Naval Facilities Engineering Command

Northwest
Silverdale, Washington

Final

Sampling and Analysis Plan
Site Inspection for Per- and Polyfluoroalkyl Substances

Former Naval Arctic Research Laboratory Barrow
Utqiaġvik, Alaska

August 2019

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SAP Worksheet #1—Title and Approval Page

Northwest
Silverdale, Washington

Final

Sampling and Analysis Plan
Site Inspection for Per- and Polyfluoroalkyl Substances

Former Naval Arctic Research Laboratory Barrow
Utqiaġvik, Alaska

August 2019

Prepared for NAVFAC Northwest
by CH2M HILL, Inc.
Seattle, Washington
Contract N62470-16-D-9000
CTO 4117

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Approval Signatures

Chemist/Quality Assurance Officer, NAVFAC Atlantic Date

Kendra Leibman, RPM, NAVFAC Northwest Date

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Executive Summary

This Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) outlines the sampling activities in support of a Site Inspection (SI) for per- and polyfluoroalkyl substances (PFAS) at Former Naval Arctic Research Laboratory Barrow (NARL Barrow) in Utqiaġvik, Alaska. CH2M HILL, Inc. (CH2M) prepared this document under the Department of the Navy (Navy), Naval Facilities Engineering Command, Comprehensive Long-term Environmental Action—Navy 9000 Contract N62470-16-D-9000, Contract Task Order 4117, in accordance with the Navy's UFP-SAP policy guidance to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses.

Former NARL Barrow is a former Navy research facility and support camp partially located within the boundary of the City of Utqiaġvik (formerly known as Barrow) on the coastal plain of Alaska's North Slope. It is located 330 miles above the Arctic Circle. Former NARL Barrow operated from the mid-1900s to early 1980s, with the primary purpose of serving as a center for scientific study in the region. It is no longer actively used by the Navy. An investigation of PFAS in Imikpuk Lake, a lake adjacent to current Navy property at Former NARL Barrow, was conducted in 2017 and identified PFAS (perfluorooctanoic acid [PFOA], perfluorooctane sulfonate [PFOS], and perfluorobutane sulfonate [PFBS]) in the surface water. The summed concentrations of PFOS and PFOA exceeded the United States Environmental Protection Agency (USEPA) lifetime health advisory of 70 parts per trillion (Navy, 2018; Alaska DHSS, 2017)[1]. Exposure to humans through ingestion of Imikpuk Lake water has been addressed by the following actions performed by the Navy (in order of occurrence): (1) a public meeting to share the results with the community, (2) installation of signs around the lake warning the community not to drink or cook with the water, and (3) meetings with local leadership and health officials regarding the PFAS results in the lake. The Navy will continue to communicate the status of the PFAS investigation in and near Imikpuk Lake to the community via public meetings, such as the Restoration Advisory Board. A Preliminary Assessment (PA) for PFAS (Navy, 2019a) was conducted for Former NARL Barrow in 2018. The PA identified three areas that are considered potential PFAS source areas: (1) Building 136, (2) Potential Crash Site A, and (3) Potential Crash Site B. The PA recommended additional investigation at these three areas based on the potential for aqueous film-forming foam to have been stored, used, or released during Navy operations at these locations as well as the results of the investigation of PFAS in Imikpuk Lake. The objectives of the SI are to:

- Determine if PFAS are present in groundwater and soil, and if present, evaluate whether there is a potentially unacceptable risk to human health.
- Evaluate PFAS concentrations in surface water in Imikpuk Lake using current analytical methods.

Groundwater, soil, and surface water samples will be collected from the three potential source areas identified in the PA and analyzed for the 18 PFAS compounds by listed in Method 537 via liquid chromatography tandem mass spectrometry compliant with Quality Systems Manual 5.1.1 Table B-15.

This SAP consists of 37 worksheets specific to the scope of work for the SI at Former NARL Barrow. All tables are embedded within the worksheets. All figures are included at the end of the document. Field standard operating procedures (SOPs) are included in **Appendix A**. The Laboratory Department of Defense Environmental Laboratory Accreditation Program letter for the supporting laboratory is included in **Appendix B**.

The laboratory information cited in this SAP is specific to Battelle in Norwell, MA. If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the Navy for approval.

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[1] Sampling and analysis occurred before issuance of state-specific action levels for surface water used as drinking water.

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SAP Worksheets

Appendices

Tables

Figures

Acronyms and Abbreviations

°C	degree Celsius
µg/L	microgram(s) per liter
9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid
ADEC	Alaska Department of Environmental Quality
ADONA	4,8-dioxa-3H-perfluorononanoic acid
AFFF	aqueous film-forming foam
AQM	Activity Quality Manager
bgs	below ground surface
CA	corrective action
CCV	continuing calibration verification
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	chain of custody
CTO	Contract Task Order
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct push technology
DQI	data quality indicator
DV	data validation
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
FD	field duplicate
FTL	Field Team Leader
H&S	health and safety
HDPE	high density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
HQ	hazard quotient
HSM	Health and Safety Manager
HSP	Health and Safety Plan
ICAL	initial calibration
ICV	initial calibration verification
ID	Identification
IDW	Investigation-derived waste
IS	internal standards
ISC	instrument sensitivity check
kg	kilogram
LC	liquid chromatograph

LCL	lower criteria limit
LCS	laboratory control sample
LIMS	laboratory information management system
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
mg	milligram
mg/L	milligram per liter
mL	milliliter
MPC	Measurement Performance Criteria
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NARL	Former Naval Arctic Research Laboratory
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NTU	nephelometric turbidity unit
NW	northwest
ORP	oxidation-reduction potential
PA	Preliminary Assessment
PAL	project action limit
PC	Project Chemist
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutane sulfonate
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFDpA	Perfluoroheptanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFHxA	Perfluorohexoanoic acid
PFNA	Perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFTA	Perfluorotetradecanoic acid
PFTE	polytetrafluoroethylene
PFTrDA	Perfluorotridecanoic acid
PFUnA	Perfluoroundecanoic acid
PID	photoionization detector
PM	Project Manager
POC	point of contact
PQO	project quality objective
PQL	project quantitation limit
PVC	polyvinyl chloride
QA	quality assurance

QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RF	radio frequency
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SI	Site Inspection
SME	Subject Matter Expert
SOP	standard operating procedure
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
SVOC	semivolatile organic compounds
TBD	to be determined
UFP	Uniform Federal Policy
UIC	Ukpeaġvik Inupiat Corporation
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WQP	water quality parameter

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SAP Worksheet #2—SAP Identifying Information

Site Name:	Former Naval Arctic Research Laboratory (NARL) Barrow, Utqiaġvik, Alaska
Operable Unit/Solid Waste Management Unit:	Not Applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-16-D-9000
Contract Title:	Comprehensive Long-term Environmental Action—Navy (CLEAN) 9000 Program
Work Assignment Number (optional):	Contract Task Order (CTO) 4117

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the following:
    - *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
    - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
    - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
    - *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for Naval Facilities Engineering Command (NAVFAC) Remedial Project Managers* (NAVFAC, 2017)
2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act
3. This document is a project-specific SAP.
4. List dates of scoping sessions that were held:

Scoping Session	Date
Project Scoping Session (Naval Facilities Engineering Command Northwest [NAVFAC NW] Remedial Project Manager [RPM] and CH2M)	January 30, 2019
Stakeholder Project Scoping Session (Ukpeaġvik Inupiat Corporation [UIC], UMIAQ Environmental, NAVFAC NW RPM, and CH2M)	March 5, 2019

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Sampling and Analysis Plan for Investigation of PFAS in Drinking Water, Former Naval Arctic Research Laboratory Utqiaġvik (Barrow), Alaska	July 2017

SAP Worksheet #2—SAP Identifying Information (continued)

