GC/MS	EPA 8260D	Vinyl chloride
GC/MS	EPA 8260C SIM	1,4-Dioxane
GC	EPA 8081B	4,4'-DDD
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Mirex
GC	EPA 8081B	Toxaphene
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330A	1,3-Dinitrobenzene
HPLC	EPA 8330A	2,4-Dinitrotoluene
HPLC	EPA 8330A	2,6-Dinitrotoluene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	1,3,5-Trinitrobenzene
HPLC	EPA 8330A	2,4,6-Trinitrotoluene
GC	EPA 8015C	Diesel Range Organics
GC	EPA 8015C	WI-Diesel Range Organics
GC	EPA 8015C	Gasoline Range Organics
GC	EPA 8015C	WI-Gasoline Range Organics
GC	FL-PRO	FL-PRO
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 8:2 [1H,1H,2H,2H-perfluorodecane sulfonate] (8:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 4:2 [1H,1H,2H,2H-perfluorohexane sulfonate] (4:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Fluorotelomer sulfonate 6:2 [1H,1H,2H,2H-perfluorooctane sulfonate] (6:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	GenX (HFPO-DA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-butanesulfonate (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-butanoic acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-decanesulfonate (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-decanoic acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-dodecanoic acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-heptanesulfonate (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-heptanoic acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-hexanesulfonate (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-hexanoic acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-nonanesulfonate (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-nonanoic acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorooctanesulfonate (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-octanesulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-octanoic acid (PFOA)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-pentanoic acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-1-pentansulfonate (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-tetradecanoic acid (PFTeDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-tridecanoic acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluoro-n-undecanoic acid (PFUDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-methylperfluoro-1-octanesulfonamide (MeFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-ethylperfluoro-1-octanesulfonamide (EtFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	1H,1H,2H,2H-perfluorododecane sulfonate (10:2FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-Ethyl Perfluorooctane sulfonamido ethanol (EtFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	N-Methyl Perfluorooctane sulfonamido ethanol (MeFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Sodium dodecafluoro-3H-4, 8-dioxanonanoate (NaDONA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	9Cl-PF3ONS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	11Cl-PF3OUDS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorododecanesulfonic acid (PFDOS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	Perfluorooctadecanoic acid (PFODA)
HPLC	EPA 8330B MOD	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B MOD	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B MOD	1,3-Dinitrobenzene
HPLC	EPA 8330B MOD	2,4-Dinitrotoluene
HPLC	EPA 8330B MOD	2,6-Dinitrotoluene
HPLC	EPA 8330B MOD	HMX
HPLC	EPA 8330B MOD	Nitrobenzene
HPLC	EPA 8330B MOD	Nitrocellulose
HPLC	EPA 8330B MOD	Nitroguanidine
HPLC	EPA 8330B MOD	Guanidine nitrate
HPLC	EPA 8330B MOD	Nitroglycerin (NG)
HPLC	EPA 8330B MOD	2-Nitrotoluene
HPLC	EPA 8330B MOD	3-Nitrotoluene
HPLC	EPA 8330B MOD	4-Nitrotoluene
HPLC	EPA 8330B MOD	RDX
HPLC	EPA 8330B MOD	Tetryl
HPLC	EPA 8330B MOD	1,3,5-Trinitrobenzene
HPLC	EPA 8330B MOD	2,4,6-Trinitrotoluene
ICP	EPA 6010D	Aluminum
ICP	EPA 6010D	Antimony
ICP	EPA 6010D	Arsenic
ICP	EPA 6010D	Barium
ICP	EPA 6010D	Beryllium
ICP	EPA 6010D	Cadmium
ICP	EPA 6010D	Calcium
ICP	EPA 6010D	Chromium
ICP	EPA 6010D	Cobalt
ICP	EPA 6010D	Copper
ICP	EPA 6010D	Iron
ICP	EPA 6010D	Lead
ICP	EPA 6010D	Magnesium

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010D	Manganese
ICP	EPA 6010D	Molybdenum
ICP	EPA 6010D	Nickel
ICP	EPA 6010D	Potassium
ICP	EPA 6010D	Selenium
ICP	EPA 6010D	Silver
ICP	EPA 6010D	Sodium
ICP	EPA 6010D	Thallium
ICP	EPA 6010D	Tin
ICP	EPA 6010D	Vanadium
ICP	EPA 6010D	Zinc
ICP/MS	EPA 6020B	Aluminum
ICP/MS	EPA 6020B	Antimony
ICP/MS	EPA 6020B	Arsenic
ICP/MS	EPA 6020B	Barium
ICP/MS	EPA 6020B	Beryllium
ICP/MS	EPA 6020B	Cadmium
ICP/MS	EPA 6020B	Calcium
ICP/MS	EPA 6020B	Chromium
ICP/MS	EPA 6020B	Cobalt
ICP/MS	EPA 6020B	Copper
ICP/MS	EPA 6020B	Iron
ICP/MS	EPA 6020B	Lead
ICP/MS	EPA 6020B	Magnesium
ICP/MS	EPA 6020B	Manganese
ICP/MS	EPA 6020B	Nickel
ICP/MS	EPA 6020B	Potassium
ICP/MS	EPA 6020B	Selenium
ICP/MS	EPA 6020B	Silver
ICP/MS	EPA 6020B	Sodium
ICP/MS	EPA 6020B	Thallium
ICP/MS	EPA 6020B	Vanadium
ICP/MS	EPA 6020B	Zinc
CVAA	EPA 7471B	Mercury
Titration	Walkley-Black	TOC
UV/VIS	EPA 9012B	Total Cyanide

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
UV/VIS	EPA 9065	Phenolics
UV/VIS	EPA 9066	Phenolics
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 7199 / EPA 3060A	Hexavalent chromium
UV/VIS	EPA 7196A EPA 3060A	Hexavalent chromium
Pensky-Martens	EPA 1010A	Ignitability
Electrode	EPA 9045D	Corrosivity
Photometric	Sec. 7.3.3 SW-846	Reactive Cyanide
Titration	Sec. 7.3.4 SW-846	Reactive Sulfide
Filtration	EPA 9095B	Paint Filter Test
UV/VIS	EPA 365.1 MOD	Phosphorus
UV/VIS	EPA 353.2 MOD	Nitrate
UV/VIS	EPA 353.2 MOD	Nitrite
UV/VIS	EPA 353.2 MOD	Nitrate-Nitrite
UV/VIS	EPA 350.1	Ammonia
Gas Diffusion / UV/VIS	EPA 350.1	Ammonia - N
UV/VIS	EPA 351.2 MOD	TKN
GC	MADEP-EPH MOD	Extractable Petroleum Hydrocarbons (EPH) Modified
GC	MADEP-VPH-MOD	Volatile Petroleum Hydrocarbons (VPH) Modified
Preparation	**Method**	**Type**
Organic Preparation	EPA 3550C	Preparation of Soil by Sonication
Organic Preparation	EPA 3546	Microwave Extraction
Organic Cleanup	EPA 3620B	Florisil Cleanup Procedure
Organic Cleanup	EPA 3660B	Sulfur Cleanup Procedure

Solid and Chemical Materials

Technology	Method	Analyte
Organic Cleanup	EPA 3665A	Sulfuric Acid Cleanup Procedure
Organic Cleanup	EPA 3640C	GPC Cleanup Procedure
Volatile Organic Preparation	EPA 5035	Closed-System Purge-and-Trap and extraction for Volatile Organics in Soil and Waste Samples
Volatile Organic Preparation	EPA 3585	Waste Dilution for Volatile Organics
Waste Dilution	EPA 3580A	Waste Dilution
Inorganic Preparation	EPA 3050B	Preparation of Soils by Hotblock
Inorganic Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
Inorganic Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure (SPLP)
Inorganic Metals Preparation	EPA 3010A	Acid Digestion of Aqueous Samples and TCLP/SPLP Extracts

Biological Tissue

Technology	Method	Analyte
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Toxaphene
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221

Biological Tissue		
Technology	**Method**	**Analyte**
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268
GC/MS	EPA 8270E	1,1’-Biphenyl
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Benzo(a)anthracene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Dimethoate
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Fluoranthene
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Methyl parathion
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Phenanthrene
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	Pronamide
GC/MS	EPA 8270E	Pyrene
Preparation	**Method**	**Type**
Organic Preparation	EPA 3540C	Soxhlet Extraction

Drinking water

Technology	Method	Analyte
GC/MS	EPA 524.2	1,1,1,2-Tetrachloroethane
GC/MS	EPA 524.2	1,1,1-Trichloroethane
GC/MS	EPA 524.2	1,1,2,2-Tetrachloroethane
GC/MS	EPA 524.2	1,1,2-Trichloroethane
GC/MS	EPA 524.2	1,1-Dichloroethane
GC/MS	EPA 524.2	1,1-Dichloroethene
GC/MS	EPA 524.2	1,1-Dichloropropene
GC/MS	EPA 524.2	1,2,3-Trichlorobenzene
GC/MS	EPA 524.2	1,2,3-Trichloropropane
GC/MS	EPA 524.2	1,2,4-Trichlorobenzene
GC/MS	EPA 524.2	1,2,4-Trimethylbenzene
GC/MS	EPA 524.2	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 524.2	1,2-Dibromoethane (EDB)
GC/MS	EPA 524.2	1,2-Dichlorobenzene
GC/MS	EPA 524.2	1,2-Dichloroethane
GC/MS	EPA 524.2	1,2-Dichloropropane
GC/MS	EPA 524.2	1,3,5-Trimethylbenzene
GC/MS	EPA 524.2	1,3-Dichlorobenzene
GC/MS	EPA 524.2	1,3-Dichloropropane
GC/MS	EPA 524.2	1,4-Dichlorobenzene
GC/MS	EPA 524.2	2,2-Dichloropropane
GC/MS	EPA 524.2	2-Butanone (MEK)
GC/MS	EPA 524.2	2-Chlorotoluene
GC/MS	EPA 524.2	2-Hexanone
GC/MS	EPA 524.2	2-Nitropropane
GC/MS	EPA 524.2	3-Chloropropene (Allyl chloride)
GC/MS	EPA 524.2	4-Chlorotoluene
GC/MS	EPA 524.2	4-Methyl-2-pentanone
GC/MS	EPA 524.2	Acetone
GC/MS	EPA 524.2	Acrylonitrile
GC/MS	EPA 524.2	Benzene
GC/MS	EPA 524.2	Bromobenzene
GC/MS	EPA 524.2	Bromochloromethane
GC/MS	EPA 524.2	Bromodichloromethane
GC/MS	EPA 524.2	Bromoform
GC/MS	EPA 524.2	Bromomethane (Methyl bromide)
GC/MS	EPA 524.2	Carbon disulfide
GC/MS	EPA 524.2	Carbon tetrachloride

Drinking water		
Technology	**Method**	**Analyte**
GC/MS	EPA 524.2	Chlorobenzene
GC/MS	EPA 524.2	Chloroethane
GC/MS	EPA 524.2	Chloroform
GC/MS	EPA 524.2	Chloromethane (Methyl chloride)
GC/MS	EPA 524.2	cis-1,2-Dichloroethene
GC/MS	EPA 524.2	cis-1,3-Dichloropropene
GC/MS	EPA 524.2	Cyclohexane
GC/MS	EPA 524.2	Dibromochloromethane
GC/MS	EPA 524.2	Dibromomethane (Methylene bromide)
GC/MS	EPA 524.2	Dichlorodifluoromethane
GC/MS	EPA 524.2	Ethyl ether
GC/MS	EPA 524.2	Ethyl methacrylate
GC/MS	EPA 524.2	Ethylbenzene
GC/MS	EPA 524.2	Hexachlorobutadiene
GC/MS	EPA 524.2	Isopropylbenzene
GC/MS	EPA 524.2	m+p - Xylenes
GC/MS	EPA 524.2	Methacrylonitrile
GC/MS	EPA 524.2	Methyl iodide (Iodomethane)
GC/MS	EPA 524.2	Methyl methacrylate
GC/MS	EPA 524.2	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 524.2	Methylene chloride
GC/MS	EPA 524.2	Naphthalene
GC/MS	EPA 524.2	n-Butylbenzene
GC/MS	EPA 524.2	n-Propylbenzene
GC/MS	EPA 524.2	o - Xylenes
GC/MS	EPA 524.2	Pentachloroethane
GC/MS	EPA 524.2	p-Isopropyltoluene
GC/MS	EPA 524.2	Propionitrile (Ethyl cyanide)
GC/MS	EPA 524.2	sec-Butylbenzene
GC/MS	EPA 524.2	Styrene
GC/MS	EPA 524.2	tert-Butylbenzene
GC/MS	EPA 524.2	Tetrachloroethene
GC/MS	EPA 524.2	Toluene
GC/MS	EPA 524.2	trans-1,2-Dichloroethene
GC/MS	EPA 524.2	trans-1,3-Dichloropropene
GC/MS	EPA 524.2	trans-1,4-Dichloro-2-butene

Drinking water

Technology	Method	Analyte
GC/MS	EPA 524.2	Trichloroethene
GC/MS	EPA 524.2	Trichlorofluoromethane
GC/MS	EPA 524.2	Vinyl chloride
GC/MS	EPA 524.2	Xylenes (total)
LC/MS/MS	EPA 537.1	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	EPA 537.1	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	EPA 537.1	Perfluoro-1-butanesulfonate (PFBS)
LC/MS/MS	EPA 537.1	Perfluoro-n-decanoic acid (PFDA)
LC/MS/MS	EPA 537.1	Perfluoro-n-dodecanoic acid (PFDoA)
LC/MS/MS	EPA 537.1	Perfluoro-n-heptanoic acid (PFHpA)
LC/MS/MS	EPA 537.1	Perfluoro-1-hexanesulfonate (PFHxS)
LC/MS/MS	EPA 537.1	Perfluoro-n-hexanoic acid (PFHxA)
LC/MS/MS	EPA 537.1	Perfluoro-n-nonanoic acid (PFNA)
LC/MS/MS	EPA 537.1	Perfluorooctanesulfonate (PFOS)
LC/MS/MS	EPA 537.1	Perfluoro-n-octanoic acid (PFOA)
LC/MS/MS	EPA 537.1	Perfluoro-n-tetradecanoic acid (PFTeDA)
LC/MS/MS	EPA 537.1	Perfluoro-n-tridecanoic acid (PFTrDA)
LC/MS/MS	EPA 537.1	Perfluoro-n-undecanoic acid (PFUDA)
LC/MS/MS	EPA 537.1	NaDONA
LC/MS/MS	EPA 537.1	GenX
LC/MS/MS	EPA 537.1	9CL-PF3ONS
LC/MS/MS	EPA 537.1	11CL-PF3OUDS
LC/MS/MS	EPA 533	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA 533	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA 533	1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)
LC/MS/MS	EPA 533	1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)
LC/MS/MS	EPA 533	1H, 1H, 2H, 2H-perfluorohexane sulfonic acid (4:2 FTS)
LC/MS/MS	EPA 533	Hexafluoropropylene oxide dimer acid (GenX)
LC/MS/MS	EPA 533	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA 533	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA 533	Perfluoro(2-ehtoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA 533	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA 533	Perfluoroheptanesulfonic acid (PFHpS)

Drinking water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA 533	Perfluoropentanesulfonic acid (PFPeS)
LC/MS/MS	EPA 533	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA 533	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA 533	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA 533	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA 533	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA 533	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA 533	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA 533	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA 533	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA 533	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA 533	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA 533	Perfluoroundecanoic acid (PFUdA)
LC/MS/MS	EPA 533	Perfluorooctanesulfonic acid (PFOS)

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2224.

R. Douglas Leonard Jr., VP, PILR SBU

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SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

PACE ANALYTICAL GULF COAST
7979 Innovation Park Drive
Baton Rouge, LA 70820
April Zarychta 225-769-7059

Valid To: August 31, 2024 Certificate Number: 6429.01

In recognition of the successful completion of the A2LA evaluation process, including an assessment of the laboratory's compliance with the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.4 of the DoD/DOE Quality Systems Manual for Environmental Laboratories, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies: ICP-MS, IC, FIA, GC-MS, GC-ED, CVAA, Spectrophotometer, GC-FID, LC/MS/MS, GC-ECD, GC-NPD, HPLC

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Metals		
Aluminum	EPA 6020B	EPA 6020B
Antimony	EPA 6020B	EPA 6020B
Arsenic	EPA 6020B	EPA 6020B
Barium	EPA 6020B	EPA 6020B
Beryllium	EPA 6020B	EPA 6020B
Boron	EPA 6020B	EPA 6020B
Cadmium	EPA 6020B	EPA 6020B
Calcium	EPA 6020B	EPA 6020B
Chromium	EPA 6020B	EPA 6020B
Cobalt	EPA 6020B	EPA 6020B
Copper	EPA 6020B	EPA 6020B
Iron	EPA 6020B	EPA 6020B
Lead	EPA 6020B	EPA 6020B
Magnesium	EPA 6020B	EPA 6020B
Manganese	EPA 6020B	EPA 6020B
Molybdenum	EPA 6020B	EPA 6020B
Nickel	EPA 6020B	EPA 6020B
Potassium	EPA 6020B	EPA 6020B
Selenium	EPA 6020B	EPA 6020B

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Silver	EPA 6020B	EPA 6020B
Sodium	EPA 6020B	EPA 6020B
Strontium	EPA 6020B	EPA 6020B
Thallium	EPA 6020B	EPA 6020B
Tin	EPA 6020B	EPA 6020B
Titanium	EPA 6020B	EPA 6020B
Total Hardness		
Vanadium	EPA 6020B	EPA 6020B
Zinc	EPA 6020B	EPA 6020B
Zirconium	EPA 6020B	EPA 6020B
Mercury	EPA 7470A	EPA 7471B
Volatiles		
1,1,1,2-Tetrachloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,1,1-Trichloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,1,2,2-Tetrachloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,1,2-Trichloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,1-Dichloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,1-Dichloroethene	EPA 8260B/C/D	EPA 8260B/C/D
1,1-Dichloropropene	EPA 8260B/C/D	EPA 8260B/C/D
1,2 Dichlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,2 Dichloroethane	EPA 8260B/C/D	EPA 8260B/C/D
1,2,3-Trichlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,2,3-Trichloropropane	EPA 8260B/C/D	EPA 8260B/C/D
1,2,4-Trichlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,2,4-Trimethylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260B/C/D	EPA 8260B/C/D
1,2-Dibromoethane (EDB)	EPA 8260B/C/D	EPA 8260B/C/D
1,2-Dichloropropane	EPA 8260B/C/D	EPA 8260B/C/D
1,3 Dichlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,3,5-Trimethylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
1,3-Dichloropropane	EPA 8260B/C/D	EPA 8260B/C/D
1,4 Dichlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
1-Chlorohexane	EPA 8260B/C/D	EPA 8260B/C/D
2,2-Dichloropropane	EPA 8260B/C/D	EPA 8260B/C/D
2-Butanone (MEK)	EPA 8260B/C/D	EPA 8260B/C/D
2-Chloroethylvinylether	EPA 8260B/C/D	EPA 8260B/C/D
2-Chlorotoluene	EPA 8260B/C/D	EPA 8260B/C/D
2-Hexanone	EPA 8260B/C/D	EPA 8260B/C/D
4-Chlorotoluene	EPA 8260B/C/D	EPA 8260B/C/D
4-Methyl-2-pentanone (MIBK)	EPA 8260B/C/D	EPA 8260B/C/D
Acetone	EPA 8260B/C/D	EPA 8260B/C/D
Acetonitrile	EPA 8260B/C/D	EPA 8260B/C/D
Acrolein	EPA 8260B/C/D	EPA 8260B/C/D
Acrylonitrile	EPA 8260B/C/D	EPA 8260B/C/D

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Benzene	EPA 8260B/C/D	EPA 8260B/C/D
Bromobenzene	EPA 8260B/C/D	EPA 8260B/C/D
Bromochloromethane	EPA 8260B/C/D	EPA 8260B/C/D
Bromodichloromethane	EPA 8260B/C/D	EPA 8260B/C/D
Bromoform	EPA 8260B/C/D	EPA 8260B/C/D
Bromomethane	EPA 8260B/C/D	EPA 8260B/C/D
Carbon disulfide	EPA 8260B/C/D	EPA 8260B/C/D
Carbon tetrachloride	EPA 8260B/C/D	EPA 8260B/C/D
Chlorobenzene	EPA 8260B/C/D	EPA 8260B/C/D
Chloroethane	EPA 8260B/C/D	EPA 8260B/C/D
Chloroform	EPA 8260B/C/D	EPA 8260B/C/D
Chloromethane	EPA 8260B/C/D	EPA 8260B/C/D
cis-1,2-Dichloroethene	EPA 8260B/C/D	EPA 8260B/C/D
cis-1,3-Dichloropropylene	EPA 8260B/C/D	EPA 8260B/C/D
Dibromochloromethane	EPA 8260B/C/D	EPA 8260B/C/D
Dibromomethane	EPA 8260B/C/D	EPA 8260B/C/D
Dichlorodifluoromethane	EPA 8260B/C/D	EPA 8260B/C/D
Diisopropyl Ether (DIPE)	EPA 8260B/C/D	EPA 8260B/C/D
Ethylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
Hexachlorobutadiene	EPA 8260B/C/D	EPA 8260B/C/D
Isopropylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
m+p-Xylene	EPA 8260B/C/D	EPA 8260B/C/D
Methyl tert-butyl ether (MTBE)	EPA 8260B/C/D	EPA 8260B/C/D
Methylene Chloride	EPA 8260B/C/D	EPA 8260B/C/D
Methylcyclohexane	EPA 8260B/C/D	EPA 8260B/C/D
Methyl acetate	EPA 8260B/C/D	EPA 8260B/C/D
Naphthalene	EPA 8260B/C/D	EPA 8260B/C/D
n-Butylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
n-Propylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
o-Xylene	EPA 8260B/C/D	EPA 8260B/C/D
p-Isopropyltoluene	EPA 8260B/C/D	EPA 8260B/C/D
sec-Butylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
Styrene	EPA 8260B/C/D	EPA 8260B/C/D
tert-Butylbenzene	EPA 8260B/C/D	EPA 8260B/C/D
Tetrachloroethene	EPA 8260B/C/D	EPA 8260B/C/D
Toluene	EPA 8260B/C/D	EPA 8260B/C/D
trans-1,2-Dichloroethene	EPA 8260B/C/D	EPA 8260B/C/D
trans-1,3-Dichloropropene	EPA 8260B/C/D	EPA 8260B/C/D
Trichloroethene	EPA 8260B/C/D	EPA 8260B/C/D
Trichlorofluoromethane	EPA 8260B/C/D	EPA 8260B/C/D
Vinyl acetate	EPA 8260B/C/D	EPA 8260B/C/D
Vinyl chloride	EPA 8260B/C/D	EPA 8260B/C/D
Xylenes, total	EPA 8260B/C/D	EPA 8260B/C/D
Cyclohexane	EPA 8260B/C/D	EPA 8260B/C/D
Ethyl Acetate	EPA 8260B/C/D	EPA 8260B/C/D
n-Butanol	EPA 8260B/C/D	EPA 8260B/C/D
GRO (Modified)- Total	EPA 8015C/D	EPA 8015 C/D

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Ethane	RSK 175	-----------------
Ethene	RSK 175	-----------------
Methane	RSK 175	-----------------
Semivolatiles		
1,2,4,5-Tetrachlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
1,2-Dichlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
1,3-Dichlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
1,4-Dichlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
1,2-Diphenylhydrazine	EPA 8270C/D/E	EPA 8270C/D/E
1,2,4-Trichlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
1-Methylnaphthalene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
2,3,4,6-Tetrachlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4,5-Trichlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4,6-Trichlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4-Dichlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4-Dimethylphenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4-Dinitrophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,4-Dinitrotoluene	EPA 8270C/D/E	EPA 8270C/D/E
2,6-Dichlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2,6-Dinitrotoluene	EPA 8270C/D/E	EPA 8270C/D/E
2-Chloronaphthalene	EPA 8270C/D/E	EPA 8270C/D/E
2-Chlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
2-Methyl-4,6-Dinitrophenol	EPA 8270C/D/E	EPA 8270C/D/E
2-Methylnaphthalene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
2-Methylphenol	EPA 8270C/D/E	EPA 8270C/D/E
2-Nitroaniline	EPA 8270C/D/E	EPA 8270C/D/E
2-Nitrophenol	EPA 8270C/D/E	EPA 8270C/D/E
3,3'-Dichlorobenzidine	EPA 8270C/D/E	EPA 8270C/D/E
3-Nitroaniline	EPA 8270C/D/E	EPA 8270C/D/E
4-Bromophenyl-phenylether	EPA 8270C/D/E	EPA 8270C/D/E
4-Chloro-3-methylphenol	EPA 8270C/D/E	EPA 8270C/D/E
4-Chloroaniline	EPA 8270C/D/E	EPA 8270C/D/E
4-Chlorophenyl-phenylether	EPA 8270C/D/E	EPA 8270C/D/E
4-Methylphenol (and/or 3-Methylphenol)	EPA 8270C/D/E	EPA 8270C/D/E
4-Nitroaniline	EPA 8270C/D/E	EPA 8270C/D/E
4-Nitrophenol	EPA 8270C/D/E	EPA 8270C/D/E
Acenaphthene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Acenaphthylene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Aniline	EPA 8270C/D/E	EPA 8270C/D/E
Anthracene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Benzidine	EPA 8270C/D/E	EPA 8270C/D/E
Acetophenol	EPA 8270C/D/E	EPA 8270C/D/E
Atrazine	EPA 8270C/D/E	EPA 8270C/D/E
Benzo(a)anthracene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Benzo(a)pyrene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Benzo(b)fluoranthene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Benzo(g,h,i)perylene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Benzo(k)fluoranthene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Benzoic acid	EPA 8270C/D/E	EPA 8270C/D/E
Benzyl alcohol	EPA 8270C/D/E	EPA 8270C/D/E
bis(2-Chloroethoxy)methane	EPA 8270C/D/E	EPA 8270C/D/E
Biphenyl	EPA 8270C/D/E	EPA 8270C/D/E
bis(2-Chloroethyl)ether	EPA 8270C/D/E	EPA 8270C/D/E
bis(2-Chloroiospropyl) ether	EPA 8270C/D/E	EPA 8270C/D/E
bis(2-ethylhexyl) phthalate	EPA 8270C/D/E	EPA 8270C/D/E
Butyl benzyl phthalate	EPA 8270C/D/E	EPA 8270C/D/E
Carbazole	EPA 8270C/D/E	EPA 8270C/D/E
Caprolactom	EPA 8270C/D/E	EPA 8270C/D/E
Chrysene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Dibenzo(a,h)anthracene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Dibenzofuran	EPA 8270C/D/E	EPA 8270C/D/E
Diethyl phthalate	EPA 8270C/D/E	EPA 8270C/D/E
Dimethyl phthalate	EPA 8270C/D/E	EPA 8270C/D/E
Di-n-butylphthalate	EPA 8270C/D/E	EPA 8270C/D/E
Di-n-octylphthalate	EPA 8270C/D/E	EPA 8270C/D/E
Fluoranthene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Fluorene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Hexachlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
Hexachlorobutadiene	EPA 8270C/D/E	EPA 8270C/D/E
Hexachlorocyclopentadiene	EPA 8270C/D/E	EPA 8270C/D/E
Indeno(1,2,3, cd)pyrene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Isophorone	EPA 8270C/D/E	EPA 8270C/D/E
Naphthalene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Nitrobenzene	EPA 8270C/D/E	EPA 8270C/D/E
N-Nitrosodiethylamine	EPA 8270C/D/E	EPA 8270C/D/E
N-Nitrosodimethylamine	EPA 8270C/D/E	EPA 8270C/D/E

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
N-Nitroso-di-n-propylamine	EPA 8270C/D/E	EPA 8270C/D/E
N-Nitrosodiphenylamine	EPA 8270C/D/E	EPA 8270C/D/E
o-Toluidine	EPA 8270C/D/E	EPA 8270C/D/E
Pentachlorobenzene	EPA 8270C/D/E	EPA 8270C/D/E
Pentachlorophenol	EPA 8270C/D/E	EPA 8270C/D/E
Phenanthrene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Phenol	EPA 8270C/D/E	EPA 8270C/D/E
Pyrene	EPA 8270C/D/E EPA 8270C/D/E SIM	EPA 8270C/D/E EPA 8270C/D/E SIM
Pyridine	EPA 8270C/D/E	EPA 8270C/D/E
1,4-Dioxane	EPA 8270C/D/E SIM	EPA 8270C/D/E SIM
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011	EPA 8011
1,2-Dibromethane (EDB)	EPA 8011	EPA 8011
DRO (Modified)-Total	EPA 8015C/D	EPA 8015C/D
Petroleum Hydrocarbons	FL-PRO	FL-PRO
OR (Modified)-Total	EPA 8015C/D	EPA 8015C/D
C11-C22 Aromatic Hydrocarbons	MADEP EPH	MADEP EPH
C19-C36 Aliphatic Hydrocarbons	MADEP EPH	MADEP EPH
C9-C18 Aliphatic Hydrocarbons	MADEP EPH	MADEP EPH
Wet Chemistry		
Bromide	EPA 9056A	----------------
Chloride	EPA 9056A	----------------
Fluoride	EPA 9056A	----------------
Nitrate and Nitrite as N	EPA 9056A EPA 353.2	----------------
Nitrate as N	EPA 9056A EPA 353.2	----------------
Nitrite as N	EPA 9056A EPA 353.2	----------------
Sulfate	EPA 9056A EPA 9038	----------------
Total Cyanide	EPA 9012B	EPA 9012B
TOC	EPA 9060A	EPA 9060A
Ignitability	EPA 1010A/B	EPA 1010A/B EPA 1030
Total Phenolics (4AAP)	EPA 9066	---------------
Corrosivity (pH)	EPA 9040C	EPA 9045D
COD	HACH 8000	---------------
Turbidity	SM 2130B	---------------
Total Kjeldahl Nitrogen	HACH 10242	---------------
Acidity (as $CaCO_3$)	SM 2310B	---------------
Total Alkalinity (as $CaCO_3$)	SM 2320B	---------------

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Reactive Cyanide	SW 846 Sec 7.3	SW 846 Sec 7.3
Acetic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Butyric Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Formic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Lactic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Propionic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Pentanoic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
i-Pentanoic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Pyruic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Hexanoic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
i-Hexanoic Acid	Pace SOP-BTRO-0042	Pace SOP-BTRO-0042
Total Dissolved Solid (TDS)	SM 2540C	---------------
Non-Filterable Residue (TSS)	SM 2540D	---------------
Ferrous Iron	SM 3500- Fe B	---------------
Orthophosphate as P	SM 4500- PE	---------------
Sulfide	SM 4500-S2 D SM 4500-S2 F	---------------
Silica	SM 4500-SiO2 C	---------------
Sulfate	SM 4500-SO4 E	---------------
Ammonia as N	SM 4500-NH3 B and D	---------------
Oil & Grease	EPA 1664A	EPA 9071B
Percent Moisture	---------------	ENV-SOP-BTRO-0157

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
PFAS					
NFDHA (Nonafluoro-3,6 dioxaheptanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFEESA (Perfluoro(2-ethoxyethane)sulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633

Parameter/Analyte	AFFF	Tissue	Non-Potable Water	Hazardous Waste	
				Aqueous	Solid
PFMPA (Perfluoro-3-methoxypropanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFMBA (Perfluoro-4-methoxybutanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
4:2 FTS (1H, 1H, 2H, 2H-Perfluorohexanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
6:2 FTS (1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
8:2 FTS (1H, 1H, 2H, 2H-Perfluorodecanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFBA (Perfluorobutanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
PFHpS (Perfluoroheptanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFPeS (Perfluoropentanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFPeA (Perfluoropentanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
NMeFOSAA(N-methyl perfluorooctanesulfonamidoacetic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
NEtFOSAA(N-ethyl perfluorooctanesulfonamidoacetic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFBS(Perfluorobutanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
PFTA(Perfluorotetradecanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFTrDA(Perfluorotridecanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
11Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
HFPO-DA (GenX , Hexafluoropropylene oxide dimer acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
ADONA (4,8-dioxa-3H-perfluorononanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
PFDA (Perfluorodecanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFDoA (Perfluorododecanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFHpA (Perfluoroheptanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFHxS (Perfluorohexanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFHxA (Perfluorohexanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFNA (Perfluorononanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
PFOS (Perfluorooctanesulfonic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFOA (Perfluorooctanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFUnA (Perfluoroundecanoic acid)	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15 Draft Method EPA 1633
PFDoS (Perfluorododecanesulfonic acid)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
NMeFOSE (N-Methyl perfluorooctane sulfonamidoethanol)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
NEtFOSE (N-Ethyl perfluorooctane sulfonamidoethanol)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
NMeFOSA (N-Methyl perfluorooctane sulfonamide)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
NEtFOSA (N-Ethyl perfluorooctane sulfonamide)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
Perfluorodecanesulfonate (PFDS)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633

Parameter/Analyte	**AFFF**	**Tissue**	**Non-Potable Water**	**Hazardous Waste**	
				Aqueous	**Solid**
Perfluorononanesulfonate (PFNS)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
Perfluorooctane sulfonamide (PFOSA)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
3-Perfluoropropyl propanoic acid (3:3FTCA)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633
3-Perfluoroheptyl propanoic acid (7:3FTCA)	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633	Draft Method EPA 1633

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Pesticides/Herbicides/PCBs		
Aldrin	EPA 8081B	EPA 8081B
alpha-BHC	EPA 8081B	EPA 8081B
alpha-Chlordane	EPA 8081B	EPA 8081B
beta-BHC	EPA 8081B	EPA 8081B
Chlordane	EPA 8081B	EPA 8081B
Chlordane (total)	EPA 8081B	EPA 8081B
DDD (4,4’)	EPA 8081B	EPA 8081B
DDE (4,4’)	EPA 8081B	EPA 8081B
DDT (4,4’)	EPA 8081B	EPA 8081B
Delta-BHC	EPA 8081B	EPA 8081B
Diallate	EPA 8081B	EPA 8081B
Dieldrin	EPA 8081B	EPA 8081B
Endosulfan I	EPA 8081B	EPA 8081B
Endosulfan II	EPA 8081B	EPA 8081B
Endosulfan sulfate	EPA 8081B	EPA 8081B
Endrin	EPA 8081B	EPA 8081B
Endrin aldehyde	EPA 8081B	EPA 8081B
Endrin ketone	EPA 8081B	EPA 8081B
gamma-BHC (lindane)	EPA 8081B	EPA 8081B
gamma-Chlordane	EPA 8081B	EPA 8081B
Heptachlor	EPA 8081B	EPA 8081B

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Heptachlor Epoxide (beta)	EPA 8081B	EPA 8081B
Methoxychlor	EPA 8081B	EPA 8081B
Toxaphene	EPA 8081B	EPA 8081B
Toxaphene (total)	EPA 8081B	EPA 8081B
Aroclor 1016	EPA 8082A	EPA 8082A
Aroclor 1221	EPA 8082A	EPA 8082A
Aroclor 1232	EPA 8082A	EPA 8082A
Aroclor 1242	EPA 8082A	EPA 8082A
Aroclor 1248	EPA 8082A	EPA 8082A
Aroclor 1254	EPA 8082A	EPA 8082A
Aroclor 1260	EPA 8082A	EPA 8082A
Aroclor 1262	EPA 8082A	EPA 8082A
Aroclor 1268	EPA 8082A	EPA 8082A
Azinphos-methyl (Guthion)	EPA 8141B	EPA 8141B
Diazinon	EPA 8141B	EPA 8141B
Disulfoton	EPA 8141B	EPA 8141B
Malathion	EPA 8141B	EPA 8141B
Parathion, ethyl	EPA 8141B	EPA 8141B
Parathion, methyl	EPA 8141B	EPA 8141B
Phorate	EPA 8141B	EPA 8141B
Ronnel	EPA 8141B	EPA 8141B
Stirophos	EPA 8141B	EPA 8141B
2,4, DB	EPA 8151B	EPA 8151B
2,4-D	EPA 8151B	EPA 8151B
2,4,5-T	EPA 8151B	EPA 8151B
2,4,5-TP (silvex)	EPA 8151B	EPA 8151B
2,4-DP (Dichlorprop)	EPA 8151B	EPA 8151B
3,5-Dichlorobenzoic acid	EPA 8151B	EPA 8151B
4-Nitrophenol	EPA 8151B	EPA 8151B
Acifluorfen	EPA 8151B	EPA 8151B
Bentazon	EPA 8151B	EPA 8151B
Chloramben	EPA 8151B	EPA 8151B
Dacthal (DCPA)	EPA 8151B	EPA 8151B
Dalapon	EPA 8151B	EPA 8151B
Dicamba	EPA 8151B	--------------
Dinoseb	EPA 8151B	EPA 8151B
MCPA	EPA 8151B	EPA 8151B
MCPP	EPA 8151B	EPA 8151B
Pentachlorophenol	EPA 8151B	EPA 8151B
Picloram	EPA 8151B	--------------

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
Explosives		
1,3,5-TNB (1,3,5-Trinitrobenzene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
1,3-DNB (1,3-Dinitrobenzene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
2,4,6-TNT (2,4,6-Trinitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
2,4-DNT (2,4-Dinitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
2,6-DNT (2,6-Dinitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
2-Am-DNT (2-Amino-4,6-dinitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
2-NT (2-Nitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
3,5-Dinitroaniline	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
3-NT (3-Nitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
4-Am-DNT (4-Amino-2,6-dinitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
4-NT (4-Nitrotoluene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
NB (Nitrobenzene)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
NG (Nitroglycerin)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)

Parameter/Analyte	**Solid Hazardous Waste**	
	Aqueous	**Solid**
PETN (Pentaerythritol tetranitrate)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
Tetryl (Methyl-2,4,6 trinitrophenylnitramine)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
NQ (Nitroguanidine)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)
NC (Nitrocellulose)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)	EPA 8330A/B (including QSM 5.4 Compliant 8330 with ISM prep)

Parameter/Analyte	**Drinking Water**
NMeFOSAA(N-methyl perfluorooctanesulfonamidoacetic acid)	EPA 537.1
NEtFOSAA(N-ethyl perfluorooctanesulfonamidoacetic acid)	EPA 537.1
PFBS(Perfluorobutanesulfonic acid)	EPA 537.1
PFTA(Perfluorotetradecanoic acid)	EPA 537.1
PFTrDA(Perfluorotridecanoic acid)	EPA 537.1
11Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)	EPA 537.1
9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid)	EPA 537.1
HFPO-DA (GenX , Hexafluoropropylene oxide dimer acid)	EPA 537.1
ADONA (4,8-dioxa-3H-perfluorononanoic acid)	EPA 537.1
PFDA(Perfluorodecanoic acid)	EPA 537.1
PFDoA(Perfluorododecanoic acid)	EPA 537.1
PFHpA(Perfluoroheptanoic acid)	EPA 537.1
PFHxS(Perfluorohexanesulfonic acid)	EPA 537.1
PFHxA(Perfluorohexanoic acid)	EPA 537.1
PFNA(Perfluorononanoic acid)	EPA 537.1
PFOS(Perfluorooctanesulfonic acid)	EPA 537.1
PFOA(Perfluorooctanoic acid)	EPA 537.1
PFUnA(Perfluoroundecanoic acid)	EPA 537.1

Parameter/Analyte	**Solid Hazardous Waste**		**AFFF**
	Aqueous	**Solid**	
Prep Methods			---------------
Acid Digestions – Metals	EPA 3010A	------------	---------------
Separatory Funnel	EPA 3510C	------------	---------------
Solid Phase Extraction	EPA 3535A	------------	---------------
Purge and Trap	EPA 5030B	EPA 5035	---------------
TCLP	---------------	EPA 1311	---------------
SPLP	---------------	EPA 1312	---------------
Acid Digestion	---------------	EPA 3050B	---------------
Extraction – Sonication	---------------	EPA 3550C	---------------
Extraction – Soxhlet	---------------	EPA 3540C	---------------
Extraction – Microwave	---------------	EPA 3546	---------------
Volatile Compositing with Methanolic Extraction	---------------	EPA 5035 mod	---------------
TOP Assay Digestion	Pace SWI-BTRO-0001	Pace SWI-BTRO-0001	Pace SWI-BTRO-0001

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for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2017, the 2009 TNI Environmental Testing Laboratory Standard, the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP), as detailed in version 5.4 of the DoD Quality System Manual for Environmental Laboratories (QSM), the A2LA *R220 – Specific Requirements – A2LA DoD Environmental Laboratory Accreditation Program*, accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated *April 2017*)

Presented this 31st day of August 2022.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 6429.01
Valid to August 31, 2024

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

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APPENDIX G
LABORATORY STANDARD OPERATING PROCEDURES (SOPs)

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	ENV-SOP-BTRO-0149 v02_Draft Method 1633 SOP	
	Effective Date: 06/07/2022	

Management Approval:
Abigail Guerin Approved on 6/7/2022 10:10:03 AM
Russell McNiece Approved on 6/7/2022 1:54:36 PM
Jacqueline Bendolph Approved on 6/7/2022 2:19:28 PM

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure for the determination of the per- and polyfluoroalkyl substances (PFAS) in Table 1 in aqueous (all non-potable water and leachate), solid (soil, biosolids, sediment) and tissue samples by liquid chromatography/mass spectrometry (LC-MS/MS).

The method calibrates and quantifies PFAS analytes using isotopically labeled standards. Where linear and branched isomers are present in the sample and either qualitative or quantitative standards containing branched and linear isomers are commercially available, the PFAS analyte is reported as a single analyte consisting of the sum of the linear and branched isomer concentrations.

The instrumental portion of this method is for use only by analysts experienced with LC-MS/MS or under the close supervision of such qualified persons. The laboratory must demonstrate the ability to generate acceptable results using the procedure in Sections 11.3.1 and 11.4.

By their very nature, many components of PFAS present analytical challenges unique to this class of analytes. For example, PFAS analytes readily adhere to the walls of the sample containers and may also stratify in the container.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

The target analytes and the normal LODs and LOQs that can be achieved with this procedure are provided in Table 1, Appendix A.

LOQs are established in accordance with Pace policy and SOPs for method validation and for the determination of detection limits (DL) and quantitation limits (LOQ). DL and LOQ are routinely verified and updated when needed. The current LOQ for each target analyte that can be determined by this SOP as of the effective date of this SOP is provided in Table 1, Appendix A. LOQ is equivalent to Minimum Level of Quantitation (ML).

DL and LOQ are always adjusted to account for actual amounts used and for dilution.

2.0 SUMMARY OF METHOD

Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification (see Section 9.2.1) using isotopically labeled compounds added to the samples before extraction.

Individual PFAS analytes are identified through peak analysis of the quantification and confirmation ions, where applicable.

Quantitative determination of target analyte concentrations is made with respect to an isotopically labeled PFAS standard; the concentrations are then used to convert raw peak areas in sample chromatograms to final concentrations.

Results for target analytes are recovery corrected by the method of quantification (i.e., either isotope dilution or extracted internal standard quantification, see Section 9.2.1). Isotopically labeled compound recoveries are determined by comparison to the responses of one of seven non-extracted internal standards (a.k.a., the "recovery" standards) and are used as general indicators of overall analytical quality.

The quality of the analysis is assured through reproducible calibration and testing of the extraction, cleanup, and LC-MS/MS systems.

2.1 Extraction

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

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

2.1.3 **Tissue samples** are spiked with EIS, extracted in methanol with potassium hydroxide and acetonitrile, and cleaned up by carbon and SPE cartridges before analysis.

3.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and elevated baselines causing misinterpretation of chromatograms. Specific selection of reagents and solvents is required.

Clean all equipment prior to, and after each use to avoid PFAS cross-contamination. Typical cleaning solvents used include water, methanol, and methanolic ammonium hydroxide. The residual PFAS content of disposable plasticware and filters must be verified by batch/lot number and may be used without cleaning if PFAS levels are **less than half the LOQ**.

Prior to use, glassware must be solvent rinsed and then air dried. A solvent rinse procedure using methanolic ammonium hydroxide (1%) and methanol is recommended.

All parts of the SPE manifold must be cleaned between samples by rinsing with methanolic ammonium hydroxide (1%) and air drying prior to use. Smaller parts, like the needles, adapters, reservoirs, and stopcocks associated with the manifold should be rinsed with tap water prior to rinsing with methanolic ammonium hydroxide (1%) and air drying. After loading the samples but prior to elution procedures, the chamber should be rinsed with methanolic ammonium hydroxide (1%).

All equipment used in the filleting, dissecting, shucking, compositing, and homogenization of tissue must be cleaned with detergent and hot water, then rinsed with ultra-pure water followed by a series of solvent rinses. A typical solvent rinse procedure would be acetone, followed by toluene, and then dichloromethane.

All materials used in the analysis must be demonstrated to be free from interferences by running method blanks (Section 11.1.1) at the beginning and with each extraction batch (samples started through the extraction process on a given analytical batch to a maximum of 20 field samples).

Reagent water (Section 8.1) can be used to simulate water samples and Ottawa sand and/or reagent-grade sand (Section 7.2) can be used to simulate soils. For tissue, fish fillets, chicken breast or other similar animal tissue (see Section 7.2) may be used as the reference matrix. The laboratory must verify that the source product used does not contain PFAS in detectable amounts.

Interferences co-extracted from samples will vary considerably from source to source, depending on the diversity of the site being sampled. Interfering compounds may be present at concentrations several orders of magnitude higher than the native PFAS. Because low levels of PFAS are measured by this method, elimination of interferences is essential. The cleanup steps given in Section 9.3 can be used to reduce or eliminate these interferences and thereby permit reliable determination of the PFAS at the levels shown in Table 1. The most frequently encountered interferences are fluoropolymers; however, when analyzing whole fish samples, bile salts (e.g., Taurodeoxycholic Acid [TDCA]) can interfere in the chromatography. For this reason, analysis of a standard containing TDCA is required as part of establishing the initial chromatographic conditions (see Sections 8.2.7 and 9.2.3).

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

Extracted Internal Standard (EIS) quantification – The response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities.

Isotope dilution (ID) quantitation – A means of determining a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. The labeled PFAS are spiked into each sample and allow identification and correction of the concentration of the native compounds in the analytical process.

Isotopically labeled compound – An analog of a target analyte in the method which has been synthesized with one or more atoms in the structure replaced by a stable (non-radioactive) isotope of that atom. Common stable isotopes used are 13C (Carbon-13) or Deuterium (D or 2H). These labeled compounds do not occur in nature, so they can be used for isotope dilution quantitation or other method-specific purposes.

Minimum Level of quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The ML represents the lowest concentration at which an analyte can be measured with a known level of confidence. It may be equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.

5.0 HEALTH AND SAFETY

The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.

PFOA has been described as likely to be carcinogenic to humans. Pure standards should be handled by trained personnel, with suitable protection to skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.

The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (HSE) policies and procedures specified in this SOP and in the Pace Chemical Hygiene / Safety Manual.

Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.

Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. Use these acids in a fume hood whenever possible with additional PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. Any processes that emit large volumes of solvents (evaporation/concentration processes) must be in a hood or apparatus that prevents employee exposure.

Contact your supervisor or local HSE coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME, AND STORAGE

Samples should be collected in accordance with a sampling plan and procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project. Many states have state-specific sampling instructions for PFAS, which should be followed by the client where required. Collect samples in HDPE containers following conventional sampling practices (Reference 5). All sample containers must have linerless HDPE or polypropylene caps. Other sample collection techniques, or sample volumes, may be used if documented.

The laboratory does not perform sample collection or field measurements for this test method. To assure sample collection and field checks and treatment are performed in accordance with applicable regulations, Pace project managers will inform the client of these requirements at the time of request for analytical services when the request for testing is received prior to sample collection. If samples were already collected, the laboratory will record any nonconformance to these requirements in the laboratory's sample receipt record when sufficient information about sample collection is provided with the samples.

The nature of the tissues of interest may vary by project. Field sampling plans and protocols should explicitly state the samples to be collected and if any processing will be conducted in the field (e.g., filleting of whole fish or removal of organs). All field procedures must involve materials and equipment that have been shown to be free of PFAS. Fish may be cleaned, filleted, or processed in other ways in the field, such that the laboratory may expect to receive whole fish, fish fillets, or other tissues for analysis. If whole fish are collected, wrap the fish in aluminum foil or food-grade polyethylene wrap, and maintain at 0 - 6 ºC from the time of collection until receipt at the laboratory, to a maximum time of 24 hours. If a longer transport time is necessary, freeze the sample before shipping. Ideally, fish should be frozen upon collection and shipped to the laboratory as soon as possible.

The laboratory will provide containers for the collection of samples upon client request for analytical services.

Requirements for container type, preservation, and field quality control (QC) for the common list of test methods offered by Pace are included in the laboratory's quality manual.

General Requirements

Matrix	Routine Container[1]	Sample Amount[2]	Preservation	Holding Time Collection to Prep/ Prep to Analysis
Aqueous (non-potable water) containing <100 mg/L SS	2 x 500 mL linerless HDPE 1 x 125 mL linerless HDPE[3]	500 mL	Thermal: 0-6°C OR ≤ -20°C	28/28[4] OR 90/28
Aqueous (leachate)	2 x 125 mL linerless HDPE	100 mL	Thermal: 0-6°C OR ≤ -20°C	28/28 OR 90/28
Solid (soil and sediment)	3 oz/ 90 mL linerless polypropylene straight sided	5 g	Thermal: 0-6°C OR ≤ -20°C	90/28[5]
Solid (biosolid)	3 oz/ 90 mL linerless polypropylene straight sided	0.5 g	Thermal: 0-6°C OR ≤ -20°C	90/28
Tissue[6]	3 oz/ 90 mL linerless polypropylene straight sided	2 g	Thermal: ≤ -20°C	90/28

[1] *Aqueous sample containers should be filled only to the appropriate gradation marked on the container, or to the shoulder of the container if no gradations are provided. To allow room for expansion during freezing (if necessary), aqueous sample containers should not be overfilled.*

[2] *Miniumum amount needed for each discrete analysis. Solid and biosolid sample amounts reflect the dry sample weight.*

[3] *Needed for percent suspended solids and screening analyses.*

[4] *In the single lab validation, issues were observed with certain perfluorooctane sulfonamidoethanols and perfluorooctane sulfonamidoacetic acids after 7 days.*

[5] *Samples may need to be extracted as soon as possible if NFDHA is an important analyte. The onus is on the client to indicate if NFDHA is an important analyte, prior to shipment. If no such designation is given, follow stated hold time.*

[6] *Container listed here will be used for tissue homogenate; samples may be received at the laboratory as whole fish or filets wrapped in aluminum foil or food grade polyethylene wrap. Ideally fish should be frozen upon collection and shipped to the laboratory as soon as possible.*

Note: Project-specific requirements dictate which storage condition applies. The storage condition to be used for each project must be formally documented in written form (QAPP or otherwise) before samples are received. Without any prior indication from the client, the lab will store all aqueous and solid samples at 0-6°C until extraction, with a 28-day preparation holding time.

Thermal preservation is checked and recorded on receipt in the laboratory.

Prepared sample extracts of all matrices are stored at 0-6°C until sample analysis.

After analysis, unless otherwise specified in the analytical services contract, samples are retained for 30 days from date of final report and then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT AND SUPPLIES

7.1 Equipment

Due to the possibility of adsorption of analytes onto glass, HDPE containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

Sample Preparation

- Oven – Capable of maintaining a temperature of 105 ± 5 ºC
- Analytical balance – Capable of weighing 0.0001 g
- Top loading balance – Capable of weighing 0.01 g
- Calibrated mechanical variable volume pipettes with disposable HDPE or polypropylene tips (10 µL to 5 mL) – used for preparation of calibration standards and spiked samples
- Point of Use water preparation system – Millipore Synergy UV
- Ultrasonic mixer (sonicator) – Fisher Scientific Ultrasonic Cleaner FS60
- pH Paper, range 0-14 - (Whatman® PanpehaTM or equivalent), 0.5-unit readability
- Analog or digital vortex mixer, single or multi-tube (Fisher Scientific 02-215-452, or equivalent)
- Volumetric flasks, Class A
- 15 and 50-mL conical polypropylene tubes with polypropylene screw caps for preparing and storing extract solutions and for collection of eluents (Fisher Scientific 05-527-90 and 14-432-22, or equivalent)
- Variable speed mixing table (VWR Model 3500 Orbital Shaker, or equivalent)

Filtration

- Silanized glass wool (Pyrex 3950 or equivalent)
- Disposable syringe filter, 25 mm, 0.2 µm Nylon membrane, Phenomenex AF0-1207-52 or equivalent
- Glass fiber filter, 47 mm, 1 µm, PALL 61631 or equivalent
- Centrifuge (Thermo Scientific ST-40 or equivalent), capable of reaching at least 3000 rpm
- Syringe (BD 309646 or equivalent), polypropylene/HDPE, 5 mL
- Disposable glass and plastic pipets

Solid-Phase Extraction

- Solid Phase Extraction (SPE) cartridges (Phenomenex 8B-S038-SCH, 150 mg WAX, or equivalent)
- SPE reservoirs – 60 mL, Phenomenex part# AH0-7189, or equivalent
- SPE adapter caps – Phenomenex Part# AH0-7191 (Adapter cap for 1, 3, 6 mL SPE tubes)
- Vacuum manifold for SPE Cartridges – Sigma-Aldrich Cat# 57265: Visiprep SPE Vacuum manifold, or equivalent
- Disposable liners for Visiprep Manifold – Millipore-Sigma part# 57059 / Restek part# 28310-VM, or equivalent
- Vacuum tubing – 1/4” ID, 5/8” OD, 3/16” wall; Fisher Scientific part# 14-176-6B or equivalent

- Vacuum Pump – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges. Millipore model# WP6111560, 115V, 60Hz, 3.5A

Evaporation

- Automatic or manual solvent evaporation system – TurboVap® LV or equivalent
- Evaporation/concentrator tubes, 60 mL clear glass, 30 x 125 mm, without caps – Fisher cat# 02-993-275; Caps: Qorpak item # CAP-00178; Tubes with Caps: Qorpak item# GLC-07878; or equivalent

Instrument

- High-performance liquid chromatograph (HPLC) equipped with tandem quadrupole mass spectrometer – Agilent 6495C or equivalent; LC/MS Data Acquisition for 6400 Series Triple Quadrupole Version 10.1, Build 10.1.67; Quantitative Analysis Version 10.1, Build 10.1.733.0
- Agilent Zorbax RRHD Eclipse Plus C18, 2.1 x 50 mm analytical column (Agilent Part # 959757-902), or equivalent
- Guard cartridge/column – ZORBAX RRHD Eclipse Plus C18, 2.1mm, 1.8 µm, 1200 bar pressure, UHPLC guard (Agilent Part # 821725-901), or equivalent
- Trap/delay column – Agilent Zorbax Eclipse Plus C18, 2.1 mm, 1.8 µm (Agilent Part# 821725-901), or equivalent

7.2 Supplies

Due to the possibility of adsorption of analytes onto glass, HDPE containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges/tubes, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

- Reference matrix: Aqueous – reagent water
- Reference matrix: Solid – Ottawa sand
- Reference matrix: Tissue – fish fillets, chicken breast or similar animal tissue
- Bottles – HDPE or glass, with linerless HDPE or polypropylene caps. Various sizes. QEC item # 6212-Q016/BC-150-PACE (500 mL), 6212-Q008/BC-280-PACE (250 mL), 6213-U004/BC-500-PACE (125 mL), 6213-U002/BC-400-PACE (60 mL)
- Screw top vials, 250 µL PP, and Cap, 9mm, clear, thin PP/silicone septa – used in sample analysis and pre-screening (Agilent Cat # 5190-2243 and 5191-8151), or equivalent
- Polypropylene vials – for storage (Wheaton W985872: 2 mL cryovials), or equivalent
- Single step filter vials – Restek Thomson SINGLE StEP® Standard Filter Vials, 0.2 µm Nylon membrane, with Black Preslit caps Cat # 25891 or equivalent; used in sample pre-screening
- Extract/Standard storage containers – 15 mL, 8 mL, or 4 mL narrow-mouth HDPE container - Thermo Scientific item# 2002-9050, 2002-9025, 2002-9125; 2.0 mL screw-top polypropylene cryogenic vials – Grainger item# 6EMV1;1.5 mL snap-cap polypropylene microcentrifuge tubes - Fisher item# 05-408-129; or equivalent

8.0 REAGENTS AND STANDARDS

8.1 Reagents

Reagents prepared by the laboratory may be stored in either glass or HDPE containers. Proper cleaning procedures (Section 3) must be followed prior to using the containers.