6. List organizational partners (stakeholders) and connection with lead organization:
    - NAVFAC NW – RPM
    - NAVFAC Atlantic - Chemist/Quality Assurance Officer (QAO)
    - UMIAQ Environmental – Community Stakeholder
    - Ukpeaġvik Inupiat Corporation (UIC) – Community Stakeholder
    - Alaska Department of Environmental Conservation (ADEC) Contaminated Sites Program – State Regulator
7. Lead organization:
    - Department of the Navy (Navy)
8. If any required SAP elements or required information are N/A to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion as follows:
    - Crosswalk table is excluded because all required information is provided in this SAP.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Kendra Leibman	NAVFAC NW RPM	NAVFAC NW	(360) 396-0022	kendra.leibman@navy.mil
Kenneth Bowers	NAFVAC Chemist/QAO	NAVFAC Atlantic	(757)-322-8341	kenneth.a.bowers@navy.mil
Christie Burke	Technical Services Librarian	Tuzzy Consortium Library	(907) 852-4050	P.O. Box 2130, Barrow, AK 99723
Gretchen Caudill	State RPM	ADEC	(907) 451-2370	gretchen.caudill@alaska.gov
Nagruk Harcharek	General Manager, Logistics Support	UIC	(907) 852-7503	nagruk.harcharek@uicscience.com
Cynthia Trapp	Environmental Specialist, Emergency Management	UMIAQ Environmental	(907) 677-8220	cynthia.trapp@UICUmiaq.com
Maggie Radford	Project Manager (PM)/Activity Manager (AM)	CH2M	(425)-233-3328	maggie.radford@ch2m.com
Katie Tippin	Senior Technical Consultant (STC)/SAP Reviewer	CH2M	(757) 671-6258	katie.tippin@ch2m.com
Paul Townley	Activity Quality Manager (AQM)	CH2M	(425) 233-3302	paul.townley@ch2m.com
Peter Lawson	Hydrogeology Subject Matter Expert (SME)	CH2M	(530) 229-3383	peter.lawson@ch2m.com
Ali Salter-Blanc	Task Manager (TM)	CH2M	(503) 872-4834	alexandra.salter-blanc@ch2m.com
Anita Dodson	CLEAN Program Chemist/SAP Reviewer	CH2M	(757) 671-6218	anita.dodson@ch2m.com
Juan Acaron	Project Chemist (PC)	CH2M	(352)-214-2814	juan.acaron@ch2m.com
Roni Warren	Human Health Risk Assessor	CH2M	(814) 364-2454	roni.warren@ch2m.com
To be determined (TBD)	Field Team Leader (FTL)/Site Safety Coordinator (SSC)	CH2M	TBD	TBD
TBD	Field Team Member(s)	CH2M	TBD	TBD
Jonathan Thorn	Laboratory PM	Battelle	(781) 681-5565	TBD
TBD	Data Validator	TBD	TBD	TBD

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/ Email receipt	SAP Section Reviewed	Date SAP Read
Maggie Radford	CH2M/PM, AM	(425)-233-3328			
Ali Salter-Blanc	CH2M/TM	(503) 872-4834			
Katie Tippin	CH2M/STC	(757) 671-6258			
Paul Townley	CH2M//AQM	(425) 233-3302			
Peter Lawson	CH2M/Hydrogeology SME	(530) 229-3383			
Anita Dodson	CH2M/CLEAN Program Chemist, SAP Reviewer	(757) 671-6218			
Juan Acaron	CH2M/PC	(352)-214-2814			
Roni Warren	CH2M/Human Health Risk Assessor	(814) 364-2454			
TBD	FTL/SSC	TBD			
TBD	Field Team Member(s)	TBD			
Jonathan Thorn	Battelle, Laboratory PM	(781) 681-5565			
TBD	TBD, Data Validator	TBD			