- Acetic acid – ACS grade or equivalent, store at room temperature; Fisher cat# A38C-212 or equivalent
    - Acetic acid (0.1%) - dissolve acetic acid (1 mL) in reagent water (1 L), store at room temperature, replace after 3 months
- Acetonitrile – UPLC grade or equivalent, verified before use, store at room temperature; Fisher A996-4 or equivalent
- Ammonium acetate – LC/MS grade or equivalent, store at 2-8° C, replace 2 years after opening date; Fisher A637-500 or equivalent
- Ammonium hydroxide – certified ACS+ grade or equivalent, 30% in water, store at room temperature; Fisher A470-250 or equivalent
    - Aqueous ammonium hydroxide (3%) – add ammonium hydroxide (10 mL, 30%) to reagent water (90 mL), store at room temperature, replace after 3 months
    - Methanolic ammonium hydroxide (0.3%) – add ammonium hydroxide (1 mL, 30%) to methanol (99 mL), store at room temperature, replace after 1 month
    - Methanolic ammonium hydroxide (1%) – add ammonium hydroxide (3.3 mL, 30%) to methanol (97 mL), store at room temperature, replace after 1 month
    - Methanolic ammonium hydroxide (2%) – add ammonium hydroxide (6.6 mL, 30%) to methanol (93.4 mL), store at room temperature, replace after 1 month
- Carbon – EnviCarb® 1-M-USP or equivalent, verified by lot number before use, store at room temperature. Sigma 57210-U
- Eluent A – Acetonitrile, Ultra LCMS grade or equivalent; Fisher A996-4 or equivalent
- Eluent B – 2 mM ammonium acetate in 95:5 water/acetonitrile. Dissolve 0.154 g of ammonium acetate in 950 mL of water and 50 mL of acetonitrile. Store at room temperature, shelf life 2 months
- Formic acid – greater than 96% purity or equivalent, store at room temperature; Acros 14793-0010 or equivalent
    - Formic acid (aqueous, 0.1 M) – dissolve formic acid (4.6 g) in reagent water (1 L), store at room temperature, replace after 2 years
    - Formic acid (aqueous, 0.3 M) – dissolve formic acid (13.8 g) in reagent water (1 L), store at room temperature, replace after 2 years
    - Formic acid (aqueous, 5% v/v) – mix 5 mL formic acid with 95 mL reagent water, store at room temperature, replace after 2 years

    - Formic acid (aqueous, 50% v/v) – mix 50 mL formic acid with 50 mL reagent water, store at room temperature, replace after 2 years
    - Formic acid (methanolic 1:1, 0.1 M formic acid/methanol) – mix equal volumes of methanol and 0.1 M formic acid, store at room temperature, replace after 2 years.
- Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid – add ammonium hydroxide (3.3 mL, 30%), reagent water (1.7 mL) and acetic acid (0.625 mL) to methanol (92 mL), store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank (Section 11.2.1) and sample extract dilutions.
- Methanol – HPLC grade or better, 99.9% purity, store at room temperature; Fisher A452-4 or equivalent
- Potassium hydroxide – certified ACS or equivalent, store at room temperature, replace after 2 years; Fisher P250-500 or equivalent
    - Methanolic potassium hydroxide (0.05 M) – add 3.3 g of potassium hydroxide to 1 L of methanol, store at room temperature, replace after 3 months.
- Reagent water – Laboratory reagent water, test by lot/batch number for residual PFAS content.

8.2 Standards

Prepare standard solutions from materials of known purity and composition or purchase as solutions or mixtures with certification to their purity, concentration, and authenticity. Observe the safety precautions in Section 5.

Purchase of commercial standard solutions or mixtures is highly recommended for this method; however, when these are not available, preparation of stock solutions from neat materials may be necessary. If the chemical purity is 98% or greater, the weight may be used without correction to calculate the concentration of the standard.

When not being used, store standard solutions in the dark at 4 °C, unless the vendor recommends otherwise, in tightly sealed screw-capped vials. Place a mark on the vial at the level of the solution so that solvent loss by evaporation can be detected. Replace the solution if solvent loss has occurred.

Note: ^{18}O-mass labeled perfluoroalkyl sulfonates may undergo isotopic exchange with water under certain conditions, which lowers the isotopic purity of the standards over time.

The laboratory must maintain records of the certificates for all standards for traceability purposes. Copies of the certificates should be provided as part of the data packages in order to check that proper calculations were performed.

8.2.1 Extracted Internal Standard (EIS) – (isotopically labeled compound) Prepare the EIS solution containing the isotopically labeled compounds listed in Table 2 as extracted internal standards in methanol from stock standards. An aliquot of EIS solution is added to each sample prior to extraction. The list of isotopically labeled compounds in Table 2 represents the compounds that were available at the time this method was validated. Other isotopically labeled compounds may be used as they become available. Prepare the EIS Standard according to the table below:

Component	Aliquot for 2.2 mL Prep	Aliquot for 6.6 mL Prep
MPFAC-HIF-ES	1.1 mL	3.3 mL

Component	Aliquot for 2.2 mL Prep	Aliquot for 6.6 mL Prep
Methanol	1.1 mL	3.3 mL

8.2.2 **Non-Extracted Internal Standard (NIS) –** Prepare the NIS solution containing the isotopically labeled compounds listed in Table 2 as non-extracted internal standards in methanol from stock standards. An aliquot of NIS solution is added to each sample prior to instrumental analysis. Prepare the NIS Standard according to the table below:

Component	Aliquot for 2.2 mL Prep	Aliquot for 6.6 mL Prep
MPFAC-HIF-IS	1.1 mL	3.3 mL
Methanol	1.1 mL	3.3 mL

8.2.3 **Native Standards Solutions –** Prepare spiking solutions containing the method analytes listed in Table 3 in methanol from stock standards. The solution(s) is used to prepare the calibration standards and to spike the known reference QC samples that are analyzed with every batch. Quantitative standards containing a mixture of branched and linear isomers must be used for method analytes if they are commercially available. Currently, these include PFOS, PFHxS, NMeFOSAA, and NEtFOSAA. Prepare the Primary Dilution Standards (PDS) according to the table below. A set of 10X-dilute PDS solutions (10X PDS A, 10X PDS B, 10X PDS C, 10X PDS D) is then created from the original PDS solutions, as noted below the table. Finally, a separate set of PDS solutions is prepared according to the table below and used for Initial Calibration Verification purposes. This set of ICV PDS solutions (PDS 2A, PDS 2B, PDS 2C, PDS 2D) is prepared either from a separate, second source or separate manufacturer lot than that used for the original PDS/10XPDS solutions. If a second source or lot is unavailable, a separate preparation using the same stocks is acceptable.

All values in mL	PDS A	PDS B	PDS C	PDS D
PFAC-MXH	1.1			
PFAC-MXI	1.1			
PFAC-MXJ		1.1		
PFAC-MXF			1.1	
PFAC-MXG				1.1
MeOH	0.55	1.1	0.275	1.65
Final Volume	2.75	2.2	1.375	2.75

Note: 10X PDS Mixes are prepared by diluting 200 µL of PDS A, B, C, or D with 1.8 mL of MeOH for a final volume of 2 mL. Alternately, 200 µL each of PDS A, B, C, and D may be diluted with 1.2 mL of MeOH for a final volume of 2 mL. If the latter preparation is used, MeOH volumes used to prep ICAL L1-L4 must be adjusted.

ICV PDS Preparation:

All values in µL	PDS 2A	PDS 2B	PDS 2C	PDS 2D
PFAC-MXH	40			
PFAC-MXI	40			
PFAC-MXJ		50		
PFAC-MXF			80	
PFAC-MXG				40
MeOH	920	950	920	960

All values in µL	PDS 2A	PDS 2B	PDS 2C	PDS 2D
Final Volume	1000	1000	1000	1000

Note: PDS 2A/2B/2C/2D concentrations are equivalent to 10X PDS A/B/C/D

8.2.4 **Calibration standard solutions –** A series of calibration solutions containing the target analytes and the EIS and NIS is used to establish the initial calibration of the analytical instrument. The concentration of the method analytes in the solutions varies to encompass the working range of the instrument, while the concentrations of the EIS and NIS remain constant. The calibration solutions are prepared using methanolic ammonium hydroxide (1%), water, acetic acid and the method analyte and isotopically labeled compound standard solutions. After dilution, the final solution will match the solvent mix of sample extracts, which contain methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid (Section 8.1). Calibration standard solutions do not undergo solid phase extraction/cleanup. Prepare the calibration standard solutions according to the table below:

Component[1]	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
10X PDS A/B/C/D	25	25	62.5	156.25						
PDS A/B/C/D					62.5	62.5	156.25	312.5	625	781.25
EIS	100	50	50	50	100	50	50	50	50	50
NIS	100	50	50	50	100	50	50	50	50	50
Water	400	200	200	200	400	200	200	200	200	200
Acetic Acid	62.5	31.25	31.25	31.25	62.5	31.25	31.25	31.25	31.25	31.25
Methanol[2]	9237.5	4568.75	4418.75	4043.75	9087.5	4418.75	4043.75	3418.75	2168.75	1543.75
Final Volume	10000	5000	5000	5000	10000	5000	5000	5000	5000	5000

[1] *All values listed are µL*

[2] *Methanolic Ammonium Hydroxide (1%)*

Prepare the ICV Standard according to the table below:

Component	Aliquot for ICV STD (µL)
PDS 2A/2B/2C/2D	62.5
EIS	20
NIS	20
Water	80
Acetic Acid	12.5
Methanol[1]	1617.5
Final Volume	2000

[1] *Methanolic Ammonium Hydroxide (1%)*

Concentrations for calibration solutions are presented in Table 3. A minimum of six contiguous calibration standards are required for a valid analysis when using a linear calibration model, with at least five of the six calibration standards being within the quantitation range (e.g., from the LOQ to the highest calibration standard). If a second-order calibration model is used, then a minimum of seven calibration standards are required, with at least six of the seven calibration standards within the quantitation range. The lowest level calibration standard must meet a signal-to-noise ratio of 3:1 and be at a concentration less than or equal to the Limit of Quantitation (LOQ). All initial calibration requirements listed in Section 9.2 must be met.

Note: Additional calibration standards, at levels lower than the lowest calibration standard listed in the method, may be added to accommodate a lower limit of quantitation if the instrument sensitivity allows. Calibration standards at the high end of the calibration may be eliminated if the linearity of the instrument is exceeded or at the low end if those calibration standards do not meet the S/N ratio criterion of 3:1, so long as the required number of calibration points is met. All analytes with commercially available stable isotope analogues must be quantified using isotope dilution.

8.2.5 **Qualitative Standards –** Standards that contain mixtures of the branched and linear isomers of the method analytes and that are used for comparison against suspected branched isomer peaks in field samples. These qualitative standards are not required for those analytes where the quantitative standards in Section 8.2.4 already contain the branched and linear isomers. Qualitative standards that are currently commercially available include PFOA, PFNA, PFOSA, NEtFOSE, and NMeFOSE. Create intermediate standards of each individual qualitative standard at a concentration of approximately 1 µg/mL and use those to prepare the check standard according to the table below.

Component	Aliquot for Isomer Check STD (µL)
Intermediate STD (each of 7)	100
EIS STD	100
NIS STD	100
Water	400
Acetic Acid	62.5
Methanol[1]	8637.5
Final Volume	10000

[1] *Methanolic Ammonium Hydroxide (1%)*

8.2.6 **Instrument Blank –** A solvent blank is analyzed at the beginning of each analytical sequence, to demonstrate clean instrumental background, and after samples containing high levels of target compounds (e.g., calibration, CCV) to monitor carryover from the previous injection. The instrument blank consists of clean reagent fortified with the EIS and NIS for quantitation purposes.

8.2.7 **Bile Salts Check Standard containing Taurodeoxycholic Acid (TDCA) –**TDCA is used to evaluate the chromatographic program relative to the risk of an interference from bile salts in samples. A solution is prepared at a concentration of 10 ng/mL in the same solvent as the calibration standards and is analyzed at the beginning of each analytical sequence**.** Using Cayman Chemical item# 15935 (or equivalent), create a stock standard and then an intermediate standard with a concentration of 1 µg/mL. Use the intermediate standard to prepare the Bile Salts Check Standard according to the table below.

Component	Aliquot for Bile Salts Check STD (µL)
Intermediate TDCA Standard	100
EIS STD	100
NIS STD	100
Water	400
Acetic Acid	62.5
Methanol[1]	9237.5
Final Volume	10000

[1] *Methanolic Ammonium Hydroxide (1%)*

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 **Support Equipment –** Refer to lab-specific SOP(s) for additional information on calibration and verification requirements for support equipment that may be used in this procedure.

9.1.2 **Instrument –** All maintenance activities are listed in daily maintenance logs that are assigned to each instrument.

Mass Calibration – The mass spectrometer must undergo mass calibration to ensure accurate assignments by the instrument. This mass calibration must be performed at least annually to maintain instrument sensitivity and stability. Mass calibration must be repeated on an as-needed basis (e.g., QC failures, ion masses fall outside of the instrument required mass window, major instrument maintenance, or if the instrument is moved). Mass calibration must be performed using the calibration compounds and procedures prescribed by the manufacturer. The procedures used for mass calibration and mass calibration verification must evaluate an ion range that encompasses the ion range (Q1 and Q2 m/z) of the analytes of interest of this method.

Mass Calibration Verification – A mass calibration verification must be performed following mass calibration, prior to standard and sample analyses. Mass verification checks must also be performed after any subsequent mass calibrations. The laboratory must follow the instructions for the individual instrument software to confirm the mass calibration, mass resolution and peak relative response. Mass calibration verification must be performed using standards whose mass range brackets the masses of interest (quantitative and qualitative ions). Check the instrument mass resolution to ensure that it is at least unit resolution. Unit resolution is demonstrated when the value of the peak width at half-height is within 0.5 ± 0.1 amu or Da.

Multiple Reaction Monitoring (MRM) is required to achieve better sensitivity with the mass spectrometer than full-scan analysis. The ions to be monitored (quantitation and confirmation transitions, also referred to as precursor and product ions) for each native compound, EIS, and NIS are given in Table 2.

The chromatographic conditions should be optimized for compound separation and sensitivity. The same optimized operating conditions must be used for the analysis of all standards, blanks, IDOCs, MDL and LCS standards, and samples. Different instruments may require slightly different operating conditions. Modification of the solvent composition of the standard or extract by increasing the aqueous content to prevent poor peak shape is not permitted. The peak shape of early eluting compounds may be improved by increasing the volume of the injection loop or increasing the aqueous content of the initial mobile phase composition.

Retention Time (RT) calibration – After RT windows have been empirically confirmed for each analyte, once per ICAL and at the beginning of the analytical sequence, the position of each method target analyte, EIS analyte, and NIS analyte peak shall be set using the midpoint standard of the ICAL curve when ICAL is performed. When ICAL is not performed, the initial CCV retention times or the midpoint standard of the ICAL curve can be used to establish the RT window position.

Native target analyte, EIS analyte, and NIS analyte RTs must fall within 0.4 minutes (24 sec) of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. All branched isomer peaks identified in either the calibration standard or the qualitative standard must fall within in the retention time window for that analyte.

For all target analytes with exact corresponding isotopically labeled analogs, target analyte peaks must elute within ±0.1 minutes (±6 sec) of the associated EIS.

When establishing the chromatographic conditions, it is important to consider the potential interference of bile salts during analyses of samples. Inject the Bile Salt Check standard (Sections 8.2.7, 9.2.3) during the retention time calibration process and adjust the conditions to ensure that TDCA does not coelute with any of the target analytes, EIS, or NIS standards. Analytical conditions must be set to allow a separation of at least 1 minute between TDCA and PFOS.

9.2 Initial Calibration

9.2.1 Calibration Design

Prior to the analysis of samples, and after the mass calibration check has met all criteria in Section 9.1.2, each LC-MS/MS system must be calibrated at a minimum of 6 standard concentrations (Section 8.2.4 and Table 3). This method procedure calibrates and quantifies 40 PFAS target analytes, using the isotopically labeled compounds added to the sample prior to extraction, by one of two approaches:

- Isotope Dilution quantification (ID), whereby the response of the target compound is compared to the response of its isotopically labeled analog; twenty-four target compounds are quantified in this way.
- Extracted Internal Standard quantification (EIS), whereby the response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities; sixteen target compounds are quantified in this way.

Initial calibration is performed using a series of at least six solutions, with the concentrations of at least five of the six calibration standards being within the quantification range. If a second-order calibration model is used, one additional concentration is required. The initial calibration solutions contain the entire suite of EIS, NIS, and target compounds. Calibration is verified at least once every ten field samples with a calibration verification (CV/CCV) standard, performed by analysis of a mid-level calibration solution. Calibration verification uses the mean RRs or RFs determined from the initial calibration to calculate the analyte concentrations in the verification standard.

Note: Six is the minimum number of calibration standards that must be used in the initial calibration; however, the laboratory may use more standards, as long as the criteria in Section 9.2.3 can be met.

Each LC-MS/MS system must be calibrated whenever the laboratory takes corrective action that might change or affect the initial calibration criteria, or if either the CCV or ISC acceptance criteria have not been met.

9.2.2 Calibration Sequence

Calibration standards must be analyzed in sequence from lowest to highest concentration to minimize the chance that carryover from a higher concentration standard will boost the area of a lower concentration standard. A typical sequence for days when calibration is required is shown below.

Description[1]	Comment
ICAL L1	
ICAL L2	
ICAL L3	
ICAL L4	
ICAL L5	
ICAL L6	
ICAL L7	
ICAL L8	
ICAL L9	
ICAL L10	
IBLK	Must be <1/2 LOQ
ICV	%R must be 70 – 130%
ISOMER CHECK	
BILE SALTS CHECK	TDCA must be resolved by ≥1 min from PFOS
CCV (ISC)	%R must be 70-130%; begins and ends Analytical Sequence

[1] *See Table 3 for calibration concentrations.*

9.2.3 ICAL Evaluation

If the criteria for initial calibration are not met, inspect the system for problems and take corrective actions to achieve the criteria. This may require the preparation and analysis of fresh calibration standards. All initial calibration criteria must be met before any samples or required blanks are analyzed.

Instrument Sensitivity – Sufficient instrument sensitivity is established if a signal-to-noise ratio ≥ 3:1 can be achieved when analyzing the lowest concentration standard within the quantitation range that the laboratory includes in its assessment of calibration linearity (see Table 3).

Curve Fit – One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or $1/x^2$) is allowed for linear and non-linear regressions.

Option 1: Calculate the relative standard deviation (RSD) of the RR or RF values of the initial calibration standards for each native compound and isotopically labeled compound. The RSD must be ≤ 20% to establish instrument linearity.

Option 2: Calculate the relative standard error (RSE) of the initial calibration standards for each native compound and isotopically labeled compound. The RSE for all method analytes must be ≤ 20% to establish instrument linearity.

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 ICAL standards, restrict the range of calibration, or select an alternate method of calibration.

If more than the minimum number of standards are analyzed and levels are excluded from the calibration, only the lowest or highest standards may be excluded, except as noted here. The removal of calibration levels from the interior of the curve is allowed only when there is sound technical reason for doing so and when the level is removed for all analytes; for example, when it can be proven that the wrong standard was analyzed for the calibration level or there is obvious evidence that the instrument malfunctioned during injection of the standard. The removal of any calibration level from the interior of the curve must be approved by the department supervisor/manager. Management approval and the rationale for the level removal must be documented and kept with the technical record.

Replacing a calibration standard may sometimes be needed to correct for a technical problem that occurred during analysis such as power failure, incomplete injection of the standard, or a similar situation. Replacement of one standard, when analyzed within 24 hours of original analysis time and replacing all analytes in the original standard, is permitted. The replacement of the standard must be approved by the department supervisor/manager; approval and the reason for replacement must be documented and kept with the technical record.

Initial Calibration Verification (ICV) – As part of the IDOC, each time a new Analyte PDS is prepared, and once after each ICAL, analyze an ICV sample prepared from a second source (different from the source of the ICAL standards). If a second vendor is not available, then a different lot of the standard from the same vendor should be used. The ICV should be prepared and analyzed just like a CCV. Acceptance criteria for the ICV are identical to the CCVs: the calculated concentration for each analyte must be within ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, correct the problem and rerun the ICV. If the problem persists, repeat the ICAL. Samples are not to be analyzed until the ICAL has been verified by acceptable ICV accuracy. The lab will add additional target analytes to the ICV mix as second source standards become commercially available.

Qualitative Isomer Check – Calibration standards for PFOS, PFHxS, NMeFOSAA and NEtFOSAA contain both branched and linear isomers. For target compounds which have multiple chromatographic peaks due to branched and linear isomers, but for which quantitative standards are not available, a qualitative isomer check is analyzed with each calibration event and at the beginning of each analysis sequence to demonstrate the peak shape and retention time of the branched isomers. See Section 10.1 for integration information.

Bile Salts Check – The laboratory must analyze a Bile Salts Check standard (Section 8.2.7) after the initial calibration, and prior to the analysis of samples, to check for interferences caused by bile salts. If an interference is present, the chromatographic conditions must be modified to eliminate the interference from TDCA (e.g., changing the retention time of TDCA such that it is resolved from PFOS by at least one minute), and the initial calibration repeated.

9.2.4 Continuing Calibration Verification (CCV or CV) – After a passing MS resolution and a successful initial calibration is achieved and prior to the analysis of any samples, the calibration is verified by injecting an aliquot of the appropriate concentration ICAL standard, analyzed with the same conditions used during the ICAL. CCV is performed at the beginning of each analytical sequence, after every ten samples, and at the end of the analytical sequence. In this context, a “sample” is defined as a field sample. MBs, CCVs, LCSs, MSs, FDs, TBs and MSDs are not counted as samples. All CCV analyses are performed using the mid-level ICAL standard, except for the daily Instrument Sensitivity Check, as noted below.

Calculate concentration for each native and EIS compound in the CCV using the equation in Section 10.3. The recovery of native and EIS compounds for the CCVs must be within 70 – 130%. If the CCV criteria are not met, recalibrate the LC-MS/MS according to Section 9.2. Alternately, the analyst may immediately analyze two CCVs for confirmation. If both confirmation CCV analyses meet the recovery criteria, analysis may proceed; however, the analyst must rerun any samples that were analyzed after the failing CCV and before the 2 passing CCVs. If either of the 2 confirmation CCV analyses fails to meet the acceptance criteria, recalibrate the LC-MS/MS according to Section 9.2.

If an individual target compound recovery in a CCV is above the upper control limit and all associated samples are ND for that compound, the data for those samples may be reported. In such cases, a narrative statement must be included in the report indicating the specific compound result that was biased high in the CCV, and that samples were ND for that compound and thus reportable.

Instrument Sensitivity Check (ISC) – An ISC at the concentration of the lowest calibration standard within the quantitation range is required to be analyzed at the beginning of the analytical run (Section 9.4). The signal-to-noise ratio (Section 10.1.1) of the ISC must be greater than or equal to 3:1. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem must be corrected before analyses can proceed.

9.3 Sample Preparation

This section describes the sample preparation procedures for aqueous samples with <100 mg/L Suspended Solids (Section 9.3.3), solid samples (soil, sediment or biosolid; Section 9.3.4) and tissue samples (Section 9.3.5). For solid samples and aqueous samples that contain particles, percent solids are determined using the procedures in Section 9.3.2. This section also describes the solid phase extraction (SPE, Section 9.3.6) and extract cleanup protocols for all matrices (Sections 9.3.7 – 9.3.9).

Note: The laboratory may choose to pre-screen some samples prior to performing the analysis, following the protocol described in Appendix C. For aqueous samples, use the secondary container provided for suspended solids to perform the pre-screening. If high levels of PFAS are present in the sample, a lower volume is required for analysis.

Do not use any fluoropolymer articles or task wipes in these extraction procedures. Use only HDPE or polypropylene wash bottles and centrifuge tubes. Reagents and solvents for cleaning syringes may be kept in glass containers.

9.3.1 Subsampling – The laboratory may subsample the aqueous samples as described in Appendix D; however, subsampling must meet project-specific requirements. The laboratory must notify the client that subsampling has occurred. Subsampling is acceptable for samples which exceed the 100 mg/L SS method application limit, samples which require greater than a 10X dilution for over-range detections or are known/expected to be highly contaminated, and samples which fail the acceptance criteria for EIS compounds (see Section 9.4.2). Any time subsampling is required, no less than 2% of the typical extracted volume (or mass) may be subsampled. In cases where less than 2% of an aqueous sample is required for subsample (i.e., less than 10 mL, or less than 2 mL for leachates), serial dilution must be employed.

9.3.2 Determination of Percent Solids

Percent solids analysis must be performed on all aqueous, solid, and multi-phase samples prior to preparation and analysis.

Suspended Solids (SS) in aqueous liquids and multi-phase samples consisting of mainly an aqueous phase – All aqueous samples will be logged in for both DM1633 and TSS analysis. The TSS analysis will follow the Method SM2540D protocol, with the analyst filtering ≥50 mL of aqueous sample, and the LOQ being adjusted accordingly. This should provide an LOQ of ≤100 mg/L. Any aqueous sample returning a SS content of >100 mg/L shall be diluted following the prescriptions in Section 9.4.2. Samples containing 100-499 mg/L SS will be subsampled and prepared at a 5X dilution; samples containing 500-999 mg/L SS will be subsampled and prepared at a 10X dilution; samples containing 1000-1999 mg/L will be subsampled and prepared at a 20X dilution.

Percent Solids in solid samples (excluding tissues) – All solid samples will be logged in for both DM1633 and percent solids analysis. The percent solids analysis will follow the Method SM2540G protocol.

9.3.3 Aqueous Sample Processing

This method is applicable to aqueous samples containing up to 100 mg/L SS per sample. Therefore, aqueous sample preparation cannot begin until the TSS analysis is completed on each sample. The procedure requires the preparation of the entire sample. Smaller sample volumes may be analyzed for samples containing SS greater than specified for this method, or when unavoidable due to high level of PFAS. Typical sample size is 500 mL; however, sample size may vary, depending on project requirements, applicable regulations, and sample characteristics. The sample is to be analyzed in its entirety and should not be filtered. Leachate samples are analyzed using a 100 mL sample volume. Therefore, they must not be included in the same sample preparation batch as aqueous samples analyzed using 500 mL sample volumes.

Homogenize the sample by inverting the sample 3 – 4 times. Do not filter the sample. The standard procedure is to analyze the entire sample, plus a basic methanol rinse of the container.

The volume of the aqueous sample analyzed is determined by weighing the full sample bottle and then the empty sample bottle. Weigh each sample bottle (with the lid) to the nearest 0.1 g.

Prepare a method blank and two LCSs using PFAS-free water in HDPE bottles. Select a volume of water that is typical of the samples in the batch. Spike one LCS sample with native standard solution at 2x the LOQ. This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point. This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples with native standard solution (Section 8.2.3) at a concentration equivalent to the mid-level calibration point.

Spike an aliquot of EIS solution (Section 8.2.1) directly into the sample in the original bottle (or subsampled bottle) as well as to the bottles prepared for the QC samples. Mix by swirling or inverting the sample container.

Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid (Section 8.1) or ammonium hydroxide (or with 5% formic acid [Section 8.1] and 3% aqueous ammonium hydroxide [Section 8.1]). The sample is now ready for solid-phase extraction (SPE) and cleanup (Sections 9.3.6 and 9.3.7).

9.3.4 Solid Sample (excluding tissues) Processing

Mix the sample in its original jar. If it is impractical to mix the sample within its container transfer the sample to a larger container. Mix the sample thoroughly, stirring from the bottom to the top and in a circular motion along the sides of the jar, breaking particles up by pressing against the side of the container. The homogenized sample should be even in color and have no separate layers. Store the homogenized material in its original container or in multiple smaller containers. Determine the percent solids as per Section 9.3.2.

Note: The target sample weight for sediment or soil is 5 g dry weight. The target sample weight for biosolids is 0.5 g dry weight. Small amounts of reagent free water used for method blanks (10% of sample weight or less) can be added to unusually dry samples. This is an option, not a requirement.

Check the LIMS system for the percent solids data associated with the samples to be prepared. Using the percent solids data and the calculation below, weigh out an aliquot of each solid sample, not dried, into a 50 mL polypropylene centrifuge tube. Sample mass should be within ±0.2 g of target mass for soil and sediment samples, and within ±0.02 g of target mass for biosolids samples. Sample aliquot should provide 5 g dry weight (Wi_{Dry} below) for soil and sediment or 0.5 g dry weight for biosolids. Because biosolid samples are analyzed with a 0.5 g sample mass, they must not be included in the same sample preparation batch as solid samples analyzed with 5 g sample masses.

$$Solid\ Sample\ Target\ Mass\ (g) = \frac{Wi_{Dry}\ (g)}{\%\ solids\ (decimal)}$$

Prepare batch QC samples using 5 g of reference solid (Section 7.2) wetted with 2.5 g of reagent water for the method blank and two LCSs (use 0.5 g of reference solid with 0.25 g of reagent water for biosolid extraction batches). The addition of reagent water to the sand provides a matrix closer in composition to real-world samples. Spike one LCS sample with native standard solution at 2x the LOQ. This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point. This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples with native standard solution (Section 8.2.3) at a concentration equivalent to the mid-level calibration point.

Spike an aliquot of EIS solution (Section 8.2.1) directly into each centrifuge tube containing the aliquoted field and QC samples. Vortex or shake the sample to disperse the standard and allow to equilibrate for approximately 30 minutes.

Add 10 mL of 0.3% methanolic ammonium hydroxide (Section 8.1) to each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 2800 rpm for 10 minutes and transfer the supernatant to a clean 50 mL polypropylene centrifuge tube.

Add 15 mL of 0.3% methanolic ammonium hydroxide (Section 8.1) to the remaining solid sample in each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 2800 rpm for 10 minutes and decant the supernatant from the second extraction into the centrifuge tube with the supernatant from the first extraction.

Add another 5 mL of 0.3% methanolic ammonium hydroxide (Section 8.1) to the remaining sample in each centrifuge tube. Shake by hand to disperse, centrifuge at 2800 rpm for 10 minutes and decant the supernatant from the third extraction into the centrifuge tube with supernatant from the first and second extractions.

Using a 10 mg scoop, add 10 mg of carbon (Section 8.1) to the combined extract, mix by occasional hand shaking for no more than five minutes and then centrifuge at 2800 rpm for 10 minutes. Immediately decant the extract into a 60 mL glass or plastic evaporation or concentrator tube.

Dilute to approximately 35 mL with reagent water. A separate concentrator tube marked at the 35 mL level may be kept for a visual reference to get the approximate volume, but a close accounting of all water present in the sample should be maintained by the analyst regardless. Samples containing more than 50% water may yield extracts that are greater than 35 mL in volume; therefore, do not add water to these. Adding water to the sample extract is recommended for dry solid samples. Determine the water content in the sample as follows (percent moisture is determined from the % solids):

$$Water\ Content\ in\ Sample = \frac{Sample\ Weight\ (g)\ x\ Moisture\ (\%)}{100} + water\ added\ earlier$$

Or, if the Target Solid Sample Mass equation was used and the target sample mass was aliquoted for extraction as calculated, determine the water content in the sample as follows (use 0.5 instead of 5 for biosolid samples):

$$Water\ Content\ in\ Sample\ (g)\ =\ Recorded\ Solid\ Sample\ Mass\ (g) - 5$$

Concentrate each extract at approximately 55 ºC with a N2 flow of approximately 1.2 L/min to a final volume that is based on the water content of the sample (see table below). Allow extracts to concentrate for 25 minutes, then mix (by vortex if the volume is < 20 mL or using a glass pipette if the volume is > 20 mL). Continue concentrating and mixing every 10 minutes until the extract has been reduced to the required volume as specified in the table below. If the extract volume appears to stop dropping, the concentration must be stopped and the volume at which it was stopped recorded. The concentrated extract must still contain some methanol, about 5-10 mL. The pre-cleanup extract in 11.3.10 should contain no more than 20% methanol. The laboratory has flexibility to modify the volumes used to achieve this goal. Some laboratories may prefer not to add water in Section 11.3.8. The following table provides guidance to help determine the final extract volume, based on the water content of the original solid sample. A good rule of thumb is to make the “Concentrated Final Volume” 7-10 mL above the “Water Content in Sample” value.

Water Content in Sample[1]	Concentrated Final Volume
< 5 g	12 mL

5 – 8 g	12-15 mL
8 – 9 g	15-18 mL
9 – 10 g	16-19 mL

[1] *Determined from the % solids results determined in Section 9.3.2, and includes any water added to the sample or extract in the steps above.*

Note: Slowly concentrating extracts, in 1 mL increments, is necessary to prevent excessive concentration and the loss of neutral compounds (methyl and ethyl FOSEs and FOSAs) and other highly volatile compounds. The extract must be concentrated to remove the methanol as excess methanol during SPE clean-up results in poor recovery of C13 and C14 carboxylic acids and C10 and C12 sulfonates. If all the methanol is evaporated, the neutral compounds are likely to have poor recovery; if too much methanol is in the final concentrated extract, then the longer-chain compounds are likely to have poor recovery.

Add 40 - 50 mL of reagent water to the extract and vortex. Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid (Section 8.1) or ammonium hydroxide (or with 5% formic acid [Section 8.1] and 3% aqueous ammonium hydroxide [Section 8.1]). The extract is now ready for solid-phase extraction (SPE) and cleanup (Sections 9.3.6 and 9.3.8).

9.3.5 Tissue Sample Processing

Prior to processing tissue samples, the laboratory must determine the exact tissue to be analyzed. Common requests for analysis of fish tissue include whole fish with the skin on, whole fish with the skin removed, edible fish fillets (filleted in the field or by the laboratory), specific organs, and other portions. Once the appropriate tissue has been determined, the samples must be prepared and homogenized.

Pace utilizes the Green Bay location for tissue homogenization, following ENV-SOP-GBAY-0129 (Sample Homogenization, Compositing, and Subsampling; specifically, Section 9.4).

For each sample, weigh a 2 g aliquot of homogenized tissue into a 15 mL polypropylene centrifuge tube. Reseal the container with the remaining homogenized portion of the sample and return it to frozen storage in case it needs to be used for reanalysis.

Note: The default sample weight for tissue is 2 g wet weight; however, a 1 g sample may be used. Higher sample weights are not recommended for this method.

Prepare the batch QC samples using 2 g of reference tissue matrix (Section 7.2) for the method blank and two LCSs. Spike one LCS sample with native standard solutions at 2x the LOQ. This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point. This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples with native standard solution (Section 8.2.3) at a concentration equivalent to the mid-level calibration point.

Spike an aliquot of EIS solution (Section 8.2.1) directly into each field and QC sample.

Vortex and allow to equilibrate for approximately 30 minutes.

Add 10 mL of 0.05M KOH in methanol (Section 8.1) to each sample. Vortex to disperse the tissue then place tubes on a variable speed mixing table to shake for at least 16 hours. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant in a 50-mL polypropylene centrifuge tube.

Add 10 mL of acetonitrile to remaining tissue in the 15 mL centrifuge tube, vortex to mix and disperse the tissue. Sonicate for 30 minutes. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant, adding it to the 50 mL centrifuge tube containing the initial extract.

Add 5 mL of 0.05M KOH in methanol to the remaining sample in each centrifuge tube. Vortex to disperse the tissue and hand mix briefly. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant, adding it to the 50-mL centrifuge tube containing the first two extracts.

Using a 10 mg scoop, add 10 mg of carbon (Section 8.1) to the combined extract, mix by occasional hand shaking over a period of no more than five minutes and then centrifuge at 2800 rpm for 10 minutes. Immediately decant the extract into a 60 mL glass evaporation or concentrator tube.

Add 1 mL of reagent water to each evaporation/concentrator tube, set the evaporator/concentrator to 55 ºC with a N_2 flow of 1.2 L/min and concentrate the extract to 2.5 mL (only ~1 mL of the methanol should remain).

Add reagent water to each evaporation/concentrator tube to dilute the extracts to 50 mL.

Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid-phase extraction (SPE) and cleanup (Sections 9.3.6 and 9.3.9).

9.3.6 Solid Phase Extraction

All matrices (including batch QC) must undergo SPE and carbon cleanup to remove interferences (Section 9.3.7). The SPE cartridge conditioning and sample loading process described below is for use with all matrices; SPE cartridge elution and any additional extract treatment is matrix specific and may be found in Sections 9.3.7 through 9.3.9.

Note: Carbon cleanup is required. Carbon cleanup may remove analytes if the sample has a very low organic carbon content (this is unusual for non-drinking water environmental samples). This will be apparent if the isotope dilution standard recoveries are significantly higher on the reanalysis. If the laboratory can demonstrate that the carbon cleanup is detrimental to the sample analysis (by comparing results when skipping the carbon cleanup during reanalysis), then the carbon cleanup may be skipped for that specific sample. Carbon cleanup is performed prior to the SPE process for solid and tissue samples.

Pack clean salinized glass wool to half the height of the WAX SPE cartridge barrel (Section 7.1).

Set up the vacuum manifold with one WAX SPE cartridge plus a reservoir and reservoir adaptor for each cartridge for each sample and QC aliquot.

Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide (Section 8.1) followed by 5 mL of 0.3M formic acid (Section 8.1). Do not allow the WAX SPE to go dry. Discard the wash solvents.

Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading. Adjust the vacuum and pass the sample through the cartridge at 10-15 mL/min. Retain the empty sample bottle for later rinsing (Section 9.3.7). Discard eluate.

Note: For aqueous samples, in the event the SPE cartridge clogs during sample loading, first attempt to rinse and dry the clogged cartridge, following protocol in the following paragraph. The cartridge is then ready for elution. Place a second cartridge in the appropriate manifold location and pre-condition as above. Continue loading the remaining sample aliquot on the second cartridge, using the same reservoir. Proceed to next step.

Rinse the walls of the reservoir with 5 mL reagent water (twice) followed by 5 mL of 1:1 0.1M formic acid/methanol (Section 8.1) and pass those rinses through the cartridge using vacuum. Dry the cartridge by pulling air through. Discard the rinse solution. Continue to the elution and concentration steps based on the matrix.

9.3.7 Elution, Cleanup, and Filtration of Aqueous Sample Extracts

Note: If two cartridges were used, each cartridge must separately be submitted to the elution steps described below. Elute both cartridges into the same collection tube, using 5 mL of elution solvent for each. One of the elution aliquots must be used to perform the sample bottle rinse prior to eluting the cartridge. Using a gentle stream of Nitrogen and 55 ºC water bath to concentrate the ~10 mL of combined eluate to ~5 mL, then follow the carbon cleanup and filtration steps below. This concentration step is only applicable to situations where two SPE cartridges were eluted, each with 5 mL of elution solvent.

Place clean collection tubes inside the manifold, ensuring that the extract delivery needles do not touch the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

Add 5 mL of 1% methanolic ammonium hydroxide (Section 8.1) to the sample bottle. Cap the bottle and rotate to ensure all internal surfaces of each bottle are rinsed; avoid vigorous shaking when rinsing the 500 mL aqueous sample bottles with only 5 mL of methanol – any evaporation/vaporization will contribute to loss of extract here. After rinsing the inside of the sample bottle, use a plastic transfer pipette to transfer the rinse to the SPE reservoir, using it to wash the walls of the reservoir. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

Note: Air dry the empty sample bottle after the rinse is transferred. Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in Section 9.3.3.

Add 25 µL of concentrated acetic acid to each sample eluted in the collection tubes and vortex to mix. Add 10 mg of carbon (Section 8.1) to each sample and batch QC extract, using a 10 mg scoop. Hand shake occasionally for no more than 5 minutes. It is important to minimize the time the sample extract is in contact with the carbon. Immediately vortex (30 seconds) and centrifuge at 2800 rpm for 10 minutes.

Remove the plunger from a 5 mL polypropylene syringe and place a syringe filter (25 mm filter, 0.2 µm nylon membrane) onto the syringe; repeat to prepare one syringe for each sample in the prep batch. Add NIS solution (Section 8.2.2) to a clean collection tube for each sample prepared. Carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS. Repeat for all samples in the prep batch. Vortex to mix and transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

Note: Avoid attaching the filter to the syringe before removing the plunger from the syringe barrel, as the syringe disk filters can be compromised by the sudden vacuum created when the plunger is removed.

9.3.8 Elution and Filtration of Solid Sample Extracts

Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved.

Rinse the inside of the evaporation/concentrator tube using 5 mL of 1% methanolic ammonium hydroxide (Section 8.1). Then, using a plastic transfer pipette, transfer the rinse to the SPE reservoir, washing the walls of the reservoir. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

Add 25 µL of concentrated acetic acid to each sample extract in its collection tube and swirl to mix. Remove the plunger from a 5-mL polypropylene syringe and place a syringe filter (25 mm filter, 0.2 µm nylon membrane) onto the syringe; repeat to prepare one syringe for each sample in the prep batch. Add NIS solution (Section 8.2.2) to a clean collection tube for each sample prepared. Carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS. Repeat for all samples in the prep batch. Vortex to mix and transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

Note: Avoid attaching the filter to the syringe before removing the plunger from the syringe barrel, as the syringe disk filters can be compromised by the sudden vacuum created when the plunger is removed.

9.3.9 Elution and Filtration of Tissue Sample Extracts

Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved.

Rinse the inside of the evaporation/concentrator tube using 5 mL of 1% methanolic ammonium hydroxide (Section 8.1). Then, using a plastic transfer pipette, transfer the rinse to the SPE reservoir, washing the walls of the reservoir. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

Add 25 µL of concentrated acetic acid to each sample extract in its collection tube and swirl to mix. Remove the plunger from a 5 mL polypropylene syringe and place a syringe filter (25 mm filter, 0.2 µm nylon membrane) onto the syringe; repeat to prepare one syringe for each sample in the prep batch. Add NIS solution (Section 8.2.2) to a clean collection tube for each sample prepared. Carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS. Repeat for all samples in the prep batch. Vortex to mix and transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

Note: Avoid attaching the filter to the syringe before removing the plunger from the syringe barrel, as the syringe disk filters can be compromised by the sudden vacuum created when the plunger is removed.

9.4 Analysis

Analysis of sample extracts for PFAS by LC-MS/MS is performed running manufacturer's data acquisition software. The mass spectrometer is run with unit mass resolution in the multiple reaction monitoring (MRM) mode.

Perform mass calibration, establish the operating conditions (Section 9.1.2), and perform an initial calibration (Section 9.2) prior to analyzing samples.

Only after all performance criteria are met may blanks, MDLs, IPRs/LCSs, and samples be analyzed.

9.4.1 Example Analytical Sequence

After a successful initial calibration has been completed, an example analytical sequence for a batch of samples analyzed during the same analysis period is as follows. The volume injected for samples and QCs must be identical to the volume used for calibration (Section 9.2). Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial to ensure homogeneity of the extract.

- Instrument Blank
- Instrument Sensitivity Check
- Calibration Verification Standard (CCV)
- Isomer Check Standard
- Bile Salts Check Standard
- Instrument Blank
- Method Blank
- Low-level LCS (LLLCS)
- LCS
- Samples (10 or fewer)
- CCV
- Instrument Blank
- Samples (10 or fewer)
- CCV
- Instrument Blank

If the results are acceptable, the closing calibration verification solution may be used as the opening solution for the next analytical sequence.

If the response exceeds the calibration range for any sample, extracts are diluted as per Section 9.4.2 to bring all target responses within the calibration range.

Note: If the analytes that exceed the calibration range in the original analysis are known to not be of concern for the specific project (e.g., are not listed in a discharge permit), then the laboratory may consult with the client regarding the possibility of reporting that sample from the undiluted analysis.

9.4.2 Sample Dilutions

If the measured concentration for any compound exceeds the calibration range of the system, dilute a subsample of the sample extract with the methanolic ammonium hydroxide and acetic acid solution in Section 8.1 by a factor no greater than 10x and analyze the diluted extract. If the responses for each applicable EIS in the diluted extract meet the S/N and retention time requirements in Sections 10.1.1 and 10.1.2, and the EIS recoveries from the analysis of the diluted extract are greater than 5% (uncorrected for the dilution), then the compounds associated with those EISs may be quantified using isotope dilution. Use the EIS recoveries from the original analysis to select the dilution factor, with the objective of keeping the un-adjusted EIS recoveries in the dilution above that 5% lower limit (i.e., if the EIS recovery of the affected analyte in the undiluted analysis is 50%, then the sample should not be diluted more than 10:1). To account for the dilution, adjust the EIS and NIS recoveries as well as reported compound concentrations, detection limits, and LOQs.

If the EIS responses in the diluted extract do not meet the S/N and retention time requirements listed in Sections 10.1.1 and 10.1.2, then the compound cannot be measured reliably by isotope dilution in the diluted extract. In such cases, the lab must subsample a smaller aliquot of any affected aqueous sample and dilute it to 500 mL with reagent water or prepare a smaller aliquot of soil, biosolid, sediment, or tissue sample. The reduced sample volume (or mass) chosen for the re-extraction should match the dilution applied to the original extract (i.e., if the original aqueous sample extract was analyzed at a 10X dilution, 50 mL should be subsampled for the re-extraction). To account for the dilution, adjust the reported compound concentrations, detection limits, and LOQs.

If the recovery of any isotopically labeled compound is outside of the acceptance limits (Appendix B) in the original, undiluted analysis, a diluted aqueous sample or smaller aliquot (for solids and tissue) must be analyzed.

10.0 DATA ANALYSIS AND CALCULATIONS

10.1 Qualitative Identification

A native or EIS/NIS compound is positively identified in a standard, blank, sample, or QC sample when all criteria in Sections 10.1.1 through 10.1.3 are met.

10.1.1 Signal-to-noise Ratio (S/N) – Peak responses must be at least three times the background noise level (S/N 3:1). If the S/N ratio is not met due to high background noise, the laboratory must correct the issue (e.g., perform instrument troubleshooting to check and if needed, replace, the transfer line, column, detector, liner, filament, etc.). If the S/N ratio is not met but the background is low, then the analyte is to be considered a non-detect.

10.1.2 RT Criteria – Target analyte, EIS analyte, and NIS analyte RTs must fall within ± 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. The retention time window used must be of sufficient width to detect earlier-eluting branched isomers. For all method analytes with exact corresponding isotopically labeled analogs, method analytes must elute within ± 0.1 minutes of the associated EIS.

10.1.3 Branched Isomer Integration – For concentrations at or above the method LOQ, the total (branched and linear isomer) quantification ion response to the total (branched and linear isomer) confirmation ion response ratio (ion ratio) must fall within ± 50% of the ratio observed in the mid-point initial calibration standard. If project-specific requirements involve reporting sample concentrations below the LOQ, the ion ratio must also fall within ± 50% of the ratio observed in the initial daily CCV**.**

The response of all isomers in the quantitative standards should be used to define ion ratios. In samples, the total response should include the branched isomer peaks that have been identified in either the quantitative or qualitative standard. If standards (either quantitative or qualitative) are not available for purchase, only the linear isomer can be identified and quantitated in samples. The ratio requirement does not apply for PFBA, NMeFOSE, NEtFOSE, PFMPA, and PFMBA because suitable secondary transitions are unavailable (not detectable or inadequate S/N).

10.1.4 Qualification – If the field sample result does not meet all criteria stated in Sections 10.1.1 through 10.1.3, and all sample preparation avenues (e.g., extract cleanup, sample dilution, etc.) have been exhausted, the result may only be reported with a data qualifier alerting the data user that the result could not be confirmed because it did not meet the method-required criteria and therefore should be considered an estimated value. If the criteria listed above are not met for the standards, the laboratory must stop analysis of samples and correct the issue.

10.1.5 Manual Integration

Sample integration is performed automatically by quantitation software and reviewed by the analyst for any incorrect analyte identification or poor integration. Manual changes to automated integration are called manual integrations. Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are performed consistently and are ethically justified, all manual integrations must be performed, reviewed, and recorded in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration.*

10.2 Quantitative Identification

Concentrations of the target analytes are determined with respect to the extracted internal standard (EIS) which is added to the sample prior to extraction. The EIS is quantitated with respect to a NIS, as shown in Table 2, using the response ratios or response factors from the most recent multi-level initial calibration (Section 9.2). Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equations below.

All results for aqueous samples will be reported in ng/L. All results for solid samples will be reported in ng/g, on a dry-weight basis, and the percent solids for each sample will be reported separately. All results for tissue samples will be reported in ng/g, on a wet-weight basis. All QC data will be reported with the sample results.

Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria are reported down to the concentration of the LOQ (Section

11.3.1) established by the laboratory through calibration of the instrument. EPA considers the terms "reporting limit," "quantitation limit," "limit of quantitation," and "minimum level" to be synonymous.

Results for each analyte found in each field sample or QC standard at or above the LOQ will be reported to 3 significant figures. Results for each analyte found in each field sample or QC standard below the LOQ will be reported as "<LOQ," where LOQ is the concentration of the analyte at the LOQ, or as required by the regulatory/control authority or permit.

Results for each analyte found in a blank at or above the MDL will be reported to 2 significant figures. Results for each analyte found in a blank below the MDL will be reported as "<MDL," where MDL is the concentration of the analyte at the MDL, or as required by the regulatory/control authority or permit.

Results for any analyte found in a sample or extract that has been diluted will be reported at the least dilute level for which the measured concentration is within the calibration range (e.g., above the LOQ for the analyte and below the highest calibration standard) and in which isotopically labeled compound recoveries are within their respective QC acceptance criteria. This may require reporting results for some analytes from different analyses.

Recoveries of all associated EIS compounds will be reported for all field samples and QC standards.

10.3 Calculations

See the ENV-SOP-BTRO-0142, *Laboratory Calculations*, for equations for common calculations.

For the native analytes:

$$\boldsymbol{Concentration\ (ng/L or ng/g) = \frac{Area_N M_{EIS}}{Area_{EIS}(\overline{RR}\ or\ \overline{RF})}\ x\ \frac{1}{W_S}}$$

Where:

$Area_N$ = The measured area of the Q1 m/z for the native (unlabeled) PFAS

$Area_{EIS}$ = The measured area at the Q1 m/z for the EIS. See note below.

M_{EIS} = The mass of the EIS added (ng)

$\overline{\boldsymbol{RR}}$ = Average response ratio used to quantify target compounds by the isotope dilution method

$\overline{\boldsymbol{RF}}$ = Average response ratio used to quantify target compounds by the extracted internal standard method

W_S = Sample volume (L) or dry weight (g)

And for the EIS analytes:

$$\boldsymbol{Concentration\ (ng/L\ or\ ng/g) = \frac{Area_{EIS} M_{NIS}}{Area_{NIS}\overline{RF}_S}\ x\frac{1}{W_S}}$$

Where:

$Area_{EIS}$ = The measured area at the Q1 m/z for the EIS

$Area_{NIS}$ = The measured area of the Q1 m/z for the non-extracted internal standard (NIS)

M_{NIS} = The mass of the added non-extracted internal standard (NIS) compound (ng)

W_S = Sample volume (L) or dry weight (g)

$\overline{RF_S}$ = Average response factor used to quantify the isotopically labeled compound by the non-extracted internal standard method

Results for native compounds are recovery corrected by the method of quantification. Extracted internal standard (EIS) recoveries are determined similarly against the non-extracted internal standard (NIS) and are used as general indicators of overall analytical quality.

11.0 QUALITY CONTROL AND METHOD PERFORMANCE

11.1 Quality Control

The following QC samples are prepared and analyzed with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action.

QC Item	Frequency
Method Blank (MB)	1 per batch of 20 or fewer samples.
Laboratory Control Sample (LCS) / Ongoing Recovery and Precision Standard (OPR)	1 per batch of 20 or fewer samples.
Low-Level Laboratory Control Sample (LLLCS) / Low-Level Ongoing Recovery and Precision Standard (LLOPR)	1 per batch of 20 or fewer samples.
Matrix Spike (MS)	1 pair per batch of 20 or fewer samples.
Matrix Spike Duplicate (MSD)	
Sample Duplicate	1 per AFFF sample.
Extracted Internal Standard (EIS) Analytes	All CAL standards, batch QC and field samples.
Non-extracted Internal Standards (NIS)	All CAL standards, batch QC and field samples.

The minimum quality control requirements of this method consist of an initial demonstration of laboratory capability, analysis of samples spiked with isotopically labeled compounds to evaluate and document data quality, and analysis of standards and blanks as tests of continued performance. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

If the method is to be applied to a sample matrix other than water (e.g., soils, biosolids, tissue), the appropriate alternative reference matrix (Section 7.2) is substituted for the reagent water matrix in all performance tests.

The laboratory must make an initial demonstration of the ability to generate acceptable precision and recovery with this method. This demonstration is given in Section 11.4.

Analyses of method blanks (MBs) are required on an on-going basis to demonstrate the extent of background contamination in any reagents or equipment used to prepare and analyze field samples. The procedures and criteria for analyses of a MBs are described in Section 11.1.1.

The laboratory must spike all samples with isotopically labeled compounds to monitor method performance. This procedure is described in Section 11.3. When results of these spikes indicate atypical method performance for samples, the samples are diluted to evaluate whether the performance issue is caused by the sample matrix. Procedures for dilution are given in Section 9.4.2.

The laboratory must, on an ongoing basis, demonstrate that the analytical system is in control through calibration verification and the analysis of ongoing precision and recovery standards (LCS), spiked at low (LLLCS) and mid-level, and blanks. These procedures are given in Sections 11.1.2 and 11.2.1.

11.1.1 **Method Blanks (MB) –** A method blank is analyzed with each extraction batch to demonstrate freedom from contamination. The matrix for the method blank must be similar to the sample matrix for the batch (e.g., reagent water blank, solids matrix blank, or tissue blank [Section 7.2]).

Analyze the cleaned extract (Sections 9.3.7, 9.3.8, 9.3.9) of the method blank aliquot before the analysis of the LCSs (Section 11.1.2).

If any PFAS is found in the MB 1) at a concentration greater than the LOQ for the analyte, 2) at a concentration greater than one-third the regulatory compliance limit, or 3) at a concentration greater than one-tenth the concentration in a sample in the extraction batch, whichever is greatest, analysis of samples must be halted, and the problem corrected. Other project-specific requirements may apply; therefore, the laboratory may adopt more stringent acceptance limits for the method blank at their discretion. If the contamination is traceable to the extraction batch, samples affected by the blank must be re-extracted and analyzed, provided enough sample volume is available and the samples are still within holding time.

Note: For DoD (B-24) compliance, MBs must not show any analytes detected >½ LOQ, > 1/10th the amount measured in any associated sample, or 1/10th the regulatory limit, whichever is greatest.

If continued re-testing results in repeated blank contamination, the laboratory must document and report the failures (e.g., as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority.

11.1.2 **Laboratory Control Sample (LCS)/Ongoing Precision and Recovery (OPR) –** Analyze the extract of the LCS/OPR to ensure the analytical process is under control.

Compute the percent recovery of the native compounds by the appropriate quantification method depending on the compound (Sections 9.2.1, 10.2, 10.3). Compute the percent recovery of each isotopically labeled compound by the non-extracted internal standard quantitation method and the equation below:

$$Recovery\,\% = \frac{Concentration\ Found\ (ng/mL)}{Concentration\ Spiked\ (ng/mL)}\,x\,100$$

For the native compounds and isotopically labeled compounds, compare the recovery to the LCS limits. Analyte recoveries must be within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary in-house acceptance criteria of 40-150% must be used for LCS analyses until in-house limits are generated in accordance with Section 14.5.4 of EPA Draft Method 1633. The lower in-house acceptance criteria for LCS recovery cannot be <40%.

If all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may proceed. If, however, any individual concentration falls outside of the given range, the extraction/concentration processes are not being performed properly for that compound. In this event, correct the problem, re-prepare, extract, and clean up the extraction batch and repeat the ongoing precision and recovery test.

11.1.3 **Matrix Spike (MS) –** Analysis of an MS may be required in each extraction batch. Assessment of method precision can be accomplished by preparation and analysis of a matrix spike duplicate (MSD). See Appendix E for MS/MSD, MS/FD sample selection guidance.

Note: For DoD (B-24) compliance, one MS/MSD pair is required per preparatory batch. For all other regulatory programs, follow project- or client-specific requirements.

Within each extraction batch, a minimum of one pair of sample bottles is spiked as MS/MSD for every 20 samples analyzed. MS/MSD samples are spiked in the same manner as the mid-level LCS.

Analyte recoveries may exhibit matrix effect. For matrix spike samples, acceptance criteria for recovery should match LCS limits. If the % recovery falls outside of the acceptable range, corrective action must occur. The initial corrective action will be to check all calculations. If the calculations are correct, check the recovery of that analyte in the LCS. If the recovery of the analyte in the LCS is within limits, then matrix interference has been demonstrated and the laboratory operation may proceed. Analytical reports will show qualifier flags in such cases.

If the recovery for any analyte is outside the acceptance criteria for the matrix spike and the LCS, the laboratory is out of control and corrective action will be taken. Corrective action may include repreparation and reanalysis of the batch. A narrative statement will be added to document the corrective action taken.

RPDs for MS/MSDs should be ≤30%. If the RPD falls outside of the acceptable range, corrective action must occur. The initial corrective action will be to check all calculations. If the calculations are correct, check the recovery of that analyte in the LCS. If the recovery of the analyte in the LCS is within limits, then matrix interference has been demonstrated and the laboratory operation may proceed. Analytical reports will show qualifier flags in such cases.

11.2 Instrument QC

The following Instrument QC checks are performed. Refer to Appendix B for acceptance criteria and required corrective action.

QC Item	Frequency
Mass Calibration	Annually and on as-needed basis
Mass Calibration Verification	After mass calibration
Initial Calibration (ICAL)	Prior to analysis, and on as-needed basis
Initial Calibration Verification (ICV)	Following each ICAL
Instrument Blank (IBLK)	Daily prior to analysis and after high standards
Qualitative Isomer Check	Daily prior to analysis
Bile Salts Check	Daily prior to analysis
Instrument Sensitivity Check (ISC)	Daily prior to analysis
Continuing Calibration Verification (CCV)	At the beginning and every 10 samples
Continuing Calibration Blank (IBLK)	After each CCV

RT Window	After ICAL and at the beginning of analytical sequence

11.2.1 Instrument Blank (IBLK) – One instrument blank (IBLK) is analyzed immediately following the highest ICAL standard analyzed, each analysis day prior to sample analysis, and following each bracketing CCV in a sequence, to check for carryover and instrument contamination. The concentration of each analyte must be ≤ 1/2 the LOQ. If the IBLK does not pass this requirement after the highest ICAL standard, the calibration must be performed using a lower concentration for the highest standard until the acceptance criteria is met.

11.2.2 Qualitative Isomer Check – A qualitative identification standard (Section 8.2.7) containing all available isomers (branched and linear) is analyzed once daily at the beginning of the analytical sequence, to confirm the retention time of each linear and known branched isomer or isomer group. All required branched isomer peaks must be present and visibly resolved from their corresponding linear peak.