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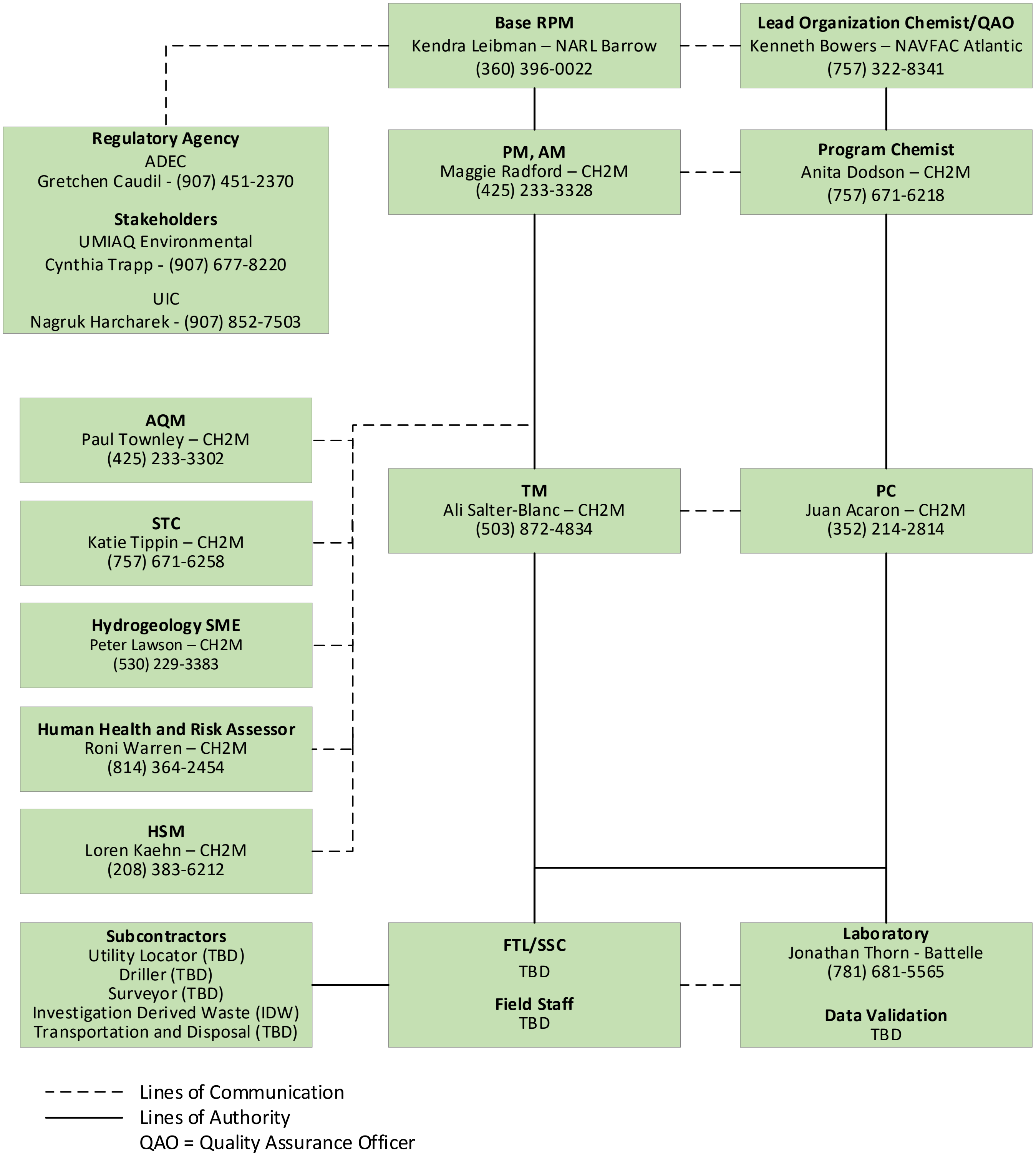
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email	Procedure
Communication with Navy (lead agency)	NAVFAC NW RPM	Kendra Leibman	kendra.leibman@navy.mil (360) 396-0022	Primary point of contact (POC) for Navy; can delegate communication to other internal or external POCs. CH2M PM or TM will notify RPM by email or telephone call within 24 hours for field changes affecting the project scope or implementation. Primary POC for Former NARL Barrow; coordinates installation-specific logistics and with other landowners potentially impacted by SI activities.
SAP reviews	NAVFAC Atlantic Chemist	Kenneth Bowers	kenneth.a.bowers@navy.mil (757)-322-8341	Provides review comments to Navy contractor on Pre-draft SAP via the Naval Installation Restoration Information System submittal. Provides overall Navy guidance via direct communication with Navy contractor chemist, as warranted.
Communication with State regulator	ADEC	Gretchen Caudill	gretchen.caudill@alaska.gov (907) 451-2370	Primary POC for ADEC; communicates directly with the Navy as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, ADEC will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with UIC	UIC	Nagruk Harcharek	nagruk.harcharek@uicscience.com (907) 852-7503	Primary POC for UIC; communicates directly with the Navy as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, UIC will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with UMIAQ	UMIAQ Environmental	Cynthia Trapp	(907) 677-8220	Primary POC for UMIAQ Environmental; communicates directly with the Navy as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, UMIAQ Environmental will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email	Procedure
Communication with Tuzzy Consortium Library	Tuzzy Consortium Library	Christie Burke	(907) 852-4050	Primary POC for Tuzzy Consortium Library to receive all copies of the SAP upon completion.
Communication regarding overall project status and implementation and primary POC with RPM and project team	CH2M AM and PM	Maggie Radford	maggie.radford@ch2m.com (425)-233-3328	Primary POC for CH2M. Interacts and coordinates activities with the RPM. Oversees project and will be informed of project status by the TM. If field changes occur, PM will communicate in-field changes to the team by email within 24 hours. All data results will be communicated to the project team following data receipt and review.
Communication regarding overall project status and implementation with PM and project team	CH2M TM	Ali Salter-Blanc	alexandra.salter-blanc@ch2m.com (503) 872-4834	Inform PM of project status. All data results will be communicated to the project team following data receipt and review.
Quality issues, and technical communications for project implementation, and data interpretation	CH2M STC	Katie Tippin	katie.tippin@ch2m.com (757) 671-6258	Primary contact regarding questions/issues encountered in the field, input on data interpretation, as needed. STC will have 24 hours to respond to technical field questions as necessary. Additionally, STC will review the data as necessary prior to Base and Navy discussions and reporting review.
Quality issues, and technical communications for project implementation, and data interpretation	CH2M Hydrogeology SME	Peter Lawson	peter.lawson@ch2m.com (530) 229-3383	Contact the Hydrogeology SME regarding questions/issues encountered relating to technical oversight for the project, as needed.
Human Health and Risk Assessment	CH2M Human Health Risk Assessor	Roni Warren	roni.warren@ch2m.com (814) 364-2454	Contact the Human Health and Risk Assessor regarding questions/issues encountered relating to investigative sampling and human health risk screening, as needed.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email	Procedure
Quality issues during and technical communications for project implementation and data interpretation	CH2M AQM	Paul Townley	paul.townley@ch2m.com (425) 233-3302	Contact the AQM regarding quality issues during project implementation. The AQM will report to the PM and the RPM.
Health and Safety (H&S)	CH2M Health and Safety Manager (HSM)	Loren Kaehn	loren.kaehn@ch2m.com (208) 383-6212	Responsible for generation of the Accident Prevention Plan (APP) and approval of the activity hazard analyses prior to the start of fieldwork. The PM will contact the HSM as needed regarding questions/issues encountered in the field.
H&S	CH2M SSC	TBD	TBD	Responsible for the adherence of team members to the site safety requirements described in the APP. Will report H&S incidents and near losses to PM as soon as possible.
Stop Work Order	CH2M PM CH2M TM CH2M FTL Field Team Members	Maggie Radford Ali Salter-Blanc TBD TBD	maggie.radford@ch2m.com (425)-233-3328 alexandra.salter-blanc@ch2m.com (503) 872-4834 TBD TBD	Any field member can immediately stop work if an unsafe condition that is immediately threatening to human health is observed. The field staff, FTL, or SSC should notify the RPM, and the CH2M PM immediately. Ultimately, the FTL and PM can stop work for a period of time. NAVFAC NW can stop work at any time.
Work plan changes in field	FTL	TBD	TBD	Documentation of deviations from the work plan will be captured in the field notes, and the PM and TM will be notified immediately. Deviations will be made only with approval from the PM.
Field changes/field progress reports	FTL	TBD	TBD	Documentation of field activities in accordance with standard operating procedures (SOPs) (**Appendix A**, **Worksheet #21**) and work plan deviations (made with the approval of STC and/or QAO) in field notes; provide daily progress reports to PM and TM.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email	Procedure
Reporting laboratory data quality issues	Battelle	Jonathan Thorn	(781) 681-5565	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported within 2 days to the PC by the laboratory.
Field and analytical corrective actions (CAs)	Program Chemist	Anita Dodson	anita.dodson@ch2m.com (757) 671-6218	Any CAs for field and analytical issues will be determined by the PC and reported to the PM within 4 hours.
Data tracking from field collection to database upload Release of analytical data	PC	Juan Acaron	juan.acaron@ch2m.com (352) 214-2814	Tracks data from sample collection through database upload daily. No analytical data can be released until validation of the data is completed and has been approved by the PC. The PC will review analytical results within 24 hours of receipt for release to the project team. The PC will inform the Navy CLEAN Program chemist who will notify the Navy QAO of any laboratory issues that would prevent the project from meeting project quality objectives (PQOs) or would cause significant delay in project schedule.
Reporting data quality issues	Data validation (DV)	TBD	TBD	The data validator reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the PC within 28 calendar days.
Field CAs	FTL and PM	FTL TBD Maggie Radford	TBD maggie.radford@ch2m.com (425)-233-3328	Field and analytical issues requiring CA will be determined by the FTL and/or PM on an as-needed basis. The PM will ensure SAP requirements are met by field staff for the duration of the project. The FTL will notify the PM via phone of any need for CA within 4 hours. The PM may notify the RPM of any field issues that would negatively affect schedule or the ability to meet project data quality objectives.

SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Kendra Leibman	NAVFAC NW RPM	NAVFAC NW	Oversees project, provides base-specific information. Primary POC for Former NARL Barrow; coordinates installation-specific logistics and with other landowners potentially impacted by SI activities.
Kenneth Bower	NAVFAC Atlantic Chemist	NAVFAC Atlantic	Reviews and approves the SAP and revisions.
Maggie Radford	AM/PM	CH2M	Coordinates with RPM, TM, and field team. Provides base-specific information. Oversees and manages project activities.
Ali Salter-Blanc	TM	CH2M	Oversees and manages project activities.
Katie Tippin	STC	CH2M	Provides senior technical support for project approach and execution. Provides QA oversight. Reviews and approves changes or revisions to the SAP.
Paul Townley	AQM	CH2M	Provides support for quality issues during and technical communications for project implementation and data interpretation.
Peter Lawson	Hydrogeology SME	CH2M	Provides subject matter technical support for project approach and execution.
Roni Warren	Human Health Risk Assessor	CH2M	Provides senior technical support for investigative sampling and human health risk screening.
Loren Kaehn	HSM	CH2M	Prepares APP and manages H&S for all field activities.
Anita Dodson	Navy Program Chemist	CH2M	Provides SAP project delivery support, reviews and approves SAPs, and performs final data evaluation and QA oversight.
Juan Acaron	PC	CH2M	Data management: Performs data evaluation and QA oversight, is the POC with laboratory and validator for analytical issues.
TBD	FTL	CH2M	Coordinates all field activities and sampling.
TBD	Field Staff	CH2M	Conducts field activities.

SAP Worksheet #7—Personnel Responsibilities Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Jonathan Thorn	Laboratory PM	Battelle	Manages samples tracking and maintains good communication with PC.
Zachary Willenberg	Laboratory QAO	Battelle	Responsible for Environmental Laboratory Accreditation Program (ELAP) accreditation letter updates, audits, CA, and checks of QA performance within the laboratory.
TBD	Data Validator	TBD	Validate laboratory data from an analytical standpoint prior to data use.

SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training beyond standard H&S training is required for this project.