11.3 Method Performance

Routine method performance is validated through analysis of matrix-specific reference samples, including spikes and PTs. Ongoing method performance is monitored through QC samples analyzed alongside samples. The parameters monitored include percent recovery of EIS compounds, blank concentrations, and native compound recoveries.

The specifications contained in this method can be met if the apparatus used is calibrated and maintained properly. The standards used for initial calibration (Section 8.2.4), calibration verification (Sections 9.2.4), and for initial (Section 11.4) and ongoing (Section 11.1.2) precision and recovery may be prepared from the same source; however, the use of a secondary source for calibration verification is highly recommended whenever available. If standards from a different vendor are not available, a different lot number from the same vendor can be considered a secondary source. A LC-MS/MS instrument will provide the most reproducible results if dedicated to the settings and conditions required for determination of PFAS by this method.

To assess method performance on the sample matrix, the laboratory must spike all samples with the EIS solution (Section 8.2.1) and all sample extracts with the NIS spiking solution (Section 8.2.2). Analyze each sample according to the procedures in this SOP. Compute the percent recovery of the EIS compound concentration using the NIS quantitation method and the equation in Section 11.1.2. The recovery of each EIS and NIS compound must be assessed and be within the control limits; the lab must maintain records of these assessments. If the recovery of any compound falls outside of these limits, method performance is unacceptable for that compound in that sample. If the recovery cannot be brought within the normal range, water samples are diluted, and smaller amounts of soils, biosolids, sediments, and other matrices are prepared and analyzed, per Section 9.4.2.

NIS areas must be greater than 30% of the average area of the calibration standards in undiluted sample extracts and extracts that required additional NIS to be added. NIS areas corrected for the dilution factor must be greater than 30% of the average area of the calibration standards in diluted samples when additional NIS was not added during dilution of the extract.

EIS Preliminary inhouse acceptance criteria of 20-150% must be used until inhouse limits are generated as described below; the inhouse lower acceptance limit cannot be <20% for any EIS compound.

After the analysis of 30 samples of a given matrix type (water, soil, biosolids, tissues, etc.) for which the isotopically labeled compounds pass the tests in Section 9.3, compute the R and the standard deviation of the percent recovery (SR) for the isotopically labeled compounds only. Express the assessment as a percent recovery interval from R - 2SR to R + 2SR for each matrix. For example, if R = 90% and SR = 10% for five analyses of soil, the recovery interval is expressed as 70 to 110%. Update the accuracy assessment for each isotopically labeled compound in each matrix on a regular basis (e.g., after each five to ten new measurements).

11.3.1 Method Validation

Detection limits (DL) and limits of quantitation (LOQ) are established at initial method setup and verified on an on-going basis thereafter. Refer to Pace ENV corporate SOP ENV-SOP-CORQ-0011 (Method Validation and Instrument Verification) and to the laboratory's relevant SOP for these procedures. DLs must be established for all the analytes using the MDL procedure at 40 CFR Part 136, Appendix B. An MDL determination must be performed for all compounds.

11.4 Analyst Qualifications and Training

Employees that perform any step of this procedure must have a completed Read and Acknowledgment Statement for this version of the SOP in their training record. In addition, prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis (see below for details). Successful means the initial and on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee's training file.

IDOC - To establish the ability to generate acceptable precision and recovery, the laboratory must perform the following operations for each sample matrix type to which the method will be applied by that laboratory.

Extract, concentrate, and analyze four aliquots of the matrix type to be tested (Section 7.2), prepared in the same way as the mid-level LCS/OPR. At least one method blank, matching the matrix being analyzed, must be prepared with the IDOC batch. If more than one MB was prepared and analyzed with the IDOC batch, all blank results must be reported. All sample processing steps that are to be used for processing samples, including preparation and extraction, cleanup, and concentration (Sections 9.3.3 through 9.3.9), must be included in this test.

Using results of the set of four analyses, compute the average percent recovery (R) of the extracts and the relative standard deviation (RSD) of the concentration for each target and EIS compound.

For each native and isotopically labeled compound, compare RSD and R with the corresponding limits for initial precision and recovery. If RSD and R for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. If, however, any individual RSD exceeds the precision limit or any individual R falls outside the range for recovery, system performance is unacceptable for that compound. Correct the problem and repeat the test.

12.0 DATA REVIEW AND CORRECTIVE ACTION

12.1 Data Review

Pace's data review process includes a series of checks performed at different stages of the analytical process by different people to ensure that SOPs were followed, the analytical record is complete and properly documented, proper corrective actions were taken for QC failure and other nonconformance(s), and that test results are reported with proper qualification.

The review steps and checks that occur as employee's complete tasks and review their own work is called primary review.

All data and results are also reviewed by an experienced peer or supervisor. Secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented in accordance with the Pace ENV's SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

A third-level review, called a completeness check, is performed by reporting or project management staff to verify the data report is not missing information and project specifications were met.

Refer to laboratory SOP for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is expected any time QC or sample results are not within acceptance criteria. If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range. Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

Refer to Appendix B for a summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

13.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

Pace proactively seeks ways to minimize waste generated during our work processes. Some examples of pollution prevention include but are not limited to: reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practice to be conducted consistent with all applicable federal and state laws and regulations. Excess reagents, samples and method process wastes must be characterized and disposed of in an acceptable manner in accordance with Pace's Chemical Hygiene Plan / Safety Manual.

14.0 MODIFICATIONS

A modification is a change to a reference test method made by the laboratory. For example, changes in stoichiometry, technology, quantitation ions, reagent or solvent volumes, reducing digestion or extraction times, instrument runtimes, etc. are all examples of modifications. Refer to Pace ENV corporate SOP ENV-SOP-CORQ-0011 (Method Validation and Instrument Verification) for the conditions under which the procedures in test method SOPs may be modified and for the procedure and document requirements.

In recognition of advances that are occurring in analytical technology, and to overcome matrix interferences, the laboratory is permitted certain options to improve separations or lower the costs of measurements. These options include alternative extraction, concentration, and cleanup procedures, and changes in sample volumes, columns, and detectors. Alternative determinative techniques and other changes are not allowed without prior review and approval.

Each time a modification is made to this method, the laboratory is required to repeat the procedure in Sections 11.3.1 and 11.4. If calibration will be affected by the change, the instrument must be recalibrated per Section 9.2. Once the modification is demonstrated to produce results equivalent or superior to results produced by this method as written, that modification may be used routinely thereafter, so long as the other requirements in this method are met (e.g., isotopically labeled compound recovery).

If a column or column system other than those specified in this method is used, that column or column system must meet all the requirements of this method.

The laboratory is required to maintain records of any modifications made to this method. These records include the following, at a minimum:

a) The names, titles, business addresses, and telephone numbers of the analyst(s) that performed the analyses and modification, and of the quality control officer that witnessed and will verify the analyses and modifications.

b) A listing of pollutant(s) measured, by name and CAS Registry number.

c) A narrative stating reason(s) for the modifications.

d) Results from all quality control (QC) tests comparing the modified method to this method, including:

i. Calibration (ICAL)

ii. Calibration verification (CCV)

iii. Initial Demonstration of Capability (IDOC)

iv. Isotopically labeled compound recovery (EIS/NIS)

v. Analysis of blanks (IBLK, MB)

vi. Accuracy assessment (Section 11.3)

e) Data that will allow an independent reviewer to validate each determination by tracing the instrument output (peak height, area, or other signal) to the final result. These data are to include:

i. Sample numbers and other identifiers

ii. Extraction dates

iii. Analysis dates and times

iv. Analysis sequence/run chronology

v. Sample weight or volume

vi. Extract volume prior to each cleanup step

vii. Extract volume after each cleanup step

viii. Final extract volume prior to injection

ix. Injection volume

x. Dilution data, differentiating between dilution of a sample or extract

xi. Instrument Identification

xii. Column (dimensions, liquid phase, solid support, film thickness, etc.)

xiii. Operating conditions (temperatures, temperature program, flow rates)

xiv. Detector (type, operating conditions, etc.)

xv. Chromatograms, printer tapes, and other recordings of raw data

xvi. Quantitation reports, data system outputs, and other data to link the raw data to the results reported

15.0 RESPONSIBILITIES

Pace ENV employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement in their training file for this version of the SOP. The employee is responsible for following the procedures in this SOP and handling temporary departures from this SOP in accordance with Pace's policy for temporary departure.

Pace supervisors/managers are responsible for training employees on the procedures in this SOP and monitoring the implementation of this SOP in their work area.

16.0 ATTACHMENTS

Not applicable.

17.0 REFERENCES

1. "Working with Carcinogens," Department of Health, Education, & Welfare, Public Health Service, Centers for Disease Control, NIOSH, Publication 77-206, August 1977, NTIS PB-

277256.

2. "OSHA Safety and Health Standards, General Industry," OSHA 2206, 29 CFR 1910.

3. "Safety in Academic Chemistry Laboratories," ACS Committee on Chemical Safety, 1979.

4. “Standard Methods for the Examination of Water and Wastewater,” 18th edition and later revisions, American Public Health Association, 1015 15th St, NW, Washington, DC 20005, 1-35: Section 1090 (Safety), 1992.

5. “Standard Practice for Sampling Water,” ASTM Annual Book of Standards, ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, 1980.

6. “Handbook of Analytical Quality Control in Water and Wastewater Laboratories,” USEPA EMSL, Cincinnati, OH 45268, EPA 600/4-79-019, April 1979.

7. “Less is Better: Laboratory Chemical Management for Waste Reduction,” American Chemical Society, 1993. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

8. “Environmental Management Guide for Small Laboratories,” USEPA, Small Business Division, Washington DC, EPA 233-B-00-001, May 2000.

9. “The Waste Management Manual for Laboratory Personnel,” American Chemical Society, 1990. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

10. SERDP. Single-Laboratory Validation Study of PFAS by Isotope Dilution LC-MS/MS. ER19-1409. January 26, 2022.

11. DoD QSM (US Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.4, 2021)

12. Woudneh, Million B., Bharat Chandramouli, Coreen Hamilton, Richard Grace, 2019, “Effects of Sample Storage on the Quantitative Determination of 29 PFAS: Observation of Analyte Interconversions during Storage”, Environmental Science and Technology 53(21): 12576-12585.

13. EPA. Draft Method 1633, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. August 2021.

14. Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017 – Total, Fixed, and Volatile Solids in Solid and Semisolid Samples, Method 2540.

18.0 REVISION HISTORY

Authorship

Primary Author[1]	Job Title	Date Complete
Stephen Somerville	PFAS Technical Director	5/5/2022

[1]The primary author is the individual / role responsible for the content of this SOP. Send questions or suggestions for content to the primary author. See the Quality Manager for questions or concerns related to implementation of this SOP.

Revisions Made from Prior Version

Section	Description of Change
6.0	Thermal preservation changed for “0-6°C” to “0-6°C or ≤ -20°C”

Document Succession: This version replaces the following documents:

Document Number & Version	Document Title	Effective Date:
ENV-SOP-BTRO-0149 v01	Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in	05/09/2022

	Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS	

Appendix A: Target Analyte Limits, Analytical Parameters, and Calibration

Table 1: Routine Analyte List Limits of Detection (LOD) and Limits of Quantitation (LOQ)[1]

Analyte	Aqueous (ng/L)		Leachate (ng/L)		Solid (ng/g)		Biosolid (ng/g)		Tissue (ng/g)	
	LOD	LOQ	LOD	LOQ	LOD	LOQ	LOD	LOQ	LOD	LOQ
PFBA	2	4	10	20	0.4	0.8	4	8		2.0
PFPeA	1	2	5	10	0.2	0.4	2	4		1.0
PFHxA	0.5	1	2.5	5	0.16	0.2	1.6	2		0.5
PFHpA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFOA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFNA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFDA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFUnA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFDoA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFTrDA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFTeDA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFBS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFPeS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFHxS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFHpS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFOS	0.75	1	3.75	5	0.15	0.2	1.5	2		0.5
PFNS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFDS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
PFDoS	0.5	1	2.5	5	0.1	0.2	1	2		0.5
4:2 FTS	2	4	10	20	0.4	0.8	4	8		2.0
6:2 FTS	2	4	10	20	0.4	0.8	4	8		2.0
8:2 FTS	2	4	10	20	0.4	0.8	4	8		2.0
PFOSA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
NMeFOSA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
NEtFOSA	0.5	1	2.5	5	0.15	0.2	1.5	2		0.5
NMeFOSAA	0.5	1	2.5	5	0.1	0.2	1	2		0.5
NEtFOSAA	0.75	1	3.75	5	0.1	0.2	1	2		0.5
NMeFOSE	5	10	25	50	1	2.0	10	20		5.0
NEtFOSE	5	10	25	50	1	2.0	10	20		5.0
HFPO-DA	2	4	10	20	0.4	0.8	4	8		2.0
ADONA	2	4	10	20	0.4	0.8	4	8		2.0
PFEESA	1	2	5	10	0.2	0.4	2	4		1.0
PFMPA	1	2	5	10	0.2	0.4	2	4		1.0
PFMBA	1	2	5	10	0.2	0.4	2	4		1.0
NFDHA	1	2	5	10	0.2	0.4	2	4		1.0
9Cl-PF3ONS	2	4	10	20	0.4	0.8	4	8		2.0
11Cl-PF3OUdS	2	4	10	20	0.4	0.8	4	8		2.0
3:3 FTCA	3	5	15	25	0.5	1.0	5	10		2.5
5:3 FTCA	6	25	30	125	2.5	5.0	25	50		12.5
7:3 FTCA	10	25	50	125	2.5	5.0	25	50		12.5

[1] *Values in place as of effective date of this SOP. LOD/LOQ are subject to change. For the most up to date LOD/LOQ, refer to the LIMS or contact the laboratory.*

Table 2: Identification and Quantification Information for Target Analytes, Extracted Internal Standards and Non-extracted Internal Standards

Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluorobutanoic acid	375-22-4	PFBA	213	169	NA	13C4-PFBA
Perfluoropentanoic acid	2706-90-3	PFPeA	263	218.9	69	13C5-PFPeA
Perfluorohexanoic acid	307-24-4	PFHxA	313	268.9	118.9	13C5-PFHxA
Perfluoroheptanoic acid	375-85-9	PFHpA	362.9	319	169	13C4-PFHpA
Perfluorooctanoic acid	335-67-1	PFOA	413	369	169	13C8-PFOA
Perfluorononanoic acid	375-95-1	PFNA	463	419	219	13C9-PFNA
Perfluorodecanoic acid	335-76-2	PFDA	513	469	219	13C6-PFDA
Perfluoroundecanoic acid	2058-94-8	PFUnA	563	518.9	269.1	13C7-PFUnA
Perfluorododecanoic acid	307-55-1	PFDoA	613	569	319	13C2-PFDoA
Perfluorotridecanoic acid	72629-94-8	PFTrDA	663.0	618.9	168.9	13C2-PFDoA
Perfluorotetradecanoic acid	376-06-7	PFTeDA	713	668.9	168.9	13C2-PFTeDA
Perfluorobutanesulfonic acid	375-73-5	PFBS	298.9	80	98.8	13C3-PFBS
Perfluoropentansulfonic acid	2706-91-4	PFPeS	349	80	98.9	13C3-PFHxS
Perfluorohexanesulfonic acid	355-46-4	PFHxS	398.9	80	99	13C3-PFHxS
Perfluoroheptanesulfonic acid	375-92-8	PFHpS	449	80	98.8	13C8-PFOS
Perfluorooctanesulfonic acid	1763-23-1	PFOS	499	80	99	13C8-PFOS
Perfluorononanesulfonic acid	68259-12-1	PFNS	549	80	98.8	13C8-PFOS
Perfluorodecanesulfonic acid	335-77-3	PFDS	599	80	98.8	13C8-PFOS
Perfluorododecanesulfonic acid	79780-39-5	PFDoS	698.9	80	99	13C8-PFOS
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	757124-72-4	4:2FTS	327	306.9	80.9	13C2-4:2FTS
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	27619-97-2	6:2FTS	427	406.9	80.9	13C2-6:2FTS
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	39108-34-4	8:2FTS	527	506.9	81	13C2-8:2FTS
Perfluorooctanesulfonamide	754-91-6	PFOSA	497.9	78	478	13C8-PFOSA
N-methyl perfluorooctanesulfonamide	31506-32-8	NMeFOSA	512	219	169	D3-NMeFOSA
N-ethyl perfluorooctanesulfonamide	4151-50-2	NEtFOSA	526	219	169	D5-NEtFOSA
N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9	NMeFOSAA	570	418.9	483	D3-NMeFOSAA
N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6	NEtFOSAA	584	418.9	526	D5-NEtFOSAA
N-methyl perfluorooctanesulfonamidoethanol	24448-09-7	NMeFOSE	616	59.1	NA	D7-NMeFOSE
N-ethyl perfluorooctanesulfonamidoethanol	1691-99-2	NEtFOSE	630	59.1	NA	D9-NEtFOSE
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	HFPO-DA	285	169	184.9	13C3-HFPODA

Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	ADONA	377	251	85.1	13C3-HFPODA
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	9Cl-PF3ONS	530.9	350.9	533→353	13C3-HFPODA
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	11Cl-PF3OUdS	630.9	450.9	633→453	13C3-HFPODA
3-Perfluoropropyl propanoic acid (FPrPA)	356-02-5	3:3FTCA	241	177	117	13C5-PFPeA
2H,2H,3H,3H-Perfluorooctanoic acid (FPePA)	914637-49-3	5:3FTCA	341	237.1	217	13C5-PFHxA
3-Perfluoroheptyl propanoic acid (FHpPA)	812-70-4	7:3FTCA	441	317	337	13C5-PFHxA
Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7	PFEESA	315	135	83	13C5-PFHxA
Perfluoro-3-methoxypropanoic acid	377-73-1	PFMPA	229	85	NA	13C5-PFPeA
Perfluoro-4-methoxybutanoic acid	863090-89-5	PFMBA	279	85	NA	13C5-PFPeA
Nonafluoro-3,6-dioxaheptanoic acid	151772-58-6	NFDHA	295	201	85	13C5-PFHxA
Extracted Internal Standard (EIS) Compounds						
Perfluoro-n-[13C4] butanoic acid	N/A	13C4-PFBA	217	172	NA	13C3-PFBA
Perfluoro-n-[13C5] pentanoic acid	N/A	13C5-PFPeA	268	223	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4,6-13C5] hexanoic acid	N/A	13C5-PFHxA	318	273	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4-13C4] heptanoic acid	N/A	13C4-PFHpA	366.9	322	NA	13C2-PFHxA
Perfluoro-n-[13C8] octanoic acid	N/A	13C8-PFOA	421	376	NA	13C4-PFOA
Perfluoro-n-[13C9] nonanoic acid	N/A	13C9-PFNA	472	427	NA	13C5-PFNA
Perfluoro-n-[1,2,3,4,5,6-13C6] decanoic acid	N/A	13C6-PFDA	519	474	NA	13C2-PFDA
Perfluoro-n-[1,2,3,4,5,6,7-13C7] undecanoic acid	N/A	13C7-PFUnA	570	525	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] dodecanoic acid	N/A	13C2-PFDoA	615	570	NA	13C2-PFDA
Perfluoro-n-[13C2] tetradecanoic acid	N/A	13C2-PFTeDA	715	669.9	NA	13C2-PFDA
Perfluoro-1-[13C3] butanesulfonic acid	N/A	13C3-PFBS	301.9	80	NA	18O2-PFHxS
Perfluoro-1-[1,2,3-13C3] hexanesulfonic acid	N/A	13C3-PFHxS	402	80	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonic acid	N/A	13C8-PFOS	507	79.9	NA	13C4-PFOS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] hexanesulfonic acid	N/A	13C2-4:2FTS	329	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] octanesulfonic acid	N/A	13C2-6:2FTS	429	81	NA	18O2-PFHxS

Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] decanesulfonic acid	N/A	13C2-8:2FTS	529	81	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonamide	N/A	13C8-PFOSA	505.9	78	NA	13C4-PFOS
N-methyl-d3-perfluoro-1-octanesulfonamide	N/A	D3-NMeFOSA	515	219	NA	13C4-PFOS
N-ethyl-d5-perfluoro-1-octanesulfonamide	N/A	D5-NEtFOSA	531	219	NA	13C4-PFOS
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	N/A	D3-NMeFOSAA	573	419	NA	13C4-PFOS
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	N/A	D5-NEtFOSAA	589	418.9	NA	13C4-PFOS
N-methyl-d7-perfluorooctanesulfonamidoethanol	N/A	D7-NMeFOSE	623	59	NA	13C4-PFOS
N-ethyl-d9 -perfluorooctanesulfonamidoethanol	N/A	D9-NEtFOSE	639	59	NA	13C4-PFOS
Tetrafluoro-2-heptafluoropropoxy-13C3 -propanoic acid	N/A	13C3-HFPO-DA	287	169	NA	13C2-PFHxA
Non-Extracted Internal Standard (NIS) Compounds						
Perfluoro-n-[2,3,4-13C3] butanoic acid	N/A	13C3-PFBA	216	172	NA	NA
Perfluoro-n-[1,2-13C2] hexanoic acid	N/A	13C2-PFHxA	315	270	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanoic acid	N/A	13C4-PFOA	417	172	NA	NA
Perfluoro-n-[1,2,3,4,5-13C5] nonanoic acid	N/A	13C5-PFNA	468	423	NA	NA
Perfluoro-n-[1,2-13C2] decanoic acid	N/A	13C2-PFDA	515	470	NA	NA
Perfluoro-1-hexane[18O2] sulfonic acid	N/A	18O2-PFHxS	403	84	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanesulfonic acid	N/A	13C4-PFOS	503	80	NA	NA

Table 3: Calibration Standard Concentrations (ng/mL)

Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
Perfluoroalkyl carboxylic acids										
PFBA	0.4	0.8	2	5	10	20	50	100	200	250
PFPeA	0.2	0.4	1	2.5	5	10	25	50	100	125
PFHxA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFHpA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFOA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5

Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
PFNA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFUnA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFDoA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFTrDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFTeDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluoroalkyl sulfonic acids										
PFBS	0.0887	0.1774	0.4435	1.109	2.218	4.435	11.088	22.175	44.35	55.438
PFPeS	0.0941	0.1882	0.4705	1.176	2.353	4.705	11.763	23.525	47.050	58.813
PFHxS	0.0914	0.1828	0.457	1.143	2.285	457	11.425	22.850	45.7	57.125
PFHpS	0.0953	0.1906	0.4765	1.191	2.383	4.765	11.913	23.825	47.65	59.563
PFOS	0.0928	0.1856	0.464	1.16	2.32	4.64	11.6	23.2	46.4	58.0
PFNS	0.0962	0.1924	0.481	1.203	2.405	4.81	12.025	24.050	48.1	60.125
PFDS	0.0965	0.193	0.4825	1.206	2.413	4.825	12.063	24.125	48.25	60.313
PFDoS	0.097	0.194	0.485	1.213	2.425	4.85	12.125	24.25	48.5	60.625
Fluorotelomer sulfonic acids										
4:2FTS	0.375	0.75	1.875	4.688	9.375	18.75	46.875	93.75	187.5	NA
6:2FTS	0.38	0.76	1.9	4.75	9.5	19	47.5	95	190	NA
8:2FTS	0.384	0.768	1.92	4.8	9.6	19.2	48	96	192	NA
Perfluorooctane sulfonamides										
PFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NMeFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NEtFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamidoacetic acids										
NMeFOSAA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NEtFOSAA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamide ethanols										
NMeFOSE	1	2	5	12.5	25	50	125	250	500	625
NEtFOSE	1	2	5	12.5	25	50	125	250	500	625
Per- and polyfluoroether carboxylic acids										
HFPO-DA	0.4	0.8	2	5	10	20	50	100	200	250
ADONA	0.378	0.756	1.89	4.725	9.45	18.9	47.25	94.5	189	236.25
PFMPA	0.2	0.4	1	2.5	5	10	25	50	100	125
PFMBA	0.2	0.4	1	2.5	5	10	25	50	100	125
NFDHA	0.2	0.4	1	2.5	5	10	25	50	100	125
Ether sulfonic acids										
9Cl-PF3ONS	0.374	0.748	1.87	4.675	9.35	18.7	46.75	93.5	187	233.75
11Cl-PF3OUdS	0.378	0.756	1.89	4.725	9.45	18.9	47.25	94.5	189	236.25
PFEESA	0.178	0.356	0.89	2.225	4.45	8.9	22.25	44.5	89	111.25
Fluorotelomer Carboxylic Acids										

Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
3:3FTCA	0.5	1	2.5	6.25	12.5	25	62.5	125	250	312.5
5:3FTCA	2.5	5	12.5	31.25	62.5	125	312.5	625	1250	1560
7:3FTCA	2.5	5	12.5	31.25	62.5	125	312.5	625	1250	1560
Extracted Internal Standard (EIS) Compounds										
13C4-PFBA	10	10	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C3-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C2-4:2FTS	5	5	5	5	5	5	5	5	5	5
13C2-6:2FTS	5	5	5	5	5	5	5	5	5	5
13C2-8:2FTS	5	5	5	5	5	5	5	5	5	5
13C8-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSAA	5	5	5	5	5	5	5	5	5	5
D5-NEtFOSAA	5	5	5	5	5	5	5	5	5	5
D7-NMeFOSE	25	25	25	25	25	25	25	25	25	25
D9-NEtFOSE	25	25	25	25	25	25	25	25	25	25
13C3-HFPODA	10	10	10	10	10	10	10	10	10	10
Non-Extracted Internal Standard (NIS) Compounds										
13C3-PFBA	5	5	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

[1] *This calibration point is used as the calibration verification (CCV)*

Appendix B: QC Summary

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Mass Calibration	Annually and on as-needed basis.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration Verification	After each Mass Calibration performed.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat Mass Calibration.	None. Do not proceed with analysis.
ICAL	At instrument set up, after CCV failure and/or major maintenance.	Must meet one of the curve fit options presented in Section 9.2.3.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
ICV	After Each ICAL.	All analytes must be within ± 30% of their true values. (%R)	Identify and correct source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria.
RT Window Position	Once per ICAL and at the beginning of the analytical window.	Position is set using the mid-point of the ICAL on the day ICAL is performed; otherwise, mid-level CCV is used.	NA	NA
RT Window Study	At method set-up and after major instrument maintenance	RT Window is ± 30 secs from RT position.	NA	NA

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ISC	Daily before sample analysis.	All native compounds within ± 30% recovery.	Identify and correct source of problem and reanalyze ISC. If problem persists, repeat ICAL.	No samples shall be analyzed until ISC has met acceptance criteria. See Section 9.2.4 for exceptions.
Qualitative Isomer Check	Once per ICAL and daily before sample analysis.	All required branched isomer peaks present and visibly resolved from linear peaks.	Identify and correct source of problem and reanalyze Isomer Check.	No samples shall be analyzed until Isomer Check has met acceptance criteria.
Bile Salts Check	Once per ICAL and daily before sample analysis.	Bile Salt peak detected >1 min outside RT window for PFOS.	Identify and correct source of problem and reanalyze Bile Salts Check.	No samples shall be analyzed until Bile Salts Check has met acceptance criteria.
CCV	Daily before sample analysis, after every 10 samples, and at end of analytical sequence.	All native and isotopically labelled compounds within ± 30% recovery.	See Section 9.2.4 for required corrective actions based on circumstance.	Qualify analytes with CCV out of criteria.
Instrument Blank (IBLK) / CCB	Daily prior to analysis and after high standards, including CCV.	Must meet criteria specified in Section 11.2.1: all detections ≤1/2 LOQ.	Identify and correct source of contamination or performance issue. Reanalyze IBLK.	No samples shall be analyzed until IBLK has met acceptance criteria.
Extracted Internal Standards (EIS)	Every field sample, standard and QC sample.	Must meet criteria specified in Section 11.3. Preliminary acceptance range: 20-150% REC (based on calculated concentration).	If batch QC is acceptable, reanalyze to confirm. If confirmed, reprepare and reanalyze samples. If reprep is within acceptance, report reprep data. If failure is confirmed by reprep, qualify as matrix impacted.	Qualify outages and explain in case narrative.

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Non-extracted Internal Standards (NIS)	Every field sample, standard and QC sample.	Must meet criteria specified in Section 11.3. Preliminary acceptance criteria: >30% REC (based on response).	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Method Blank (MB)	1 per batch of 20 or fewer samples.	Must meet criteria specified in Section 11.1.1.	If IBLK is acceptable, reanalyze MB to confirm. If confirmed, reprepare and reanalyze associated impacted samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated to unacceptable MB.	Qualify outages and explain in case narrative.
LCS/LLLCS	1 pair per batch of 20 or fewer samples.	DoD: 40-150% until in-house limits generated; must meet criteria specified in Section 11.1.2.	If most recent ISC/CCV is acceptable, reanalyze LCS to confirm. If low-failure results are confirmed, reprepare and reanalyze associated samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated to low-failure LCS. If high-failure results are confirmed and sample(s) is ND for failing compound, narrate and report sample data.	Qualify outages and explain in case narrative.
MS/MSD	1 pair per batch of 20 or fewer samples.	DoD: RSD <30% between MS/MSD	If possible, reprep to confirm.	Qualify outages and explain in case narrative.
Sample Duplicate	1 per AFFF sample.	DoD: RSD <30% between parent/DUP	If possible, reprep to confirm.	Qualify outages and explain in case narrative.

Appendix C: Sample Pre-screening Instructions

Samples that are known or suspected to contain high levels of analytes may be pre-screened using the following procedure. These are example procedures using smaller sample aliquots spiked with EIS and NIS and no clean up procedures. Other pre-screening procedures may be used.

Aqueous Samples

1. Weight out 10 (±0.1) g of sample into a 50 mL centrifuge tube.

2. Add 100 µL of EIS to the sample and vortex to mix.

3. Filter 1 mL of the sample through 0.2 µm membrane filter into a microvial. Sample is ready for instrumental analysis.

Solid and Tissue Samples

1. Weigh 1.0 (±0.1) g sample into 50 mL polypropylene centrifuge tubes.

2. Add 10 mL of 0.3% methanolic ammonium hydroxide to the sample. Vortex and mix on a shaker table (or equivalent) for 10 min. Allow to settle and/or centrifuge to produce a clear extract.

3. Filter using a filter vial:

   a. Add ~400 µL of clear extract from step 2 (e.g., by adding extract until it reaches the fill line).

   b. Use filter/plunger part and filter.

4. Transfer 200 µL of filtrate to a 1 mL polypropylene autosampler vial and dilute with 10 µL of EIS and 790 µL of 0.3% methanolic ammonium hydroxide to a final volume of 1 mL. The extract is now approximately 50X dilute, relative to a solid sample prepared by the protocols in Section 9. Sample is ready for instrumental analysis.

Calculate results using the equivalent sample weight computed as follows:

$$Equivalent\ Weight = Sample\ weight\ (g)x\,\frac{0.2\ mL}{10\ mL}$$

Appendix D: Aqueous Sample Subsampling Instructions

Note: Because some target analytes may be stratified within the sample (e.g., AFFF- contaminated media, surfactants), or adhere to the walls of the sample container, subsampling may only be done on a project-specific basis. Subsampling has been shown to increase uncertainty in PFAS analysis, especially on foaming samples.

If a reduced sample size is required, transfer a weighed subsample using the following subsampling procedure to a 60 mL HDPE bottle and dilute to approximately 60 mL using reagent water. This container is now considered the “sample bottle.”

1. Gently invert sample 3-4 times being careful to avoid foam formation and subsample immediately (do not let stand).
2. If foam forms and more than 5 mL is required – pour sample, avoiding any foam.
3. If foaming forms and a volume less than 5 mL is required – pipette from ½ cm below the foam.
4. If no foam forms – pour or pipette based on volume required.

APPENDIX E: MS/MSD, MS/FD SAMPLE SELECTION PROTOCOL

Background: DOD QSM 5.4, Table B-24 requires that a matrix spike (MS) sample and a matrix spike duplicate (MSD) or field duplicate (FD) be prepped with every prep batch. Therefore, all aqueous prep batches must include an MS/MSD or MS/FD pair, if possible. Prep analysts will select samples to be used for this purpose following a hierarchy of preference, as defined below:

Note: Any kind of blank (FB, TB, EB, RB, etc.) or samples designated as “DUP” by the client will not be used for MS/MSD/FD analysis.

1. First preference is to use client-designated samples as MS/MSD samples. This designation should show up on the prep list, under comments. It is possible that SR will miss adding this comment to the sample, but this designation will be present in the COC from the client, on the right side of the COC under “Remarks/Cooler ID.” When a client designates a sample to be used for MS/MSD analysis, they will typically provide us with more than 2 bottles (often 4, sometimes as many as 6).

2. Lacking a client-designated MS/MSD sample, the next preference is to use any sample received with more than 2 bottles provided. If an analyst selects a set of samples for prep in which none of the samples are client-designated for MS/MSD, the analyst should check for any samples in the set that were received with 3 or more bottles. If there is a sample with 3 or more bottles, pull 3 of them and use one for the parent sample and spike the other two for analysis as MS/MSD samples.

3. Lacking any samples received with 3 or more bottles, the prep analyst must use two different samples to fulfill the MS/FD pair requirement. Find two samples out of the set of samples selected for prep which were received with 2 bottles and pull both bottles for each sample. Pick one sample (pair of bottles) to be used for parent/MS prep and the other sample (pair of bottles) to be used for parent/FD. The sample selected for parent/MS will have one bottle spiked with targets and one prepped as normal, with no added spiking. The bottle which is spiked should be identified in the LIMS as MS. The sample selected for parent/FD will have both bottles prepared following normal procedures but one of the two should be identified in the LIMS as DUP.

4. If all samples in a particular prep batch were all received in just one bottle, analysis of an MS/MSD or MS/FD pair will not be possible. This should be an uncommon occurrence, as prep analysts will attempt to adjust batching to ensure that every prep batch contains an MS/MSD or MS/FD.

Management Approval:
Toni Morace Approved on 6/7/2022 2:44:30 PM
Russell McNiece Approved on 6/7/2022 2:45:41 PM
Jacqueline Bendolph Approved on 6/7/2022 2:52:07 PM

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure for TCLP and SPLP to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes, as well as Zero Head Space (ZHE) extraction designed to allow for liquid or solid separation within the device and eliminate headspace.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

Not applicable to this SOP.

2.0 SUMMARY OF METHOD

2.1 Most of the steps within these two procedures are identical. The major difference between TCLP and SPLP involves the nature of the fluids employed during the leaching procedures. A summary flowchart of the TCLP/SPLP basic steps for both non-ZHE and ZHE is presented in Attachments I and II of this SOP.

2.2 A liquid waste that yields less than 0.5% dry solid material when filtered through a glass fiber filter is defined as the TCLP or SPLP leachate. For any waste that contains 0.5% solids or greater, any liquid present is separated from the solid phase and stored for later analysis. The portion of the waste that is solid undergoes particle size reduction, if necessary, and is then extracted with an amount of leaching fluid equal to 20 times its weight. The leaching fluid to be used for volatile organics is specified in the method for both TCLP and SPLP methods.

2.3 For non-volatile TCLP determination, the fluid used is a function of the pH of the solid phase of the waste. For non-volatile SPLP determination in soil samples, the fluid used is a function of the region of the country where the sample was collected; for wastes and wastewaters under SPLP, the fluid used is specified by the method. After the 18 ± 2-hour extraction, the phases are separated by filtration through a glass fiber filter. Any aqueous initial filtrate generated during pre- filtering is added to the leachate and the resulting leachate is submitted to the analytical lab as a single sample. If the pre-filter and leachate phases are incompatible, the liquids are analyzed separately such that the results may be mathematically combined to yield a volume-weighted average concentration..

3.0 INTERFERENCES

3.1 Interferences include contaminants in the glassware, leaching vessels and reagents. Contamination may be carried over in the vessel from previously processed highly contaminated samples (particularly a problem with volatile organics). Specific interferes are discussed under the individual analytical methods. If volatile target constituents are suspected to be elevated in a particular sample (as in certain paints and fuels), additional steps must be taken to ensure that carryover will not be a problem when the ZHE apparatus is used again. Multi-phasic or heavily contaminated volatile leachates may necessitate replacing the O-ring in the ZHE. Methylene chloride and acetone are common solvents in use in the Organic Preparations department.

3.2 Although these compounds are rarely requested as target analytes, they may present problems in the volatile lab if present in significant quantities in the leachates.

3.3 Some samples may require cutting or crushing. Any tool used for these purposes must be thoroughly cleaned. All plastic products should be avoided when targeting organic compounds.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

5.0 HEALTH AND SAFETY

The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.

The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (HSE) policies and procedures specified in this SOP and in the Pace Chemical Hygiene / Safety Manual.

Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.

Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. Use these acids in a fume hood whenever possible with additional PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. Any processes that emit large volumes of solvents (evaporation/concentration processes) must be in a hood or apparatus that prevents employee exposure.

Contact your supervisor or local HSE coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME, AND STORAGE

Samples should be collected in accordance with a sampling plan and procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project.

The laboratory does not perform sample collection or field measurements for this test method. To assure sample collection and field checks and treatment are performed in accordance with applicable regulations Pace project managers will inform the client of these requirements at the time of request for analytical services when the request for testing is received prior to sample collection. If samples were already collected, the laboratory will record any nonconformance to these requirements in the laboratory's sample receipt record when sufficient information about sample collection is provided with the samples.

The laboratory will provide containers for the collection of samples upon client request for analytical services. Bottle kits are prepared in accordance with laboratory ENV-SOP-BTRO-0118, *Sample Receiving & LIMS Login*, or equivalent replacement.

Requirements for container type, preservation, and field quality control (QC) for the common list of test methods offered by Pace are included in the laboratory's quality manual.

General Requirements

Matrix	**Container Size & Type**	**Required Sample Amount**[1]	**Preservation**	**Holding Time**
Wastes may be solid, liquid, or multiphasic	Amber, glass container with PTFE lined cap for volatiles and semi-volatiles. For metals leachates, plastic containers may be used.	150 grams Note that minimum sample volumes must be met, or data must be qualified as not valid for regulatory compliance Furthermore, sufficient sample volume must be supplied to support all analyses.	>0 to <6.0°C (unless refrigeration results in irreversible changes in the matrix For ZHE, sample container should only be opened immediately prior to the leaching; care must be taken to minimize the loss of volatiles	Samples must be leached within specified days of collection, below: 14 days for Volatile and Semi-volatile organics 28 days for Mercury 180 days for the remaining Metals.
Leachates	Amber, glass container with Teflon-lined lid for semi-volatile organics. Teflon lined, septum capped VOA vials for volatile organics Plastic containers for metals	Determined by the Analytical Method Note that SPLP analyses may require more leachate volume	Metals – HNO_3 preservation to a pH of <2 (done in the Inorganics Department) Semi-volatiles – refrigeration (>0 to <6.0°C) Volatiles – preserved with HCl to pH <2 and refrigerated >0 to <6.0°C C)	Semi-volatile leachates must be extracted within 7 days of leaching. The maximum holding time from preparative procedure to analytical procedure for extractable organics, mercury, and metals are 40, 28, and 180 days, respectively. Leachates must undergo analysis for Volatiles within 14 days of TCLP/SPLP leaching, provided they have been acid preserved

[1] *Minimum amount needed for each discrete analysis.*

Thermal preservation is checked and recorded on receipt in the laboratory in accordance with laboratory ENV-SOP-BTRO-0118, *Sample Receiving & LIMS Login*, or equivalent replacement Chemical preservation is checked and recorded at time of receipt or prior to sample preparation.

After receipt, samples are stored as required by the method until sample preparation. Prepared samples (extracts, digestates, distillates, other) are stored as required by the method until sample analysis.

After analysis, unless otherwise specified in the analytical services contract, samples are retained for 21 days from date of final report and then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT AND SUPPLIES

7.1 Equipment

7.1.1 ZHE Vessel - a device used only when the waste is being tested for the mobility of volatile analytes. This type of vessel allows for initial filtration without opening the vessel and allows for the liquid/solid separation within the device and effectively precludes headspace. ZHEs are cleaned as described in Procedure 9.3.1.

7.1.2 Agitation apparatus capable of end-over-end rotation @ 30 ± 2 rpm

7.1.3 pH meter (accurate to 0.05 pH unit) – calibrated each day used

7.1.4 pH electrode with automatic temperature compensation

7.1.5 Filter holder- 142 mm polypropylene

7.1.6 Hot plate/ magnetic stirrer

7.1.7 Air Compressor

7.1.8 Analytical balance – accurate to 0.1 grams, calibrated each day used

7.1.9 Gas-tight syringe

7.1.10 Vacuum pump and manifold

7.1.11 Stainless steel sieves – 1 mm and 0.5

7.1.12 Min/Max thermometer, calibrated

7.1.13 Graduated cylinders – 1000 mL glass Class “A”

7.1.14 Carboy for extraction fluid preparation and storage

7.1.15 Glass fiber filters, 142 mm, 0.6 to 0.8 µm pore size, acid washed

7.1.16 2-liter Plastic extraction bottles

7.1.17 Stainless steel spatula or scoopula

7.1.18 250 mL glass beaker or equivalent

7.1.19 Magnetic stir bars

7.1.20 500 mL Plastic bottles (metals extract)

7.1.21 1-liter Amber glass bottles (organic extract)

7.1.22 Tedlar Bags

7.1.23 VOA vials – 20 mL and 40 mL with Teflon septum and screw rings

7.1.24 Beaker – 500 mL

7.1.25 Carboy for extraction fluid preparation and storage

7.2 Supplies

7.2.1 Borosilicate microfiber filters, 90 mm, 0.7 µm pore size

7.2.2 Syringe filter

8.0 REAGENTS AND STANDARDS

8.1 **Reagents**

8.1.1 Deionized (DI) water

8.1.2 Glacial acetic acid

8.1.3 Methanol

8.1.4 Methylene chloride

8.1.5 60/40 Weight precent mixture of Sulfuric and Nitric Acids

8.1.6 Sodium hydroxide (50%), commercially prepared

8.1.7 Hydrochloric acid (1N) – add 8.3 mL of concentrated HCl to a 100 mL volumetric flask containing approximately 50 mL of DI water and dilute to volume with DI water

8.1.8 1:1 Nitric Acid

8.1.9 pH Buffers necessary for calibration

8.1.10 TCLP Extraction Fluid # 1 – Add 114 mL of acetic acid and 70 mL 50% NaOH to 5 gallons of DI water. Check the pH When correctly prepared, the pH of this fluid will be 4.93 ± 0.05 pH units (4.88-4.98). If the pH is not within the acceptable range, then the extraction fluid must be discarded and new fluid prepared. Record in the TCLP/SPLP Extraction Fluid Logbook and assign a laboratory ID. Label the Extraction Fluid container with the appropriate label.

8.1.11 TCLP Extraction Fluid # 2 – Add 114 mL of acetic acid to 5 gallons of DI water. Check the pH. When correctly prepared, the pH of this fluid will be 2.88 ± 0.05 pH units (2.83-2.93). If the pH is not within the acceptable range, then the extraction fluid must be discarded and new fluid prepared. Record in the TCLP/SPLP Extraction Fluid Logbook and assign a laboratory ID. Label the Extraction Fluid container with the appropriate label.

8.1.12 SPLP Extraction Fluid # 1 – Add the 60/40 weight precent mixture of Sulfuric and Nitric acids (or a suitable dilution) to Deionized water until the pH is 4.20 ± 0.05. The fluid is used to determine the leachability of soil form a site that is east of the Mississippi River, and the leachability of wastes. Record the TCLP/SPLP Extraction Fluid Logbook and assign a laboratory ID. Note: Solutions are unbuffered and exact pH may not be attained.

8.1.13 SPLP Extraction Fluid # 2 – Add the 60/40 weight percent mixture of Sulfuric and Nitric acids (or a suitable dilution) to Deionized water until the pH is 5.00 ± 0.05. The fluid is used to determine the leachability of soil form a site that is west of the Mississippi River. Record in the TCLP/SPLP Extraction Fluid Logbook and assign a laboratory ID. Note: The extraction fluids should be monitored for impurities. The pH is to be checked prior to use to ensure that the fluid was made up accurately. If impurities are found or the pH is not within the above specifications the fluid will be discarded and fresh extraction fluid prepared.

8.1.14 Extraction Fluid # 1 – Add 114 mL of acetic acid and 70 mL 50% NaOH to 5 gallons of DI water. Check the pH. When correctly prepared, the pH of this fluid will be 4.93 ± 0.05 pH units (4.88-4.98). If the pH is not within the acceptable range, then the extraction fluid must be discarded and new fluid prepared. Record in the TCLP/SPLP Extraction Fluid Logbook and assign a laboratory ID. Label the Extraction Fluid container with the appropriate label.

8.2 Standards

Not applicable to this SOP.

9.0 PROCEDURE

9.1 Equipment Preparation

Not applicable to this SOP.

9.2 Initial Calibration

Not applicable to this SOP.

9.3 Sample Preparation (ZHE)

Do not allow the sample, initial liquid phase or extract to be exposed to the atmosphere any longer than is necessary. Do not homogenize the sample. To help in making this possible, have the ZHE completely put together (particularly the top) so that when the sample is weighed in the piston chamber, the top can be replaced as quickly as possible. Make sure the ZHE is clean.

9.3.1 ZHE apparatus cleaning – this procedure is used for routine cleaning of ZHE apparatus between samples.

9.3.1.1 Completely disassemble the ZHE apparatus, including removing the gaskets on the inner piston.

9.3.1.2 Rinse all components with tap water.

9.3.1.3 Fill the sink with hot soapy water and soak the apparatus for at least five minutes.

9.3.1.4 Scrub the apparatus with a scouring pad insuring that all visible contaminants are removed. Use a wire brush to reach into cramped spaces.

9.3.1.5 Rinse the components a minimum of three times with DI water.

9.3.1.6 Rinse all components (except base plate, which contains the pressure gauge) with methanol.

9.3.1.7 Assemble ZHE

9.3.1.8 Preliminary evaluations will be done on a minimum 100 g aliquot of sample.

9.3.1.9 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e., is 100% solids) the preliminary test is not required. Proceed to Procedure 14.6.

9.3.1.10 Weigh a plastic cup for all aqueous samples or 150 mL beaker for organic samples.

9.3.1.11 Weigh a 0.8 µm filter and place it on the screen of the filter apparatus. Assemble the filter apparatus.

9.3.1.12 Weigh a wide mouth 500 mL Plastic Bottle

9.3.1.13 Homogenize the sample and weigh a minimum of 100 g of sample in cup or beaker and record the weight in the logbook. Allow to settle or centrifuge.

9.3.1.14 Place the bottle under the filter apparatus.

9.3.1.15 Pour the liquid sample into the filtering apparatus followed by the solid portion of the sample. Reweigh the cup and subtract the weight of the residue from the weight of the sample to be filtered.

9.3.1.16 Apply pressure to the Millipore filter apparatus to 10 psi. Filter until no liquid passes through the filter for 2 minutes. Increase the pressure in 10 psi increments up to 50 psi. After each incremental increase of 10 psi, if no liquid has passed through the filter for 2 minutes, proceed to the next 10 psi increment.

9.3.1.17 Relieve the pressure from the filter apparatus when the gas flows through the filter or when there is more than 2 minutes between drops off filtrate at 50 psi.

9.3.1.18 Weigh the bottle and filtrate. Subtract the weight of the bottle from the weight of the bottle and filtrate. This is the liquid phase.

9.3.1.19 Subtract the liquid phase form the weight of the total sample. This is the solid phase.

Note: Some waters, such as oily wastes and some paint wastes, will obviously contain some material that appears to be a liquid. Even after applying vacuum or pressure filtration, this material may not filter. If this is the case, the material within the filtration device is defined as a solid and is carried through the extraction as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

9.3.1.20 % Solids = (weight of wet solid phase/ total weight of sample) x 100. Proceed to step 9.7. if it is obvious solids >0.5% and no liquid container in filter.

9.3.1.21 Remove the solid phase and filter, dry at 100 ± 200 ˚C until two successive weighing's are within ± 1% of each other. If organic film or odor present, do not heat, air dry overnight. If no visible solids and only film, sample is a liquid.

9.3.1.22 % dry solids = $\frac{\textbf{(Weight of dry sample + filter) − weight of filter}}{\textbf{Initial weight of sample}} \times \mathbf{100}$

9.3.1.23 If the percent dry solids is less than 0.5%, then proceed to procedure 9.4.

9.3.1.24 If the sample contains > 0.5% solids, but less than 100% solids, go back to 9.1 with fresh sample. After filtration go to step 9.5.

9.3.2 ZHE apparatus decontamination – this procedure is used to clean any ZHE apparatus with visible organic materials present or any apparatus that has been previously used to extract a sample which tested hazardous for TCLP volatiles.

9.3.2.1 Carry out the routine cleaning procedure outlined in 9.3.1 but keep the ZHE disassembled.

9.3.2.2 Dispose of all rubber O-rings and gaskets except for the wiper seal located at the bottom of the piston. These will be replaced with new O-rings and gaskets.

9.3.2.3 Fill a 500 mL beaker with methylene chloride.

9.3.2.4 Use a brush and methylene chloride to scrub the apparatus. Soaking may be necessary to clean cramped spaces.

9.3.2.5 Place only the metal parts of the apparatus in an oven ≥100 °C overnight.

9.3.2.6 Allow the apparatus to cool, and then assemble.

9.3.2.7 Fill the apparatus with DI water and tumble for 2 hours to test for residual contamination.

9.3.3 Procedure for ZHE Leak Test

9.3.3.1 Each ZHE should be checked daily prior to use for possible leaks.

9.3.3.2 To check for leak, assemble each ZHE apparatus, pressurize to 50 psi, submerge in a water bath, and check for the presence of bubbles escaping from the various fittings.

9.3.3.3 If bubbles are present, leak test has failed, and maintenance must be performed prior to use of ZHE.

9.3.3.4 If no bubbles are present, leak test has passed. Document by recording a check mark and the letter “P” in the ZHE TCLP Extractor Logbook.

9.3.4 Determination of % Solids (preliminary test)

There are several preliminary evaluations that are performed before beginning the actual TCLP/ZHE extraction procedure. The technician must determine the percent solids, whether the waste will require particle size reduction, and which fluid will be used for leaching. The %solids is defined as that fraction of the waste represented as a percentage of the total waste from which no liquid may be forced out with pressure. Wastes may be 100% solid, 100% liquid, or anything in between. Preliminary evaluations are done using a minimum 100g aliquot of waste; it may also be possible to use this aliquot for the actual non-ZHE procedure.

Particle Size Reduction – Volatile Organics

If a sample contains >0.5% solids, it is necessary to determine whether the waste requires particle size reduction for all TCLP and SPLP extractions. If the solid is smaller than 1 cm at the narrowest dimension, particle size reduction is not required and the solid is ready to be leached. If the particle size is larger than this, prepare the solid portion of the waste for extraction by crushing, cutting or grinding the waste to a particle size as described earlier. However, if the sample is to be leached for volatile organics, extra caution must be taken during the reduction process. Because manipulation of the waste is likely to cause some loss of volatile organics, exposure to the atmosphere or warm temperatures must be avoided as much as possible. If there are any unusual samples, see supervisor for instructions. Once the sample particle size is acceptable, proceed to the fluid determination portion of the process

9.3.4.1 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e., is 100% solids) the preliminary test is not required. Proceed to Procedure 9.3.8.

9.3.4.2 Weigh out a subsample of the waste of the appropriate size and record the weight to one decimal place. The appropriate size is determined by dividing 25 by the percent solids determined by filtration of the sample for extraction for non-volatiles. This value is then multiplied by 100. The actual amount of solids remaining after filtration of the liquid phase cannot exceed 25 g.

9.3.4.3 Attach a Tedlar bag to the ZHE inlet/outlet valve. Attach the compressed air line to the gas inlet/outlet valve. Apply gentle pressure of 1-10 psi to force the liquid phase of the sample into the Tedlar bag. If no additional liquid has passed through the filter in any 2-minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10 psi increment. When the liquid flow has ceased such that continued pressure filtration at 50 psi does not result in any additional filtrate within a 2-minute period, stop the filtration. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect and weigh the Tedlar bag.

9.3.4.4 Record all weights to one decimal place. To find the % soil in the sample charged to the ZHE, perform the following calculations in section 10.1.

9.3.4.5 If the percent dry solids is less than 0.5%, then proceed to Procedure 9.3.5.

9.3.4.6 If the sample contains >0.5% solids, but less than 100% solids, proceed to Procedure 9.3.6.

9.3.5 Procedure for liquid samples (less than 0.5% solid)

9.3.5.1 If the % solids is <0.5%, the filtered liquid is the TCLP or SPLP extract. Filter from a gas-tight syringe through a syringe filter to a VOA vial with minimal headspace and store at 0-6 ˚C.

9.3.5.2 Fill out the ZHE sample prep sheet and make a copy. Bring the extract and a copy of the prep sheet to the GC/MS department for analysis.

9.3.6 Procedure for multiphase samples

9.3.6.1 If the percent solids is >0.5%, perform the extraction of the solids as listed in the 100% solid section.

9.3.6.2 After the extraction period, check the ZHE for leaks as documented in the 100% solid section.

9.3.6.3 Bleed extraction fluid into Tedlar bag containing the initial liquid phase of the extract if miscible. If the phases are not miscible, collect the ZHE liquid phase as documented in the 100% solid section. If phases are not miscible, each phase is prepped and analyzed separately. The volumes of the individual phases must be determined, and the results combined mathematically by using a simple volume-weighted average. See Calculation 15.5 for final analyte concentration calculation.

9.3.6.4 Fill out the ZHE sample prep sheet and make a copy. Bring the extract and a copy of the prep sheet to the GC/MS department for analysis by SOP ENV-SOP-BTRO-0138 (Analysis of Volatile Organic Compounds (VOC) by GC/MS).

9.3.7 Procedure for samples with no free liquid (100% solid)

9.3.7.1 For TCLP analysis, check the pH of extraction fluid #1 (range 4.88 - 4.98). Record the extraction fluid ID # and pH in the logbook. For SPLP analysis, the extraction fluid used is DI water.

9.3.7.2 Place 25 ± 0.5 grams (record to one decimal place) of sample into the piston vessel. Place a top onto the piston vessel. Multiply the amount of sample (25 grams) by 20 = the amount of extraction fluid that is to be used.

9.3.7.3 With the ZHE in a vertical position, attach the compressed air line, close the bottom pressure release valve and open the top liquid inlet/outlet valve. Slowly increase pressure to 50 psi (the ZHE should “jump” when the piston slides into position). Check for airspace by adding DI water to the liquid inlet/outlet line and checking for bubbles.

9.3.7.4 Attach a Luer Lock line from the pump attached to the extraction fluid reservoir to the liquid inlet/outlet valve (Luer Lock on top of extractor). Release the gas pressure on the ZHE piston (from the gas inlet/outlet valve), open the liquid inlet/outlet valve, and begin transferring extraction fluid by pumping into the ZHE. Continue pumping until the appropriate amount of fluid has been introduced into the ZHE.

9.3.7.5 After the extraction fluid has been added, immediately close the liquid inlet/outlet valve and disconnect the extraction fluid line. Check the ZHE to be sure that all valves are closed. Attach the compressed air line and pressurize the ZHE to 5-10 psi and slowly open the liquid inlet/outlet valve to bleed out any headspace. The bleeding shall be done quickly and shall be stopped at the first sign of liquid. Once bled, re-pressurize the ZHE to 5-10 psi.

9.3.7.6 Place a rubber strap around the ZHE extractor and rotate for 18 ± 2 hours. Temperature shall be maintained at 23 ± 2 ˚C. Following rotation, document the minimum and maximum temperature in the ZHE TCLP Extractor logbook. Temperature shall be monitored for the entire room and not any individual rotator.

9.3.7.7 Record all samples, weights, rotation times, and temperatures in the ZHE logbook.

9.3.8 Sample Removal from the ZHE vessel

9.3.8.1 Remove vessel from rotator. Perform a pressure check to see if pressure was maintained during the rotation time. This is done by quickly opening and closing the gas inlet/outlet valve and noting the escape of gas or liquid. If this check does not produce gas or liquid, then the pressure was not maintained, and the samples should be reset up. Document the pressure check by recording a check mark and either a “P” for pass or “F” for fail in the ZHE TCLP Extractor logbook. Let the ZHE settle for 5 to 10 minutes before filtering.

9.3.8.2 Hook up the air compressor and place a gastight syringe on top of Luer Lock flange valve. Bleed off the extraction fluid into two 40 mL vials (properly labeled) with zero-headspace. Do not expose this extract fluid to the atmosphere any longer than is necessary. If % solid, bleed the extraction fluid into a Tedlar bag (which was labeled during the previous step to match this sample.)

9.3.8.3 Fill out the ZHE sample prep sheet and make a copy. Bring the extract and a copy Determination of extraction fluid for TCLP

9.3.8.4 Solids from samples which are 100% solid or > 0.5% solids (solid portion) are prepared and extracted as follows.

9.3.8.5 Label with the sample number, a 250 mL glass beaker, and 1 L amber jar. Weigh a small sub-sample of the solid phase of the waste and reduce to a particle size of approximately 1 mm. Sieve if necessary. Transfer 5.0 grams of sample into the 250 mL glass beaker.

9.3.8.6 Add 96.5 mL (± 1 mL) of DI water to the 250 mL glass beaker. Add a stir bar and place the sample on a magnetic stirrer and stir vigorously for 5 minutes. Measure and record the pH in the TCLP logbook. If the pH is <5, extraction fluid #1 shall be used. If the pH measured is >5, add 3.5 mL of 1.0 N HCL to the jar and slurry the mixture. Heat to 50 ˚C. Hold at this temperature for 10 minutes. Remove from the hot plate and cool to room temperature. Measure the pH If the measured pH is <5, then extraction fluid #1 will be used. If it is >5, then extraction fluid #2 must be used. Record the fluid used in the TCLP Extractions Logbook.