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SAP Worksheet #9a—Project Scoping Session Participants Sheet

Project Name: Site Inspection (SI) for PFAS **Projected Date(s) of Sampling:** Summer 2019 **PM:** Maggie Radford			**Site Name**: Former NARL Barrow **Site Location:** Utqiaġvik, Alaska	
Date of Session: 30 January 2019 **Scoping Session Purpose:** To obtain consensus on the SI approach.				
Name	**Title/Project Role**	**Affiliation**	**Phone #**	**Email Address**
Kendra Leibman	NAVFAC NW RPM	NAVFAC NW	(360) 396-0022	kendra.leibman@navy.mil
Maggie Radford	PM/AM	CH2M	(425)-233-3328	maggie.radford@ch2m.com
Peter Lawson	Hydrogeology SME	CH2M	(530) 229-3383	peter.lawson@ch2m.com
Ali Salter-Blanc	TM	CH2M	(503) 872-4834	alexandra.salter-blanc@ch2m.com
Paige Molzahn	SAP author	CH2M	(503) 872-4740	paige.molzahn@ch2m.com

Comments

The purpose of this scoping session was to develop and agree to an initial SI approach for a PFAS SI at Former NARL Barrow. The team discussed the overall objectives of the SI, which are to determine presence/absence of PFAS at source areas identified in the PA (Navy, 2019a) and collect an additional round of surface water samples at Imikpuk Lake[2]. The team discussed the three potential PFAS source areas identified at the Airstrip Site. Release of aqueous film-forming foam (AFFF) has been documented at one location: Building 136. It was proposed that active zone groundwater samples be collected from some existing monitoring wells and from new temporary monitoring wells. Soil-only sample locations were also proposed. An area south of Potential Crash Site B may be used as a laydown yard related to other work during the proposed sampling event; this was considered in the discussion of sample locations. The team agreed on the general approach and sample locations, however it was proposed that soil samples be collected from two depths (surface and top of the capillary fringe in the unsaturated soil) at all new temporary well locations (not just groundwater). The team agreed, and it was proposed that resampling surface water at Imikpuk Lake would be advantageous to expand on previously collected data. The team agreed on five surface water samples, 22 soil samples, and 16 groundwater samples.

Action Items

- CH2M will begin preparation of the SAP.

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[2] Objectives were refined in the stakeholder scoping session on March 5, 2019. See Worksheet #9b.

SAP Worksheet #9b—Project Scoping Session Participants Sheet

Project Name: Site Inspection (SI) for PFAS **Projected Date(s) of Sampling:** Summer 2019 **PM:** Maggie Radford			**Site Name**: Former NARL Barrow **Site Location:** Utqiaġvik, Alaska	
Date of Session: 5 March 2019 **Scoping Session Purpose:** To obtain consensus on the SI approach.				
Name	**Title/Project Role**	**Affiliation**	**Phone #**	**Email Address**
John Carnahan	State Regulator (at the time)	ADEC	NA	NA
Cynthia Trapp	Project Manager	UMIAQ Environmental	(907) 677-8220	cynthia.trapp@UICUmiaq.com
Terri Mitchell	General Manager	UMIAQ Environmental	(907) 667-5208	terri.mitchell@UICUmiaq.com
Lesa Zimnawoda	Project Manager	UIC Science	NA	lesa.zimnawoda@UICScience.com
Kendra Leibman	NAVFAC NW RPM	NAVFAC NW	(360) 396-0022	kendra.leibman@navy.mil
Kenneth Bowers	Chemist	NAVFAC Atlantic	(757)-322-8341	kenneth.a.bowers@navy.mil
Maggie Radford	PM/AM	CH2M	(425)-233-3328	maggie.radford@ch2m.com
Peter Lawson	Hydrogeology SME	CH2M	(530) 229-3383	peter.lawson@ch2m.com
Ali Salter-Blanc	TM	CH2M	(503) 872-4834	alexandra.salter-blanc@ch2m.com

Comments

The purpose of this scoping session was to agree to an approach for a PFAS SI at Former NARL Barrow.
The meeting began with a discussion of some differences in areas planned for further investigation during the SI versus areas included in a draft version of the PA report reviewed by stakeholders. The SI will be consistent with the final version of the PA, which conforms to current Navy policy (Navy, 2019a).

The following objectives were presented:

- Determine if PFAS are present in groundwater and soil, and if present evaluate whether there is a potentially unacceptable risk to human health.
- Evaluate PFAS concentrations in Imikpuk Lake surface water using current analytical methods.

Proposed sample locations were shared with the team. It was proposed that Building 136 would be evaluated by sampling active zone groundwater and soil using existing monitoring wells to the extent possible. Additional temporary well and soil sample locations were also proposed. The team agreed on this approach, although noted that the precise sample locations were hard to view on the draft figure. It was shared that the SAP will include zoomed-in figures. It was proposed that Crash Site A and Crash Site B would be evaluated by sampling active zone groundwater and soil in the approximate potential locations of these crashes. Following a discussion about the locations of aircraft crashes at this airstrip not being well characterized, it was agreed that sampling groundwater potentially downgradient would also be advised in order to characterize whether releases occurred at these locations. The team agreed on this approach. It was proposed that Imikpuk Lake would be sampled to evaluate long-term concentrations. The team agreed.

SAP Worksheet #9b—Project Scoping Session Participants Sheet (continued)

A concern was raised about how sampling activities will be conducted and how wells installed for sampling would be protected since some proposed sample locations are located in high traffic areas. It was shared that the wells will be temporary and will be removed following sampling, so protection will not be necessary, and the team concurred with this approach.

A concern was raised regarding drilling methods, specifically, whether direct push technology (DPT) methods would result in samples with high turbidity and what effect this may have on analytical results for PFAS. It was agreed that these considerations would be discussed and factored into SI planning.

Action Items and Resolutions

1. NAVFAC RPM to provide the team with information regarding the Navy’s policy and plans for PFAS PAs and SI to the extent the information is approved for external distribution.

   Resolution: This action was completed.

2. CH2M will add sample locations downgradient of the potential crash sites.

   Resolution: This action was completed. An additional proposed temporary well (groundwater and soil sample) was added south of Crash Site B (anticipated to be downgradient). Because of the uncertainty in the actual crash locations, additional samples will be collected in areas anticipated to be generally downgradient of the wider area surrounding each end of the runway. The location will be near, but outside of, the proposed laydown yard for unrelated remediation activities occurring at the site during the sampling event. The location may be modified as needed based on field conditions.

3. Additional discussions regarding drilling methods will be conducted and considered in the SAP.

   Resolution: These discussions occurred, and it was determined that field teams should aim for low turbidity samples to the extent possible.

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SAP Worksheet #10—Conceptual Site Model

Former NARL Barrow is in Utqiaġvik, Alaska (**Figure 1**)**. Figure 2** presents the site layout. **Table 10-1** presents a summary of the site description and background.

Table 10-1. Site Description and Background
NARL Barrow, Utqiaġvik, Alaska

Facility Location	Former NARL Barrow is located near Utqiaġvik, Alaska on the coastal plain of Alaska's North Slope (**Figure 2**).
Facility History	Former NARL Barrow is a former Navy research facility and support camp. The primary purpose of the facility was to serve as a center for scientific study in the region. The site was in active use by the Navy from 1944 to approximately 1980 when scientific operations ceased. In 1986 most of the Navy property was transferred to UIC in a land exchange agreement (Agreement, 1986), including the former Main Camp Area, which is now known as UIC-NARL (**Figure 2**). The Navy retained the Airstrip Site and the Antenna Field Site (**Figure 2**). A Preliminary Assessment (PA) for PFAS (Navy, 2019a) was conducted at Former NARL Barrow in 2018. The PA identified three areas that are considered potential PFAS source areas, all are within the Airstrip Site: Building 136, Potential Crash Site A, and Potential Crash Site B. The PA recommended additional investigation at these three areas based on the potential for AFFF to have been stored, used, or released during Navy operations (Navy, 2019a).
Site History	**The Airstrip Site** is located adjacent to the Arctic Ocean (**Figure 2**). The Navy currently maintains ownership of the Airstrip Site. The airstrip itself is approximately 1 mile long and is situated parallel to the coastline between the Arctic Ocean and North Salt Lagoon. Three specific areas within the Airstrip Site were identified during the PA (Navy, 2019a) as potential PFAS source areas: • ***Building 136 (Navy Hangar)***. Building 136 is a steel framed, approximately 35,000 square foot Navy hangar built in 1970 (NAVFAC, 2010) (**Figure 3**). This hangar was the site of a 1970 fuel spill where AFFF was applied (NEESA, 1983; Navy, 2019a). The spill and AFFF response is described as having occurred behind the hangar (southeast of Building 136) (Navy, 2019a). A former hangar that burned down in the late 1960s or early 1970s was located within the footprint of Building 136 or potentially to the southwest (Navy, 2019a; NAVFAC, 2010). It is not known whether AFFF was or was not used in any emergency response at this location (Navy, 2019a). • ***1970 Constellation Crash***. On May 5, 1970, a Lockheed L-1049H Super Constellation undershot the runway on landing and collided with a snow bank (ASN, 2018a). Depending on the direction of landing, this crash may have occurred near either the southwest or northeast end of the runway. Possible locations of this crash (***Potential Crash Sites A and B***) are shown on **Figures 3 and 4**. The nature of the accident and any ensuing emergency response actions is unknown. It is unknown whether AFFF was or was not applied at the crash site, however based on the potential for fuel fires and the date of the crash, it is possible AFFF may have been used. • ***1978 Twin Otter Crash***. On October 13, 1978 a de Havilland DHC-6 Twin Otter stalled and crashed short of the runway (BAAA, 2018; ASN, 2018b). As with the 1970 Constellation crash, depending on the direction of landing, this crash may have occurred near either ***Potential Crash Site A or B*** (**Figures 3 and 4**). The nature of the accident and any ensuing emergency response actions is unknown. It is unknown whether AFFF was or was not applied at the crash site; however, based on the potential for fuel fires and the date of the crash, it is possible AFFF may have been used.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Description and Background
NARL Barrow, Utqiaġvik, Alaska

		Imikpuk Lake is located adjacent to the Airstrip and Antenna Field Sites (**Figure 5**). The lake historically provided drinking water for Former NARL Barrow and more recently was used seasonally by hunters and fishers as a source of drinking water. PFAS was detected in surface water samples collected at Imikpuk Lake in July 2017. Concentrations of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) ranged from 143.6 to 262.3 parts per trillion. Exposure to humans through ingestion of Imikpuk Lake water has been addressed by the following actions performed by the Navy (in order of occurrence): (1) a public meeting to share the results with the community, (2) installation of signs around the lake warning the community not to drink or cook with the water, and (3) meetings with local leadership and health officials regarding the PFAS results in the lake. The Navy will continue to communicate the status of the PFAS investigation in and near Imikpuk Lake to the community via public meetings, such as the Restoration Advisory Board.
Current Use		Former NARL Barrow is unoccupied by the Navy, except for ongoing remedial efforts, primarily related to petroleum hydrocarbon impacts. Access to Navy property is not restricted. Facilities at UIC-NARL include the Barrow Arctic Research Center, Iḷisaġvik College, permanent and temporary housing, and various staging and storage areas. The community uses the airstrip runway during spring and fall whaling. Additionally, local businesses use the runway for staging during barging operations.
Site Conditions	**Physical Characteristics**	The local landscape consists of flat tundra with abundant lakes. Regional climate is impacted by the northern latitude and proximity to the ocean. Winters are long and cold, summers short and cool, and wind is persistent (USGS, 1994a; USGS, 1994b). Average monthly temperatures in Utqiaġvik range from a minimum of -5.4 degrees Fahrenheit (°F) in November to a high of 45.8 °F in July (WRCC, 2018). The average total annual precipitation is 4.67 inches, average total annual snowfall is 32.5 inches, and average maximum snow depth is 11 inches (WRCC, 2018a).
	Geology and Hydrogeology	The geology at Former NARL Barrow consists of unconsolidated sediments overlying Cretaceous age bedrock (USGS, 1994b). The geologic sequence is composed of (from deepest to shallowest) the Topogorak Formation, a marine-clay shale sequence extending from 450 feet to at least 1,400 feet below ground surface (bgs); the Grandstand Formation, a claystone and sandstone sequence extending from about 50 to 450 feet bgs; and the Gubik Formation, an unconsolidated marine and nonmarine gravel, sand, slit, and clay sequence (URS Greiner, 2000). At Former NARL Barrow, the Gubik Formation extends from the ground surface to about 50 feet bgs (URS Greiner, 2000). Coarse sand and gravel are the predominant soil types and can reach a thickness of approximately 65 feet (URS Greiner, 2000). Overlying the gravel deposits are organic and clay or loam deposits of the tundra meadows. Some finer deposits of silt, clay, and peat occur in drained lake basins and along beach ridges. Where most of the buildings have been constructed, the underlying soil consists of coarse-grained deposits. Newer buildings, toward the southeast of the Main Camp Area were constructed on top of sand and gravel fill that was placed over the tundra. The fill deposits are typically 2 to 4 feet thick but may be up to 10 feet thick in places (URS Greiner, 2000). Permafrost is continuous in the region and acts as a confining layer (USGS, 1994a). Soil at Former NARL Barrow are frozen for the majority of the year. During the summer, between late June and late October, the upper layers of the permafrost slowly thaw, producing what is termed the “active zone”. The maximum thawed depth of the active zone is reached by August or September and varies by year (NSB, 2015; USGS, 1994b). Perturbations to overlying vegetation and organic-rich soil, which are insulating, result in increased thaw depths (NSB, 2015; USGS, 1994b). At Former NARL Barrow, the thaw depth is typically less than about 1.5 feet in undisturbed areas and deeper in unvegetated areas (USGS, 1994b and 1995; URS Geiner, 2000). Deeper depths to permafrost (“thaw bulbs”) are observed under heated buildings, other artificial structures, and lakes. Conversely, unheated structures and raised heated structures that block sunlight reduce the depth to permafrost (USGS, 1995). The depth to permafrost is also influenced by topography and can be shallower under elevated roads (USGS, 1994a).

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Description and Background
NARL Barrow, Utqiaġvik, Alaska

		Groundwater at Former NARL Barrow is seasonal and exists in the active zone during the thaw season, between June and September. Because of the semi-confining nature of permafrost, there is little movement of groundwater from the active zone above the permafrost and groundwater confined beneath the permafrost. As such, there is limited to no recharge from the active zone to confined groundwater beneath the permafrost at Former NARL Barrow. Infiltration of precipitation and runoff is limited to the active zone and is prevented from reaching deeper groundwater (NEESA, 1983). The direction of groundwater flow (past and current) at the Airstrip Site is not well defined. Previous studies of local hydrogeology have found that the direction of groundwater flow in the local active zone is highly variable during the thaw season and can change from year to year because of the shallow depth of the active layer, changes to the active layer as the ground thaws, and ice-wedge polygon formation[3] (USGS, 1994b). Due to these dynamic arctic phenomena, distinct groundwater flow regimes occur at scales ranging from centimeters to tens of meters rather than at regional scales (USGS, 1994b). While groundwater flow at the Airstrip Site is not well defined, generally, shallow groundwater flow direction within the active zone typically follows topography at the Former NARL Barrow, because, in general, the permafrost surface mimics the land surface (USGS, 1994a; USGS, 1994b). Hydrological and tracer dye studies conducted in 2015 and 2016 (ERDC-CRREL, 2016; 2017) indicate that groundwater at the Airstrip Site generally flows toward Imikpuk Lake and North Salt Lagoon (**Figure 3**). Active-zone groundwater at Former NARL Barrow is anticipated to generally flow towards the Arctic Ocean, Imikpuk Lake, or nearby lagoons with deviations related to the depths of the active zone (depth to permafrost). Surface water drainage near the Airstrip Site is complex, variable, and typically limited to summer. • ***Building 136 (Navy Hangar)***. Based on observations from the early 1990s, Building 136 is situated on a surface water drainage divide that bisects the building, with the area southwest of the building draining to Imikpuk Lake and the area northeast draining to North Salt Lagoon (**Figure 3**). Two depressions near Building 136 may also impact surface water drainage: the North Depression northeast of Building 136 and the South Depression southeast of Building 136. • ***Potential Crash Site A***. Surface water near Potential Crash Site A may drain towards either Imikpuk Lake (0.06 mile south) or the Arctic Ocean (0.09 mile northwest). There is significant uncertainty in the actual groundwater flow direction near Potential Crash Site A. There is a permafrost ridge potentially located along Stevenson Road (**Figure 3**) that may indicate groundwater flows towards Imikpuk Lake. • ***Potential Crash Site B***. Surface water near Potential Crash Site B may drain towards either North Salt Lagoon (0.15 mile south) or the Arctic Ocean (0.05 mile northwest). There is significant uncertainty in the actual groundwater flow direction near Potential Crash Site B. There is a permafrost ridge potentially located along Stevenson Road (**Figure 3**) that may indicate groundwater flows towards North Salt Lagoon.