9.4 Determination of extraction fluid for SPLP

9.4.1 For soils, if the sample is from a site that is east of the Mississippi River, extraction fluid #1 should be used. If the sample is from a site west of the Mississippi River, extraction fluid #2 should be used.

9.4.2 For wastes, extraction fluid #1 should be used

9.4.3 For cyanide-containing wastes and/or soils, DI water must be used because leaching of cyanide-containing samples under acidic conditions may result in the formation of hydrogen cyanide gas

9.5 Procedure for liquid samples (less than 0.5% solid)

9.5.1 If the % solids <0.5%, the filtered liquid is the TCLP or SPLP extract.

9.6 Procedure for multiphase samples

9.6.1 If the percent solids >0.5%, weigh sufficient sample to generate at least 100 g of solid material for the extraction process. The volume or weight of sample to be extracted/leached will be adjusted by the TCLP technician to ensure that sufficient leachate is available for the matrix spike aliquot. The aliquot used in 9.3.1 may be appropriate for use if an adequate amount of solid was obtained. The amount of solid necessary is dependent upon whether enough extract will be produced to support the analysis. Additional sample can be filtered to obtain sufficient leachate (combined liquid and tumbled liquid). Record all information in the TCLP Extraction Logbook. This logbook must be completed for each sample. Store the liquid phase at 4 ± 20 ˚C.

9.6.2 Perform the extraction of the solids as listed in the 100% solid section (9.7).

9.7 Procedure for samples with no free liquid (100% solid)/ Particle Size Reduction for Non-Volatiles

If a waste contains >0.5% solids, it is necessary to determine whether the waste requires particle size reduction for all TCLP and SPLP extractions. If the solid is smaller than 1 cm at the narrowest dimension, particle size reduction is not required and the solid is ready to be leached. If the waste is filamentous (such as cloth or rags) and has a surface area per gram of material greater than or equal to 3.1 cm squared – or is smaller than 1 cm in its narrowest dimension, then particle size reduction is not required. If the particle size is larger than this, prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a particle size as described above. If there are any unusual wastes, see supervisor for instructions. Once the waste particle size is acceptable, proceed to the fluid determination portion of the process.

9.7.1 Weigh 100 g of sample into the labeled plastic extraction jar.

Note: Technician must complete the “sample description” field in the logbook. The sample description must describe the material found in the sample container.

9.7.2 Slowly add the appropriate extraction fluid (determined by section 9.4) in the amount of 20 times the sample weight (accounting for % solids).

9.7.3 Secure the bottle in the agitation device and rotate at 30 rpm for 18 ± 2 hours. The temperature must be maintained at 23 ± 20 ˚C during the TCLP extraction. Document the min/max temperature in the TCLP Extractions Logbook. Temperature shall be monitored for the entire room and not any individual rotator cabinet.

9.7.4 After rotation, allow the sample to stand and settle for at least 30 minutes before filtration.

9.7.5 Assemble a filtration vessel and filter the sample through new acid rinsed filter paper. Vacuum filtration can only be used for wastes with <10% solids content.

9.7.6 After the sample has been filtered, for 100% solids, the filtrate is the TCLP extract. For % solid samples combine the filtrate with the initial liquid phase if compatible. If incompatible, each phase is prepped and analyzed separately.

9.7.7 The TCLP extraction technician will determine which samples are to be used for the matrix spike. The MS samples will be determined for each sample type identified in section 11.1. The TCLP extraction technician will aliquot the leachate and label the matrix spike as “MS”.

9.7.8 Notify metals prep analyst of TCLP extracted samples needing metals analysis.

9.7.9 Record the pH preserve the metals aliquot of the extract to a pH of <2 with 1:1 Nitric acid. This step will be performed by the metals prep analyst. Store non-metal extracts at 4 ± 20 ˚C until ready to proceed with the preparation and/or analysis procedures required for the analytes of interest.

9.7.9.1 of the prep sheet to the GC/MS department for analysis.

10.0 DATA ANALYSIS AND CALCULATIONS

10.1 Qualitative Identification

Not applicable to this SOP.

10.2 Quantitative Identification

Not applicable to this SOP.

10.3 Calculations

10.3.1 Weight of original sample (grams) – amount of liquid = grams of solid

10.3.2 % Solid = (grams solid / grams of sample) * 100

10.3.3 Amount of extraction Fluid #1 to be used = Weight of solid x 20

10.3.4 Final analyte concentration (multi-phase samples) = $\frac{(V1)(C1) + (V2)(C2)}{V1 + V2}$

Where:
V1 = the volume of first phase (L)
C1 = the concentration in the first phase (mg/L)
V2 = the volume of second phase (L)
C2 = the concentration in the second phase (mg/L)

See the laboratory SOP ENV-SOP-BTRO-0142, *Lab Calculations*, or equivalent replacement for equations for common calculations.

11.0 QUALITY CONTROL AND METHOD PERFORMANCE

11.1 **Quality Control**

The following QC samples are prepared and analyzed with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action.

QC Item	Frequency
TCLP Blank	1 per batch of 20 or fewer samples. If batch exceeds, 20 samples, every 20.
Matrix Spike (MS)	1 per batch of 20 or fewer samples. If batch exceeds, 20 samples, every 20 – see below for additional information.

11.1.1 Sample types to be used for determining matrix spikes:

11.1.1.1 Wastewater – any water submitted from a municipality, industry, or waters of the State that contains dissolved or suspended mater. This designation is not to be used for percent solid determination. This designation is strictly to be used for assigning MS per sample type per batch.

11.1.1.2 Organic – any non-aqueous phase liquid.

11.1.1.3 Soil – complex mixture of inorganic material (clay, silt, sand, etc.) decaying organic matter, water, air and living organisms. Any soil submitted to the laboratory is assumed to be contaminated.

11.1.1.4 Solid – any solid material other than a soil. Each will be evaluated independently to determine if it is a separate matrix type for the purpose of spiking. The extraction supervisor is to be notified if the extraction technician is unsure of the sample types that will require a matrix spike.

NOTE: The TCLP technician will identify the sample(s) to be used for the matrix spike. The TCLP technician will aliquot the leachate and identify the aliquot(s) for the MS. Samples identified as the matrix spike will be designated as “MS” on the sample label. Once the leaching process has been completed and the MS designated on the sample labels, the leachates will be sent for preparative extraction or analysis as appropriate.

11.2 **Instrument QC**

Not applicable to this SOP.

11.3 **Method Performance**

Not applicable to this SOP.

11.4 Analyst Qualifications and Training

Employees that perform any step of this procedure must have a completed Read and Acknowledgment Statement for this version of the SOP in their training record. In addition, prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis. Successful means the initial and on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee's training file. Refer to laboratory ENV-SOP-BTRO-010 *Employee Orientation and Training* for more information.

12.0 DATA REVIEW AND CORRECTIVE ACTION

12.1 Data Review

Pace's data review process includes a series of checks performed at different stages of the analytical process by different people to ensure that SOPs were followed, the analytical record is complete and properly documented, proper corrective actions were taken for QC failure and other nonconformance(s), and that test results are reported with proper qualification.

The review steps and checks that occur as employee's complete tasks and review their own work is called primary review.

All data and results are also reviewed by an experienced peer or supervisor. Secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented in accordance with the Pace ENV's SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

A third-level review, called a completeness check, is performed by reporting or project management staff to verify the data report is not missing information and project specifications were met.

Refer to laboratory SOP ENV-SOP-BTRO-0158, *Data Reduction and Validation*, or equivalent replacement, for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is expected any time QC or sample results are not within acceptance criteria. Refer to the determinative methods for data acceptance criteria.

13.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

Pace proactively seeks ways to minimize waste generated during our work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practice to be conducted consistent with all applicable federal and state laws and regulations. Excess reagents, samples and method process wastes must be characterized and disposed of in an acceptable manner in accordance with Pace's Chemical Hygiene Plan / Safety Manual.

14.0 MODIFICATIONS

A modification is a change to a reference test method made by the laboratory. For example, changes in stoichiometry, technology, quantitation ions, reagent or solvent volumes, reducing digestion or extraction times, instrument runtimes, etc. are all examples of modifications. Refer to Pace ENV corporate SOP ENV-SOP-CORQ-0011 *Method Validation and Instrument Verification* for the conditions under which the procedures in test method SOPs may be modified and for the procedure and document requirements.

No modifications have been applied in this SOP.

15.0 RESPONSIBILITIES

Pace ENV employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement in their training file for this version of the SOP. The employee is responsible for following the procedures in this SOP and handling temporary departures from this SOP in accordance with Pace's policy for temporary departure.

Pace supervisors/managers are responsible for training employees on the procedures in this SOP and monitoring the implementation of this SOP in their work area.

16.0 ATTACHMENTS

Quality Control Summary Table

Attachment 1: Preliminary Evaluation

Attachment 2: Non-volatile TCLP Extraction

Attachment 3: Volatile TCLP Extraction

Attachment 4: Filtrate/Leachate Compositing

17.0 REFERENCES

17.1 Pace Quality Assurance Manual- most current version.

17.2 The NELAC Institute (TNI) Standard, Volume 1, Module 2, "Quality Systems"- most current version.

17.3 Department of Defense - Department of Energy (DOD-DOE) Quality Systems Manual- most current version.

17.4 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, Method 1311: Toxicity Characteristic Leaching Procedure", Revision 0, July 1992.

17.5 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, Method 1312: Synthetic Precipitation Leaching Procedure, Revision 0, September 1994.

18.0 REVISION HISTORY

This Version:

Section	Description of Change
All	Updated SOP references
9.3 & 9.7	Particle Size Reduction for Non-Volatiles & Volatiles

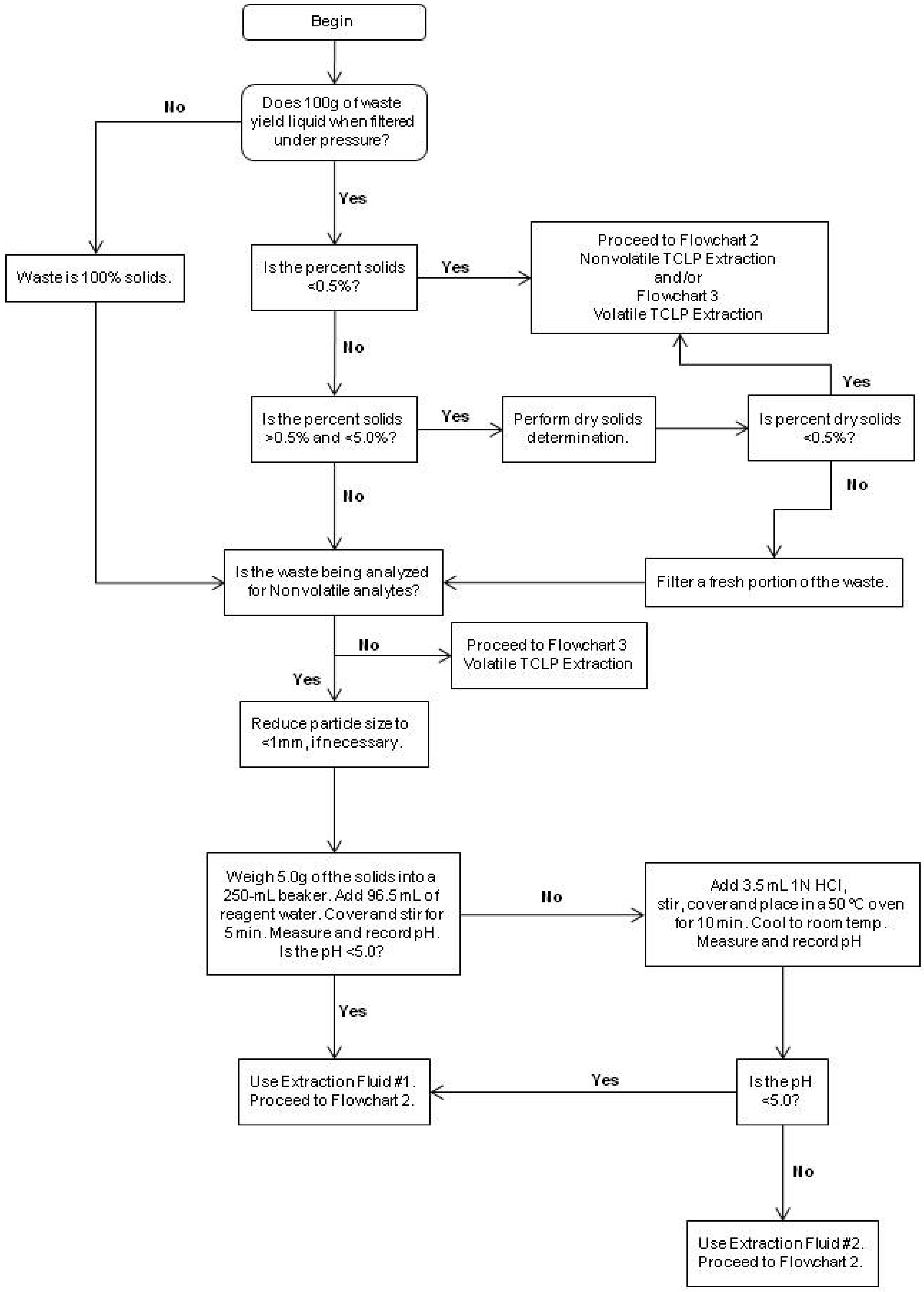
This document supersedes the following document(s):

Document Number	Title	Version
ENV-SOP-BTRO-0140	TCLP SPLP for Volatiles and Non-Volatiles (ZHE)	01

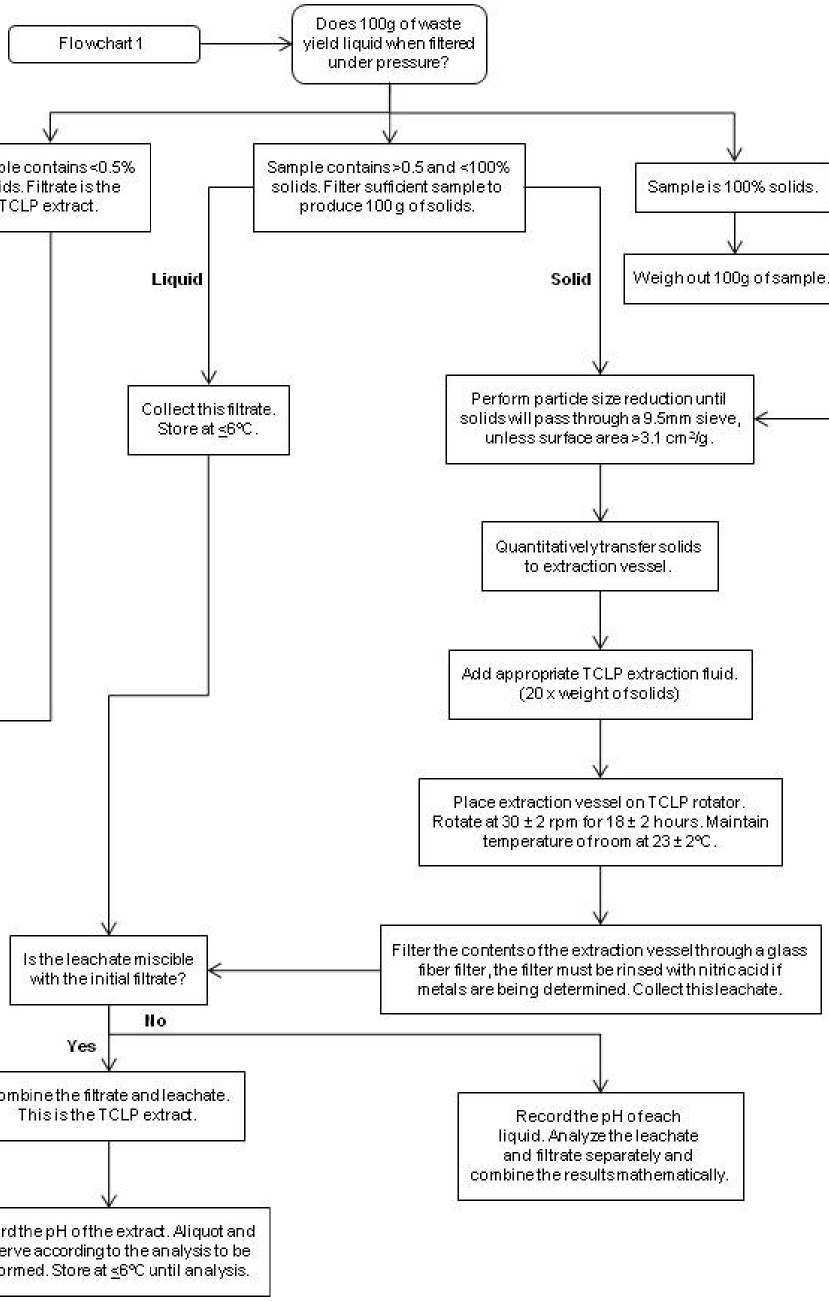
Quality Control

QC Sample	Components	Frequency	Acceptance Criteria	Corrective Action
Method Blank (MB) ***See footnote below**	TCLP Extraction Fluid	One per batch of up to 20 samples AND One per each extraction fluid AND One per each vessel type (e.g., A batch of samples for metals and semis using both fluid types will have four MBs)	1) Target analytes must be less than reporting limit. 2) If results are reported to MDL, target analytes in MB should also be evaluated to the MDL.	1) Re-analyze blank to confirm failure. 2) Qualify results and / or re-extract associated samples. ***Exceptions:*** 1) If sample ND, report sample without qualification 2) If sample result >10x MB detects and sample cannot be reanalyzed, report sample with appropriate qualifier indicating blank contamination. 3) If sample result <10x MB detects, report sample with appropriate qualifier to indicate an estimated value.
Laboratory Control Sample (LCS)	See applicable analytical SOP	See applicable analytical SOP	See applicable analytical SOP	See applicable analytical SOP
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	See applicable analytical SOP	See applicable analytical SOP	See applicable analytical SOP	See applicable analytical SOP

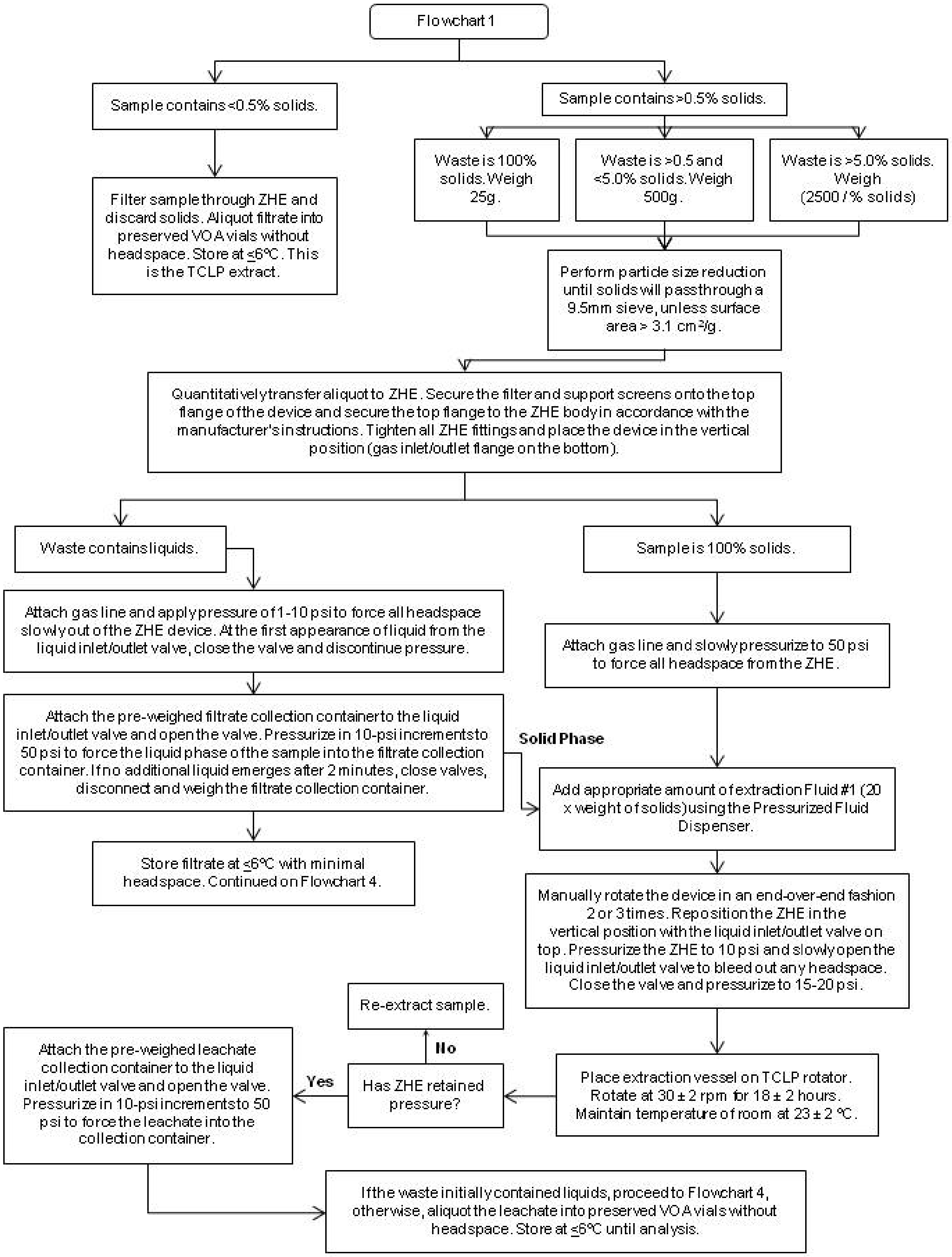
Attachment 1: Preliminary Evaluations



Attachment 2: Non-Volatile TCLP Extraction


Flowchart 1
Does 100g of waste yield liquid when filtered under pressure?
Sample contains <0.5% solids. Filtrate is the TCLP extract.
Sample contains >0.5 and <100% solids. Filter sufficient sample to produce 100 g of solids.
Sample is 100% solids.
Liquid
Solid
Weigh out 100g of sample.
Collect this filtrate. Store at ≤6°C.
Perform particle size reduction until solids will pass through a 9.5mm sieve, unless surface area >3.1 cm²/g.
Quantitatively transfer solids to extraction vessel.
Add appropriate TCLP extraction fluid. (20 x weight of solids)
Place extraction vessel on TCLP rotator. Rotate at 30 ± 2 rpm for 18 ± 2 hours. Maintain temperature of room at 23 ± 2°C.
Is the leachate miscible with the initial filtrate?
Filter the contents of the extraction vessel through a glass fiber filter, the filter must be rinsed with nitric acid if metals are being determined. Collect this leachate.
No
Yes
Combine the filtrate and leachate. This is the TCLP extract.
Record the pH of each liquid. Analyze the leachate and filtrate separately and combine the results mathematically.
Record the pH of the extract. Aliquot and preserve according to the analysis to be performed. Store at ≤6°C until analysis.

Attachment 3: Volatile TCLP Extraction



Sample contains <0.5% solids.

Filter sample through ZHE and discard solids. Aliquot filtrate into preserved VOA vials without headspace. Store at ≤6°C. This is the TCLP extract.

Sample contains >0.5% solids.

Waste is 100% solids. Weigh 25g.

Waste is >0.5 and <5.0% solids. Weigh 500g.

Waste is >5.0% solids. Weigh (2500 / % solids)

Perform particle size reduction until solids will pass through a 9.5mm sieve, unless surface area > 3.1 cm²/g.

Quantitatively transfer aliquot to ZHE. Secure the filter and support screens onto the top flange of the device and secure the top flange to the ZHE body in accordance with the manufacturer's instructions. Tighten all ZHE fittings and place the device in the vertical position (gas inlet/outlet flange on the bottom).

Waste contains liquids.

Attach gas line and apply pressure of 1-10 psi to force all headspace slowly out of the ZHE device. At the first appearance of liquid from the liquid inlet/outlet valve, close the valve and discontinue pressure.

Attach the pre-weighed filtrate collection container to the liquid inlet/outlet valve and open the valve. Pressurize in 10-psi increments to 50 psi to force the liquid phase of the sample into the filtrate collection container. If no additional liquid emerges after 2 minutes, close valves, disconnect and weigh the filtrate collection container.

Store filtrate at ≤6°C with minimal headspace. Continued on Flowchart 4.

Sample is 100% solids.

Attach gas line and slowly pressurize to 50 psi to force all headspace from the ZHE.

Add appropriate amount of extraction Fluid #1 (20 x weight of solids) using the Pressurized Fluid Dispenser.

Manually rotate the device in an end-over-end fashion 2 or 3 times. Reposition the ZHE in the vertical position with the liquid inlet/outlet valve on top. Pressurize the ZHE to 10 psi and slowly open the liquid inlet/outlet valve to bleed out any headspace. Close the valve and pressurize to 15-20 psi.

Place extraction vessel on TCLP rotator. Rotate at 30 ± 2 rpm for 18 ± 2 hours. Maintain temperature of room at 23 ± 2 °C.

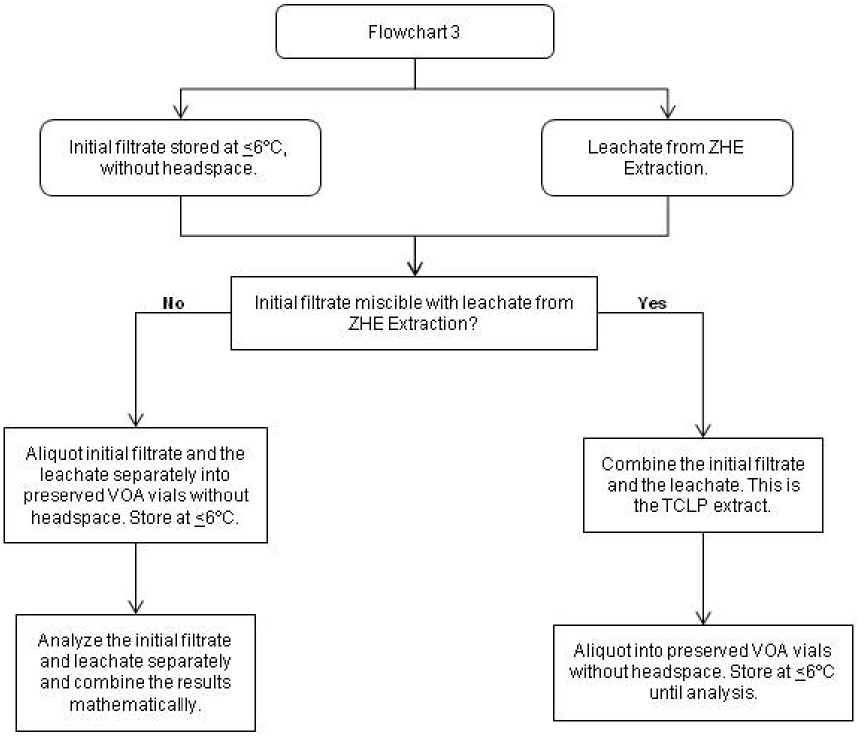
Has ZHE retained pressure?

Re-extract sample.

Attach the pre-weighed leachate collection container to the liquid inlet/outlet valve and open the valve. Pressurize in 10-psi increments to 50 psi to force the leachate into the collection container.

If the waste initially contained liquids, proceed to Flowchart 4, otherwise, aliquot the leachate into preserved VOA vials without headspace. Store at ≤6°C until analysis.

Attachment 4: Filtrate/Leachate Compositing


Flowchart 3
Initial filtrate stored at ≤6°C, without headspace.
Leachate from ZHE Extraction.
Initial filtrate miscible with leachate from ZHE Extraction?
No
Yes
Aliquot initial filtrate and the leachate separately into preserved VOA vials without headspace. Store at ≤6°C.
Analyze the initial filtrate and leachate separately and combine the results mathematicallly.
Combine the initial filtrate and the leachate. This is the TCLP extract.
Aliquot into preserved VOA vials without headspace. Store at ≤6°C until analysis.

	ENV-SOP-BTRO-0037 v02_pH by SW-846 9040C & 9045D, SM 4500-H+ B	
	Effective Date: 06/24/2022	COPYRIGHT© 2019, 2021, 2022 Pace®

Management Approval:
Michelle Smith Approved on 6/24/2022 2:08:22 PM
Russell McNiece Approved on 6/24/2022 3:33:17 PM
Jacqueline Bendolph Approved on 6/24/2022 4:44:26 PM

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the laboratory procedure for the determination of pH by Electrometric Measurement, following SM 4500-H+ B-2011, SW-846 9040C, and SW-846 9045D. This SOP is applicable to Non-Potable Water and Solids.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

Not applicable to this test method procedure.

2.0 SUMMARY OF METHOD

The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode. The measuring device is calibrated using a series of standard solutions of known pH.

3.0 INTERFERENCES

The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants, or moderate (<0.1 molar solution) salinity.