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[3] Ice-wedge polygons are formed as soil cracks in response to low temperatures in a characteristic polygon pattern that covers the tundra. These cracks fill with water during the warmer months. As the water freezes during colder months it forms ice wedges. The cycle of thaw and freeze causes these cracks and ice wedges to become larger over time.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Description and Background
NARL Barrow, Utqiaġvik, Alaska

Drinking Water Source Evaluation	Surface water is the source of potable water near Former NARL Barrow, as groundwater is not a viable source of drinking water. The City of Utqiaġvik obtains its drinking water from Isatkoak Lagoon (**Figure 2**), specifically, the Lower Isatkoak Lagoon Reservoir (Isatkoak Reservior); this water is then treated with micro- and nano-filtration (NSB, 2015). Barrow Utilities and Electric Cooperative, Inc. tested water from Isatkoak Reservoir and post-treatment water (after filtration) for PFAS in August 2017. The water from Isatkoak Reservoir tested above the USEPA lifetime health advisory for PFOS and PFOA, but the post-treated water results were non-detect. (Alaska DHSS, 2017; Navy, 2019a). Navy-owned property at Former NARL Barrow is no longer in use and there is no regular need for potable water. Nearby UIC-owned buildings are supplied potable water from the City of Utkiaġvik. Imikpuk Lake used to be the primary drinking water source for the UIC-NARL facility. In addition, water from the lake was used seasonally by hunters and fishers as a source of drinking water until the Navy identified PFOA and PFOS above the USEPA's lifetime health advisory. Exposure to humans through ingestion of Imikpuk Lake water has been addressed by the following actions performed by the Navy (in order of occurrence): (1) a public meeting to share the results with the community, (2) installation of signs around the lake warning the community not to drink or cook with the water, and (3) meetings with local leadership and health officials regarding the PFAS results in the lake. The Navy continues to communicate the status of the PFAS investigation in and near Imikpuk Lake to the community via public meetings, such as the Restoration Advisory Board.
Potential Source Areas	The following areas were identified as potential PFAS source areas during the PA (Navy, 2019a) (**Figures 3 and 4**): • Airstrip Site: Building 136 • Airstrip Site: Potential Crash Site A • Airstrip Site: Potential Crash Site B
Chemicals of Potential Concern (COPCs)	• PFOA • PFOS • Perfluorobutanesulfonic acid (PFBS) • N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) • N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) • Perfluorodecanoic acid (PFDA) • Perfluorododecanoic acid (PFDoA) • Perfluoroheptanoic acid (PFDpA) • Perfluorohexanesulfonic acid (PFHxS) • Perfluorohexoanoic acid (PFHxA) • Perfluorononanoic acid (PFNA) • Perfluorotetradecanoic acid (PFTA) • Perfluorotridecanoic acid (PFTrDA) • Perfluoroundecanoic acid (PFUnA) • 4,8-dioxa-3H-perfluorononanoic acid (ADONA) • 9-chlorohexadecafluoro-3-oxanone-1-sulfonic • 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS) • Hexafluoropropylene oxide dimer acid

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Description and Background
NARL Barrow, Utqiaġvik, Alaska

Migration Pathways	• Direct release of PFAS to surface and/or subsurface soil • Leaching of PFAS currently and/or historically present in soil to groundwater active layer • Transport via infiltration to and advection in groundwater • Transport to surface water via overland flow of snowmelt
Potential Receptors/ Exposure Routes	• Groundwater: Groundwater at and near Former NARL Barrow is not used as a drinking water source. Construction workers could be exposed to PFAS in groundwater through dermal contact with groundwater during excavation activities. • Soil and Air: Nearby residents, construction workers, maintenance/industrial workers, and visitors could be exposed to PFAS in soil through incidental ingestion of and dermal contact with surface and subsurface soil or respiration of surface soil dust in the air. Humans could be indirectly exposed to PFAS in soil through the consumption of terrestrial organisms. • Surface Water: The use of water from Imikpuk Lake for drinking and cooking water has been addressed. Nearby residents, construction workers, maintenance/industrial workers, and visitors could be exposed to PFAS in surface water through dermal contact with surface water.

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SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Problem Statement and Objectives

It is unknown whether PFAS is present in groundwater or soil at the Former NARL Barrow. PFAS were detected in Imikpuk Lake in 2017 (Navy, 2018). The objectives of the SI are to:

- Determine if PFAS are present in groundwater and soil, and if present evaluate whether there is a potentially unacceptable risk to human health.
- Evaluate PFAS concentrations in Imikpuk Lake surface water using current analytical methods.

What are the environmental questions being answered?

1. ***Are PFAS present in groundwater and soil near potential PFAS release areas identified at Former NARL Barrow?***

   Groundwater samples will be collected from 16 locations, eight from newly installed temporary monitoring wells and eight at existing monitoring wells, if determined to be viable for sampling. Soil samples will be collected at two depths (at the surface and at the top of the capillary fringe in the unsaturated soil) at eleven locations. All samples will be analyzed for PFAS by LC-MS/MS compliant with Quality Systems Manual (QSM) 5.1.1 Table B-15 or the most recent version of the QSM for which the laboratory is Department of Defense (DoD) ELAP-certified at the time of sampling. Samples will be analyzed for the 18 PFAS compounds listed in USEPA Method 537.1. **Figures 3** and **4** present the sample locations. The samples and rationale are outlined in **Worksheets #17** and **#18**.

2. ***If PFAS are detected in groundwater and soil, is there a potentially unacceptable risk to human health?***

   Results will be compared to the project action limits (PALs) (**Worksheet #15**) to determine whether there is potentially unacceptable risk to human health. Comparison to the PALs will be limited to compounds for which screening levels exist; data for the remaining compounds will be archived for future use.

3. ***What are the current concentrations of PFAS in Imikpuk Lake?***

   Surface water samples will be collected from five locations in Imikpuk Lake. All samples will be analyzed for PFAS[4] by LC-MS/MS Compliant with QSM 5.1.1 Table B-15 or the most recent version of the QSM for which the laboratory is DoD ELAP-certified at the time of sampling. **Figure 5** presents the surface water sample locations. The samples and rationale are outlined in **Worksheets #17** and **#18**. The purpose of sampling surface water is to obtain a new baseline for surface water data using LC-MS/MS Compliant with QSM 5.1.1 Table B-15.

4. ***What are the Project Action Limits (PALs)?***

   Groundwater

   The PALs for groundwater not used as a drinking water supply are ADEC groundwater cleanup levels (ADEC, 2019) and residential tapwater values determined using the USEPA Regional Screening Levels (RSL) based on a hazard quotient (HQ) = 0.1, presented in **Worksheet #15**.

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[4] While surface water samples from Imikpuk Lake were analyzed as drinking water samples in 2017, the Navy has implemented advisories such that surface water from Imikpuk lake is no longer a drinking or cooking water source, and the Navy considers samples collected from Imikpuk Lake to be surface water samples.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Soil

The PALs for soil are the ADEC soil cleanup levels for the migration to groundwater exposure pathway (ADEC, 2019) and residential soil values determined using the USEPA RSL calculator based on an HQ = 0.1, presented in **Worksheet #15**.

As shown in **Worksheet #15-3**, sometimes the laboratory or analytical method cannot achieve a limit of detection (LOD) less than the PAL. This is the case for soil analysis for PFOA:

- For perfluorooctanoic acid (PFOA), although the LOD is not less than the PAL, the detection limit (DL) is less than the PAL and therefore if present in soil at or greater than the PAL, it should be detected and reported by the laboratory. These results are reported as J-qualified detected concentrations that are less than the Limit of Quantitation (LOQ). Therefore, this LOD versus PAL exceedance is not expected to have any negative impact on the DQOs for this project.
- For all data (including when LODs are greater than PALs), nondetects will not be considered PAL exceedances.

Surface Water

There are no PALs for surface water not used as a drinking water source.

5. ***For what will the data be used?***

The data will be used to answer the environmental questions previously stated for this SI.

6. ***What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?***

The data to be collected during this investigation will include the following:

- Laboratory analytical results for PFAS in groundwater, surface water, and soil samples
  - The specific target analytes and PALs are included in **Worksheet #15**.
- Water quality parameters (WQPs), including pH, conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), temperature, and turbidity will be collected during groundwater sample collection.
- Surveyed coordinates for sample locations, with the exception of surface water samples, which will be collected using a handheld GPS device.

9. ***Are there any special data quality needs, field or laboratory, to support environmental decisions?***

Offsite laboratory analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments with respect to the aforementioned project objectives. Additionally, laboratory-specific LODs will be less than the lifetime health advisory level for PFOA and PFOS of 70 nanograms per liter or 0.07 micrograms per liter (µg/L) (for the sum of the two constituents). QC sample requirements are detailed in **Worksheet #20**. For action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheets #24** and **#28** for laboratory QC samples. These MPC are consistent with the DoD QSM (DoD, 2017) as applicable and laboratory in-house limits where the QSM does not apply.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

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

- All sampling locations are shown on **Figures 3 through 5** and are based on the rationale presented in **Worksheet #17** and in accordance with the project schedule outlined in **Worksheet #16**.
- The data will be collected following the methodologies in **Worksheet #14** and the SOPs presented in **Worksheet #21**.

11. List the PQOs in the form of if/then qualitative and quantitative statements.

Groundwater

- If PFAS are not detected in active zone groundwater, then no further action is warranted for PFAS in groundwater at this time.
- If concentrations are detected but do not exceed the PALs, then the need for future sampling or installation of permanent monitoring wells for long-term monitoring of PFAS will be evaluated with the Navy and stakeholder team.
- If concentrations exceed the PALs, additional monitoring wells will be installed, and additional groundwater samples will be collected and analyzed for PFAS to evaluate extent of PFAS impacts to groundwater. Monitoring well installation step-outs will continue until PFAS is not detected.
- If the results indicate unacceptable human health risk upon initial screening, the team will meet with the stakeholders to evaluate path forward, which could include a source removal action or implementation of land use controls.

Soil

- If PFAS are not detected in soil, then no further action is warranted for PFAS in soil at this time.
- If PFAS are detected in soil but do not exceed the PALs for the migration to groundwater exposure pathway, then no further action is warranted for PFAS in soil at this time.
- If concentrations exceed the PALs for the migration to groundwater exposure pathway, then additional soil samples will be collected and analyzed for PFAS to evaluate nature and extent of PFAS impacts to soil. Soil sample step-outs will continue until PFAS is not detected above PALs.[5]
- If the results indicate unacceptable human health risk upon initial screening, the team will meet with stakeholders to evaluate path forward.

Surface Water

- The presence of PFOS and PFOA in Imikpuk Lake has already been established (Navy, 2018). Once current concentrations of all PFAS in the current analytical method are established as a baseline, then future long-term monitoring will be evaluated with the Navy and stakeholder team.

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[5] This PQO will apply regardless of PFAS concentrations measured in groundwater, because the PAL for soil addresses the potential for future migration of PFAS to groundwater and therefore is not necessarily directly related to current groundwater concentrations.

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SAP Worksheet #12-1—Field Quality Control Samples

(Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP) Manual Section 2.6.2)

Matrix: Groundwater, Surface Water
Analytical Group: PFAS
Analytical Method: LC-MS/MS Compliant with QSM 5.1.1 Table B-15

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate (FD)	PFAS	One per 10 normal field samples.	Precision	Relative percent difference (RPD) < 25% for waters
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)		One per 20 normal field samples.	Accuracy/Precision	See **Worksheet #28**
EB		One per day for decontaminated equipment. One per event for disposable equipment.	Contamination	No analytes detected > ½ LOQ or > 1/10 sample concentration, whichever is greater
FB		One per site.	Bias/Contamination	No analytes detected > ½ LOQ or > 1/10 sample concentration, whichever is greater
Temperature Blank		One per cooler.	Representativeness	≤ 10 degrees Celsius (°C) at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen

SAP Worksheet #12-2—Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

Matrix: Surface Soil, Subsurface Soil
Analytical Group: PFAS
Analytical Method: LC-MS/MS Compliant with QSM 5.1.1 Table B-15

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
FD	PFAS	One per 10 normal field samples.	Precision	%RPD < 35% for soils
MS/MSD		One per 20 normal field samples.	Accuracy/Precision	See **Worksheet #28**
EB		One per day for decontaminated equipment. One per event for disposable equipment.	Contamination	No analytes detected > ½ LOQ or > 1/10 sample concentration, whichever is greater
FB		One per site.	Bias/Contamination	No analytes detected > ½ LOQ or > 1/10 sample concentration, whichever is greater
Temperature Blank		One per cooler.	Representativeness	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Surface water data from Imikpuk Lake	Navy. Results of Investigation of Per- and Polyfluoroalkyl Substances in Drinking Water Former Naval Arctic Research Laboratory Utqiaġvik (Barrow), Alaska. March 2018.	Navy, surface water data, July 2017	Historical sample locations were considered in the determination of proposed sample locations. Historical data will be combined with the surface water data collected at Imikpuk Lake during this investigation to make future recommendations regarding use of Imikpuk Lake.	No limitations on final validated data.

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SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities at Former NARL Barrow is detailed herein. The SOPs tabulated on **Worksheet #21** and provided in **Appendix A** address the protocols to be used for the SI. Any modification to the work approach will be documented in the field notes.

Pre-sampling Tasks

- Subcontractor procurement
  - Analytical laboratory
  - Data Validator
  - Utility locator
  - Driller
  - Surveyor
  - Investigation-derived waste (IDW) transportation and disposal contractor
- Fieldwork scheduling

Sampling Tasks

Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M field team mobilizes for field activities. Field notes will be captured on loose leaf notebook paper and forms each day. A location for the placement of IDW will be determined, and IDW will be stored in a manner consistent with the SOP presented in **Appendix A** and the Waste Management Plan and Environmental Protection Plan (WMP-EPP, Navy, 2019b). Before beginning any phase of work, CH2M and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the APP (Navy, 2019c).

Utility Clearance

Utilities will be cleared before beginning intrusive activities in accordance with the SOP listed in **Worksheet #21** and provided in **Appendix A**. CH2M will coordinate utility clearance. A third-party utility clearance subcontractor will be procured by CH2M to clearly mark subsurface utilities near the proposed temporary monitoring well and soil sample locations. Any proposed temporary monitoring well or soil boring locations within 5 feet of utility locations will be relocated to avoid impact to utilities. If a temporary monitoring well or soil boring location needs to be relocated, the field team will use its best judgment in relocating the well. The field team will notify the CH2M PM and Navy RPM of its new location and complete a Field Change Request Form.

Temporary Monitoring Well Installation

All temporary monitoring wells will be installed in accordance with the State of Alaska well construction standards by an Alaska-licensed driller. Temporary monitoring wells will be installed using direct push technology drilling techniques in accordance with the SOP listed in **Worksheet #21** and provided in **Appendix A**.

Eight temporary monitoring wells will be constructed with a 2-inch inside-diameter Schedule 40 polyvinyl chloride (PVC) riser connected to a 2-inch inside-diameter factory slotted (0.010-inch or 10-slot), PVC screen with a bottom cap. All drilling and well construction materials will be free of fluorine. No fluorine-containing greases, bentonite, or other materials will be used.

SAP Worksheet #14—Summary of Project Tasks (continued)

The temporary monitoring wells will be screened across first encountered groundwater. The top of the 1-foot screen will be set just above the water table. A sand filter pack (native sands) will be placed around the annular space of the well screen from the bottom of the boring and extend to a minimum height of 2 feet above the top of the well screen, if feasible. If the depth to active zone groundwater is too shallow to accommodate a full 2 feet of sand above the top of the screen and still provide for an adequate seal extending to ground surface (i.e., if the well is less than 5 feet in total depth), the filter pack will extend to a minimum of 1 to 2 inches above the of the well screen after settling. A bentonite seal, at least 1 foot thick, if feasible, will be placed above the top of the sand pack. The locations of the proposed temporary monitoring wells are provided on **Figures 3 and 4**.