Sodium error at pH levels >10 can be reduced or eliminated by using a low sodium-error electrode.

Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gentle wiping or detergent washing, followed by rinsing with distilled water. An additional treatment with hydrochloric acid (1:10) may be necessary to remove any residual film.

Temperature effects on the electrometric determination of pH arise from two sources. The first is caused by the change in electrode output at various temperatures. This interference should be controlled with instruments having temperature compensation or by calibrating the electrode-instrument system at the temperature of the samples. The second source of temperature effects is the change of pH due to changes in the sample as the temperature changes. This error is sample-dependent and cannot be controlled. It should, therefore, be noted by reporting both the pH and temperature at the time of analysis.

Many factors limit the interpretation of ORP measurements in water. These factors include irreversible reactions, electrode poisoning, multiple redox couples in the sample, small exchange currents and inert redox couples. ORP measurements in the field can correlate poorly with ORP values calculated from the redox couples in the sample. Because of these factors, the interpretation of ORP measurements will be specific to the particular application.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **Reference Electrode:** A silver-silver chloride or other reference electrode of constant potential.

- **Hygroscopic:** The ability of a waste/solid material to readily absorb water.
- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH AND SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

The laboratory provides containers for the collection of samples upon client request. Refer to laboratory SOP ENV-SOP-BTRO-0120, *Sample Kit Ordering & Preparation*, or however named, for procedures related to preparation of bottle kits for the test method(s) associated with this SOP.

The laboratory does not perform sample collection or field measurements for this test method. Samples should be collected in accordance with a sampling plan and sampling procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project.

Container Type, Minimum Sample Amount, Preservation, and Holding Time Requirements:

Matrix	Container Size & Type	Required Sample Amount[1]	Preservation	Holding Time[2, 3]
Water	125 mL HDPE	25 mL	Thermal: 0-6°C Chemical: None	Collection to Analysis: 15 Minutes

Solids	4 oz. Glass Jar	20 g	Thermal: 0-6°C Chemical: None	Collection to Analysis: 15 Minutes

[1] *Amount of sample required for each discrete test.*

[2] *For samples from South Carolina where samples are not analyzed within 15 minutes of the sample's receipt (15 minutes of sample extract being complete for solids), the result will be qualified and reported with a case narrative.*

[3] *SW-846 9040 and 9045 for pH both state that samples should be analyzed as soon as possible. 40 CFR 136 Table II defines the maximum holding time for Hydrogen ion (pH) as 15 minutes.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-BTRO-0118, *Sample Receiving & LIMS Login*, or however named.

After receipt, samples are stored at 0-6°C until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method(s).

7.1 Instrumentation

- Thermo Scientific™ Orion™ 720A pH meter, or equivalent pH meter capable of calculating slope
  - Orion™ ROSS™ Sure-Flow™ pH Electrode with Sure-flow junction, BNC connector, Thermo Scientific™, Cat. #8172BNWP (ATC).
  - Orion™ pH Electrode Filling Solution, Thermo Scientific™, Cat. #810007
  - ROSS™ Probe Storage Solution, Thermo Scientific™, Cat. #810001TS

7.2 Support Equipment

- Top loading balance, capable of accurate weight measurements to the nearest 0.1 g.
- Magnetic stir plate
- Bench top shaker
- Water bath, capable of achieving and maintaining 25°C (optional).
- Plastic specimen cups

7.3 Supplies

- Magnetic stirring bars, TFE-coated
- Plastic sample cups
- Stainless steel spatula
- Tongue depressors

- Kimwipe lab tissue, or equivalent

8.0 REAGENTS & STANDARDS

If not specially detailed below, refer to laboratory SOP ENV-SOP-BTRO-0015, *Standard and Reagent Preparation & Traceability*, or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared, when available, and expire per manufacturer.

8.1 Reagents

- Deionized (DI) water: ASTM Type I reagent grade, 18 MΩ-cm resistance or better.

8.2 Standards - pH

Use of equivalent standards from alternate vendors is acceptable so long as they are traceable to a national standard, when commercially available.

Standard	Vendor	Catalog #	Concentration (pH)	Storage (°C)
Buffer, pH 2	SPEX CertiPrep	VPACEMN-98-4L	2	Ambient
Buffer, pH 4		VPACEMN-93-4L	4	
Buffer, pH 6		VPACEMN-99-4L	6	
Buffer, pH 7		VPACEMN-94-4L	7	
Buffer, pH 10		VPACEMN-95-4L	10	
Buffer, pH 12		VPACEMN-99-4L	12	

- Buffer solutions should be routinely checked for growth or contamination. Evidence of buffer degradation should result in the immediate replacement of the affected solutions.

8.3 Formulations

Reagents and standard used in the procedure are “whole volume” and do not require additional preparation.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Support Equipment

Refer to laboratory SOP ENV-SOP-BTRO-0013, *Equipment & Instrumentation Management*, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.1.2 Instrument Set Up

9.1.2.1 Routine Instrument Operating Conditions

Refer to Appendix B for routine instrument operating conditions.

9.1.3 Automatic Temperature Compensation (ATC) Verification

Probes for pH analysis are often equipped with the capability of performing automatic temperature compensation. Some meters may also allow for the use of external probes for this same purpose. For meters capable of ATC (internal or external), the temperature measuring device must be verified prior to being placed into service and on a quarterly basis thereafter. Refer to laboratory SOP ENV-SOP-BTRO-0013, *Equipment & Instrumentation Management*, or however named, for additional information on ATC verification requirements.

9.1.4 Preparation of pH Electrode

The pH probe filling solution should be inspected prior to use. If filling solution needs to be added, perform the following steps:

1) Remove the storage bottle from the sensing bulb.
2) Clean any salt deposits from the exterior of the electrode by rinsing it with distilled water.
3) Uncover the fill hole by removing the tape and add filling solution. To maintain an adequate flow rate, the level of fill solution must always be above the reference junction and at least one inch above the sample level.
   - The fill hole should remain open whenever the electrode is in use.
4) Wet the junction by pressing down on the electrode cap to let a few drops of the filling solution flow out of the electrode and then replenish any lost filling solution.
5) Shake the electrode downward (similar to a clinical thermometer) to remove any air bubbles.
6) Soak electrode in pH electrode storage solution for 30 to 60 minutes, the, connect the electrode to the meter.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

The linear calibration range is determined prior to sample analysis, after repeat calibration verification failure, or whenever a significant change in instrument response is observed or expected. LCR should be established and verified on each day of use.

9.2.2 Calibration Levels

Standard	pH Buffer
CAL 1	2
CAL 2	4
CAL 3 (CCV)	7
CAL 4	10
CAL 5	12

9.2.3 Calibration Sequence

Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. Subsequent calibration verification is required at regular intervals throughout the analytical sequence. Upon the successful completion of the ICAL, an initial calibration verification is performed, followed by continuing calibration checks after the analysis of a maximum of ten samples, and at the end of the analytical sequence.

For corrosivity characterization, the calibration of the pH meter should include a buffer of pH 2 for acidic wastes and a pH 12 buffer for caustic wastes.

1) Press the “Calibrate” button.

2) Meter will ask, “How many buffers?” Press “5”, “Yes”. Each buffer should be poured into a plastic cup containing a magnetic stir bar.

3) Place the electrode and temperature probe in the buffer pH 2.00; stir gently and allow the meter to stabilize; press “2.00” “Yes.” Rinse electrode and temperature probe with deionized water.

4) Place the electrode and temperature probe in the buffer pH 4.00; stir gently and allow the meter to stabilize; press “4.00” “Yes.” Rinse electrode and temperature probe with deionized water. Place the electrode and temperature probe in the buffer pH 7.00; stir gently and allow the meter to stabilize; press “7.00” “Yes.” Rinse electrode and temperature probe with deionized water.

5) Place the electrode and temperature probe in the buffer pH 10.00; allow the meter to stabilize; press “10.00” “Yes.” Rinse electrode and temperature probe with deionized water.

6) Place the electrode and temperature probe in the buffer pH 12.00; stir gently and allow the meter to stabilize; press “12.00” “Yes.” Rinse electrode and temperature probe with deionized water.

7) Record the slope percent in the calibration logbook. It will be displayed after the fifth buffer has been analyzed. The slope should fall within the laboratory control limits of 92-102%. If the slope is outside of this range the meter must be recalibrated.

8) Analyze the ICV buffer (6.00) immediately after calibration. Pour the buffer into a plastic cup containing a stir bar. Place the electrode and temperature probe in the solution, stir gently and allow the solution to stabilize. The reading must be within 0.05 pH units of the true value. If not, the meter must be recalibrated. Record the result and the temperature of the ICV in the logbook. An ICV must be analyzed immediately after each ICAL.

9.2.4 Calibration Evaluation

9.2.4.1 Curve Fit

Calibration is performed by the analysis of certified pH buffer solutions (2, 4, 7, 10, and 12). The calibration slope is a conversion that the pH meter uses to convert the electrode signal in mV to pH. The meter determines the slope by measuring the difference in mV readings for each of the pH buffers. The output of a pH measuring electrode is equal to -59.16 mV per pH unit. The calculated slope must be 92-102%.

- Refer to Orion™ ROSS™ Sure-Flow™ pH Electrode specifications. Slope criteria is 92-102% of the theoretical Nernst slope.

9.2.4.2 Initial Calibration Verification

Immediately following the initial calibration, analyze a pH 6 buffer solution as the ICV to verify the acceptability of the calibration curve. Following the ICV, each of the calibration standards used for the ICAL should be reanalyzed against the new calibration curve. Record the read-back data for each buffer solution in the calibration logbook. The pH readings of the calibration standards and ICV should meet the criteria as defined in Appendix A. If the criteria are not met, the meter must be recalibrated.

9.2.4.3 Continuing Calibration Verification

A pH 7 buffer solution as a CCV is analyzed after every 10 samples, and at the end of the analytical sequence. The pH reading should meet the criteria as defined in Appendix A. If the CCV fails, perform corrective action(s), and repeat the analysis of the CCV using a fresh aliquot of pH 7 buffer. Potential causes for CCV failures could include, but are not limited to, a malfunctioning analytical system, faulty pH probe, or buffer degradation. Recalibrate if necessary.

9.3 Sample Preparation

9.3.1 Homogenization & Subsampling

Refer to laboratory SOP ENV-SOP-BTRO-0143, *Sample Homogenization and Sub-Sampling*, or however named, for information regarding the handling, homogenization, and splitting of samples in order to ensure that a representative aliquot is used for preparation.

9.3.2 Aqueous Sample Preparation

Shake samples thoroughly; pour approximately 25-50 mL into a plastic cup containing a magnetic stir bar. Sufficient sample must be available to cover the sensing element of the electrode and to give adequate clearance for the stir bar.

9.3.3 Soil Sample Preparation

1) Tare balance with an empty specimen cup.
2) Weigh 20 ± 0.1g of soil into the specimen cup. Record weight in Batch Entry Sheet.
3) Add 20 mL of deionized water. Record volume in Batch Entry Sheet.
4) Screw the lid on the specimen cup and continuously shake for 5 minutes on the shaker table.
    - Additional water may be added when working with hygroscopic soils, salts, other problematic matrices. Add additional water in 10 mL increments until there is enough free liquid to measure the pH.
5) Allow the sample to sit for about 1 hour to let the particulates settle. Record start and stop times in the logbook

9.3.4 Waste Sample Preparation

1) Tare balance with an empty 50 mL beaker.
2) Weigh 20 ± 0.1g of waste into the beaker. Record weight in logbook.
3) Add 20 mL of deionized water. Record volume in logbook.
4) Cover and continuously shake for 5 minutes on the shaker table.
    - Additional water may be added when working with hygroscopic soils, salts, or other problematic matrices. Add additional water in 10 mL increments until there is enough free liquid to measure the pH.
    - If the waste is multiphasic, decant the oily phase and measure the pH of the aqueous phase.
5) Allow the sample to sit for about 15 minutes to let the suspended waste settle. If the solution is multiphasic, decant the oily phase and measure the pH of the aqueous phase. Record start and stop times in the logbook

9.4 Analysis

9.4.1 pH Sequence Preparation

1) Allow all samples and calibration standards to equilibrate to room temperature prior to analysis. If the sample temperature differs by more than 2°C from the buffer solutions, the measured pH values must be corrected.
    - A water bath maintained at 25°C can be used to accelerate this process. and will ensure that all samples and buffer solutions are at the same temperature prior to analysis.
2) Rinse the pH probe with a portion of the buffer solution or sample to be analyzed.
3) Immerse the electrode and the temperature probe in the sample. Adjust the electrode in the holder so that, upon lowering, the electrode and temperature probe will be immersed just below the solution or decant the solution into a plastic cup and immerse the probe in the solution.
4) Press “Measure.” Allow the reading to stabilize. The display will read “Ready” when the reading is stable.
5) Record the sample number and the result to two decimal places in the logbook. Report three significant figures when reporting data in the LIMS. A duplicate is required for every batch, at least 1 per every 10 samples. Record two readings for the sample that is designated as the duplicate for each batch.

    For SW-846 9040C:

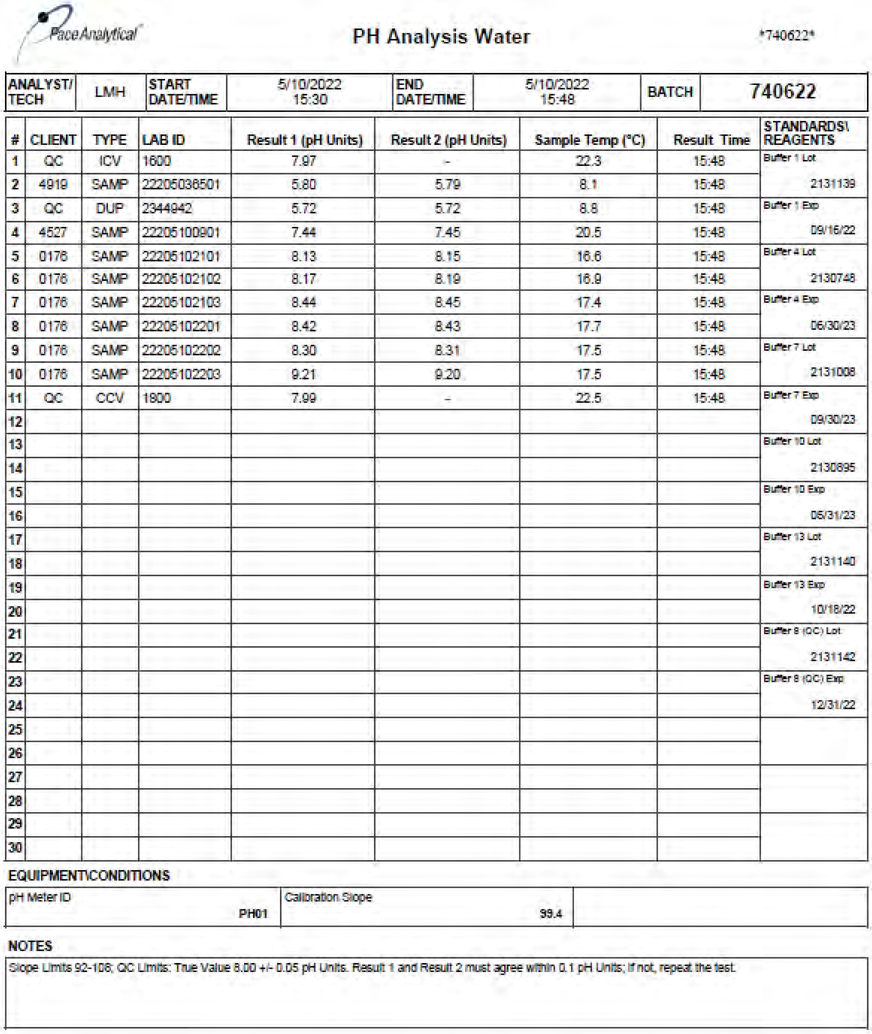
    - Determine the aqueous portion of the sample to be analyzed prior to analysis. Aqueous phase must constitute greater than 20% of the sample matrix by volume.

- Repeat measurement on successive aliquots of sample until values differ by <0.1 pH units. Two or three volume changes are usually sufficient.

6) Rinse the probe with ample DI water and blot dry with a Kimwipe between each sample. Follow the DI rinse with a small portion of the next sample to be analyzed.

7) Repeat Step.2 through Step 6 for each sample and buffer solution.

9.4.2 Example Analytical Sequence



PH Analysis Water

740622

ANALYST/ TECH	LMH	START DATE/TIME	5/10/2022 15:30	END DATE/TIME	5/10/2022 15:48	BATCH	740622

#	CLIENT	TYPE	LAB ID	Result 1 (pH Units)	Result 2 (pH Units)	Sample Temp (°C)	Result Time	STANDARDS\ REAGENTS
1	QC	ICV	1600	7.97	-	22.3	15:48	Buffer 1 Lot 2131139
2	4919	SAMP	22205036501	5.80	5.79	8.1	15:48	
3	QC	DUP	2344942	5.72	5.72	8.8	15:48	Buffer 1 Exp 09/16/22
4	4527	SAMP	22205100901	7.44	7.45	20.5	15:48	
5	0176	SAMP	22205102101	8.13	8.15	16.6	15:48	Buffer 4 Lot 2130748
6	0176	SAMP	22205102102	8.17	8.19	16.9	15:48	
7	0176	SAMP	22205102103	8.44	8.45	17.4	15:48	Buffer 4 Exp 06/30/23
8	0176	SAMP	22205102201	8.42	8.43	17.7	15:48	
9	0176	SAMP	22205102202	8.30	8.31	17.5	15:48	Buffer 7 Lot 2131008
10	0176	SAMP	22205102203	9.21	9.20	17.5	15:48	
11	QC	CCV	1800	7.99	-	22.5	15:48	Buffer 7 Exp 09/30/23
12								
13								Buffer 10 Lot 2130895
14								
15								Buffer 10 Exp 05/31/23
16								
17								Buffer 13 Lot 2131140
18								
19								Buffer 13 Exp 10/18/22
20								
21								Buffer 8 (QC) Lot 2131142
22								
23								Buffer 8 (QC) Exp 12/31/22
24								
25								
26								
27								
28								
29								
30								

EQUIPMENT\CONDITIONS

pH Meter ID PH01	Calibration Slope 99.4	

NOTES

Slope Limits 92-108; QC Limits: True Value 8.00 +/- 0.05 pH Units. Result 1 and Result 2 must agree within 0.1 pH Units; if not, repeat the test.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

Quantitative analysis is performed using the most recent calibration curve. Sample results are read directly from the meter and are reported to the nearest 0.1 pH unit. For SW-846 9040C, the last replicate measurement is reported.

10.2 Calculations

Refer to the laboratory Quality Assurance Manual and to laboratory SOP ENV-SOP-BTRO-0142, *Laboratory Calculations*, or however named, for equations used to perform common calculations.

11.0 QUALITY CONTROL & METHOD PERFORMANCE

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix A for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Sample Duplicate	DUP	1 per 10 or fewer samples, per matrix.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	Immediately following ICAL
Continuing Calibration Verification	CCV	After every 10 samples, and at end of the sequence

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

12.0 DATA REVIEW & CORRECTIVE ACTION

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to the current version of laboratory SOP ENV-SOP-BTRO-0158, *Data Review*, or however named, for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

13.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

15.0 RESPONSIBILITIES

- All employees of Pace® Analytical Services that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- Local quality personnel are responsible for tracking the currency of the R&A on this SOP for employees at the locations they are assigned to and for notifying the General Manager (GM), however named, when R&A are overdue or outstanding. The GM and the employee's direct supervisor are responsible for ensuring the employee completes the R&A assignments as required.
- The supervisors and managers of Pace® Analytical Services, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP the work area(s) they oversee.

- All employees of Pace® Analytical Services are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local Quality Manager and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual change to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Managemen*t and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI*.
- Local quality personnel are responsible for monitoring conformity to this SOP during routine internal audits of work areas that utilize this SOP and for communicating gaps and deviations found during monitoring to the work area supervisor, who is responsible for correction of the situation.

16.0 ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table
- Appendix B: Thermo Scientific™ Orion™ 720A pH Operating Conditions

17.0 REFERENCES

- ENV-SOP-CORQ-0011, *Method Validation*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *SOP for SOP and SWI,* current version.
- ENV-TMP-CORQ-0007, *Quality Manual Template*, current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- TNI Standard, "Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis", Revision 2.1, 2016.
- Department of Defense Quality Systems Manual, current version.
- Laboratory Quality Manual, ENV-MAN-BTRO-0001, current version.
- SW-846 9040C, pH Electrometric Measurement, part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, November 2004.
- SW-846 9045D, Soil and Waste pH, part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, November 2004.
- Standard Methods for the Examination of Water and Wastewater, Online Edition, SM4500H+B-2011.

18.0 REVISION HISTORY

Authorship

Primary Author[1]	Job Title	Date Complete
Michelle Smith	Wet Chemistry Supervisor	6/16/2022

[1] The primary author is the individual / role responsible for the content of this SOP. Send questions or suggestions for content to the primary author. See the Quality Manager for questions or concerns related to implementation of this SOP.

Revisions Made from Prior Version

Section	Description of Change
ALL	Updated SOP to ENV-TMP-CORQ-0005 v03_Test Method SOP Template
ALL	Removed ORP procedure and references from SOP

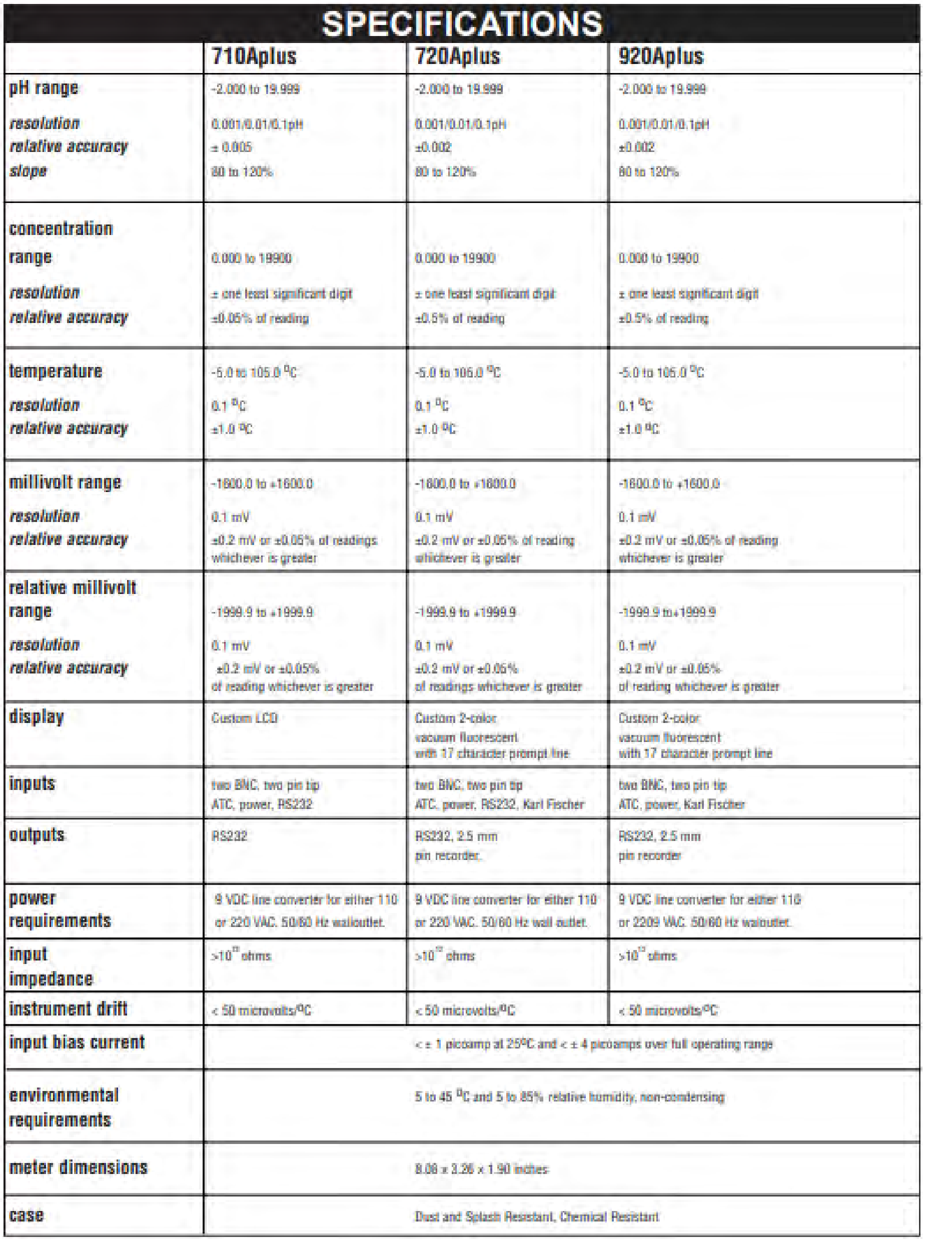
Document Succession: This version replaces the following documents:

Document Number & Version	Document Title	Effective Date:
ENV-SOP-BTRO-0037 v02	pH by SW-846 9040C, 9045D, SM 4500-H+ B	9/30/2021

Appendix A: QC Summary and Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Initial Calibration (ICAL)	ICAL prior to sample analysis	pH slope within 92-102%	Identify and correct source of problem, repeat calibration.	Flagging is not appropriate. Do not proceed with analysis
Calibration Standard Check	Immediately following ICAL	All buffers within ± 0.05 pH units of true value.	Identify and correct source of problem, repeat calibration.	Flagging is not appropriate. Do not proceed with analysis
Initial Calibration Verification (ICV)	Immediately following ICAL	pH 6 buffer within ± 0.05 pH units of true value.	Identify and correct source of problem, repeat calibration.	Flagging is not appropriate. No samples shall be analyzed until calibration has been verified.
Continuing Calibration Verification (CCV)	After every 10 samples, and at the end of analytical sequence.	pH 7 buffer within ± 0.05 pH units of true value.	Refer to Section 9.2.4.3 for required corrective actions based upon circumstance.	Results may not be reported without valid CCVs. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.
Sample Duplicate (DUP)	1 per 10 samples, per matrix.	Duplicate results within ± 0.1 pH units	Identify and correct source of problem, repeat replicate analysis.	Flagging is not appropriate.

Appendix B: Thermo Scientific™ Orion™ 720A Operating Conditions



SPECIFICATIONS

	710Aplus	720Aplus	920Aplus
pH range	-2.000 to 19.999	-2.000 to 19.999	-2.000 to 19.999
resolution	0.001/0.01/0.1pH	0.001/0.01/0.1pH	0.001/0.01/0.1pH
relative accuracy	± 0.005	±0.002	±0.002
slope	80 to 120%	80 to 120%	80 to 120%
concentration range	0.000 to 19900	0.000 to 19900	0.000 to 19900
resolution	± one least significant digit	± one least significant digit	± one least significant digit
relative accuracy	±0.05% of reading	±0.5% of reading	±0.5% of reading
temperature	-5.0 to 105.0 °C	-5.0 to 105.0 °C	-5.0 to 105.0 °C
resolution	0.1 °C	0.1 °C	0.1 °C
relative accuracy	±1.0 °C	±1.0 °C	±1.0 °C
millivolt range	-1600.0 to +1600.0	-1600.0 to +1600.0	-1600.0 to +1600.0
resolution	0.1 mV	0.1 mV	0.1 mV
relative accuracy	±0.2 mV or ±0.05% of readings whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater
relative millivolt range	-1999.9 to +1999.9	-1999.9 to +1999.9	-1999.9 to+1999.9
resolution	0.1 mV	0.1 mV	0.1 mV
relative accuracy	±0.2 mV or ±0.05% of reading whichever is greater	±0.2 mV or ±0.05% of readings whichever is greater	±0.2 mV or ±0.05% of reading whichever is greater
display	Custom LCD	Custom 2-color vacuum fluorescent with 17 character prompt line	Custom 2-color vacuum fluorescent with 17 character prompt line
inputs	two BNC, two pin tip ATC, power, RS232	two BNC, two pin tip ATC, power, RS232, Karl Fischer	two BNC, two pin tip ATC, power, Karl Fischer
outputs	RS232	RS232, 2.5 mm pin recorder.	RS232, 2.5 mm pin recorder
power requirements	9 VDC line converter for either 110 or 220 VAC. 50/60 Hz walloutlet.	9 VDC line converter for either 110 or 220 VAC. 50/60 Hz wall outlet.	9 VDC line converter for either 110 or 2209 VAC. 50/60 Hz walloutlet.
input impedance	>10^{12} ohms	>10^{12} ohms	>10^{12} ohms
instrument drift	< 50 microvolts/°C	< 50 microvolts/°C	< 50 microvolts/°C
input bias current	< ± 1 picoamp at 25°C and < ± 4 picoamps over full operating range		
environmental requirements	5 to 45 °C and 5 to 85% relative humidity, non-condensing		
meter dimensions	8.08 x 3.26 x 1.90 inches		
case	Dust and Splash Resistant, Chemical Resistant		