Well Development

Upon completion of the well installation, each temporary monitoring well will be developed by the drilling subcontractor using a combination of surging and pumping throughout the well screen. During monitoring well development, the CH2M field crew will measure WQPs, including pH, temperature, conductivity, and turbidity with a water quality meter. Development will continue until turbidity is below 10 nephelometric turbidity units (NTUs) or at least three well volumes removed. Under ideal conditions, discharge is clear as possible and parameters are stabilized (temperature, dissolved oxygen, and specific conductance within +/- 10%, pH within +/- 0.5 units, oxidation/reduction potential within 10 millivolts).Surge blocks and pumps with Teflon parts will be avoided during development.

Development information, including turbidity, pH, specific conductivity, temperature, and gallons of water removed will be recorded as field notes on loose leaf notebook paper. In addition, the water quality meter will be calibrated daily (at a minimum) and the calibration documented in the field notes.

Newly-installed temporary monitoring wells will be developed in accordance with SOP listed in **Worksheet #21** and provided in **Appendix A**.

Groundwater Sampling

Applicable field notes should be filled out completely each day on loose leaf paper and applicable forms.

Prior to groundwater level measuring and sampling, any existing monitoring wells will be identified and evaluated to determine whether the wells are viable for sample collection. Information such as general location, total well depth (if attainable) and general well condition will be captured in the field notes. The FTL will determine whether a sample can be collected from the monitoring well (for example, if the well contains dedicated tubing/pump, a sample will NOT be collected from the well).

Groundwater Level Measurements

Before groundwater sampling, and at least 24 hours after well installation and development has been completed, the depth to groundwater, to the nearest 0.01 foot, will be measured from all monitoring wells in accordance with SOP listed in **Worksheet #21** and provided in **Appendix A**. Measurements will be made from the top of the PVC riser, which will be notched. If during removal of the locking well cap, the well demonstrates signs of being under pressure (escaping air sounds or cap being pushed off by pressure), then the depth to water in that monitoring

SAP Worksheet #14—Summary of Project Tasks (continued)

well will be measured repeatedly over a period of several minutes to determine whether the water level is still changing. If over several minutes the water level continues to change, the water level in that well will not be measured for a period of 1 hour to allow the water level to equilibrate. Depth to water and time measured will be recorded in the field notes.

Collection of Groundwater Samples

Groundwater samples will be collected from eight newly installed temporary monitoring wells and eight existing monitoring wells, if determined to be viable for sampling (**Figures 3 and 4**) in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A.** If conditions of existing monitoring wells are determined not viable team will evaluate installation of new wells within the area needed to achieve the SAP objectives.

For groundwater samples collected under low flow/low stress conditions, the peristaltic pump intake will be placed at the middle of the well screen interval. Depth to water readings and WQPs will be measured and recorded (approximately every 5 minutes) before sampling using a depth-to-water meter and water quality meter, calibrated daily (at a minimum). The pump intake will be placed near the bottom of well screen, due to extremely limited saturated thickness. If excessive drawdown occurs at very low flow rates, then the well will be purged dry and sampled once recovered to the extent where a sample can be obtained. Sampling will begin when three well volumes have been purged or when minimal water level drawdown requirements are met and WQPs have stabilized for three consecutive readings, as follows:

- Temperature within 3 percent
- pH within 0.1 pH units
- Conductivity within 3 percent
- DO within 10 percent for values greater than 0.5 milligram per liter (mg/L), if 3 DO values are less than 0.5 mg/L, consider the values stabilized
- ORP within 10 millivolts
- Turbidity measurements are less than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- Depth to water, WQPs, and total well depth measurements will be recorded on Groundwater Sampling Data Sheets.

Soil Sampling

Soil samples will be collected at the surface (0 to 6 inches bgs) and top of the capillary fringe in the unsaturated soil (to be determined in the field) at each newly installed temporary monitoring well location (eight) and three standalone soil borings near Building 136 (**Figures 3 and 4**) in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.

Soil samples will be collected using a sampling tube driven to the desired sampling depth using a truck-mounted hydraulic percussion hammer. The sampling tube will be cut open using a specific knife designed to slice the acetate liners. Soil will be collected in the desired sample containers using reusable decontaminated equipment or single-use dedicated equipment. Decontamination will occur is accordance with the SOPs listed in **Worksheet #21** and provided in **Appendix A**. The three standalone soil borings will be backfilled with grout or bentonite and the surface will be repaired as required.

SAP Worksheet #14—Summary of Project Tasks (continued)

Surface Water Sampling

Collection of Surface Water Samples

Surface water will be collected from five locations (**Figure 5**) in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A.**

Surface water samples will be collected manually by submerging a clean stainless-steel or polypropylene container into the water body. The sample bottle will be gently submerged with the mouth pointed toward the surface and the bottle tilted slightly. Bubbles and floating materials should be prevented from entering the bottle.

Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use in accordance with SOP listed in **Worksheet #21** and provided in **Appendix A**. Non-disposable equipment will be decontaminated using the following solutions in this order:

1. Distilled water (laboratory certified PFAS-free) and Liquinox solution
2. Distilled water (laboratory certified PFAS-free) rinse 10 percent isopropanol and distilled water solution (laboratory certified PFAS-free) and air-dried
3. Laboratory grade deionized water (laboratory certified PFAS-free)

   Nitric acid solution will not be used in the decontamination processes due to potential H&S concerns and because an acid solution can leach metals from metallic equipment. Decontamination fluids will be contained in a 55-gallon drum and managed as described in the WMP-EPP (Navy, 2019b).

Surveying

Groundwater, surface water, and soil sample locations will be horizontally and vertically located by an Alaska-licensed surveyor in accordance with SOP listed in **Worksheet #21** and provided in **Appendix A**. The surveyor will provide coordinates of all horizontal points X, Y, to the nearest 0.5 foot and vertical point Z to the nearest 0.01 foot (0.1 foot for unpaved ground surface elevations).

Temporary Monitoring Well Abandonment

Following the completion of the sampling event, temporary monitoring wells will be removed in accordance with the SOP referenced in **Worksheet #21** and included in **Appendix A.**

Investigation-derived Waste Management

IDW is expected to consist of drill cuttings from the soil borings generated during temporary monitoring well installations, purge water from well development and groundwater sampling, and decontamination fluids. Aqueous IDW and solid IDW will be stored in separate 55-gallon drums. IDW will be managed in accordance with the SOP referenced in **Worksheet #21** and included in **Appendix A** and the WMP-EPP (Navy 2019b). Disposal requirements will follow the *Interim Per-and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers* (NAVFAC, 2017) from September 2017. Disposable equipment, including personal protective equipment, will be disposed of with normal facility trash.

SAP Worksheet #14—Summary of Project Tasks (continued)

Sample Shipment

All analytical samples and equipment will be transported to Anchorage and shipped by FedEx. All samples will be shipped in accordance with the SOP referenced in **Worksheet #21** and included in **Appendix A**.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24** and **#25**). The laboratory will analyze aqueous and solid samples for PFAS as shown on **Worksheets # 15** and **#18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23** and will be provided upon request.

Analyses will be conducted by Battelle as listed in **Worksheet #30**.

Data Validation, Review, and Management Tasks

The PC is responsible for data tracking and storage. Definitive analytical laboratory data will be reported as a Stage 4 data package including COAs for traceability and 10 percent of the data will undergo Stage 4 validation before use by the Navy. All WQP data will be checked by the PC before use. The field team leader is responsible for ensuring the photoionization detector (PID) and WQP meter are calibrated prior to sample collection. See **Worksheet #36** for more information. All analytical data will be loaded into the Naval Installation Restoration Information Solution database.

Procedures for Recording and Correcting Data

- Field data will be recorded on loose leaf notebook paper
- Project Assessment/Audit: **Worksheets #31** and **#32**
- Data Validation: **Worksheets #35** and **#36**
- Data Usability Assessment: **Worksheet #37**

Analytical and Validation Tasks

The analytical laboratory will process and prepare samples for analyses and will analyze all samples per **Worksheets #19** and **#23**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23**.

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. See **Worksheets #24** and **#25**.
- The laboratory will process and prepare samples for analysis.
- All analytical data to be used for chemical characterization of the site, excluding IDW characterization, will be validated. See **Worksheet #36** for more details.
- A data usability assessment will be performed on the SI data. See **Worksheet #37** for more details.

Demobilization

Full demobilization will occur when the project is complete, and appropriate QA/QC checks have been performed. Personnel no longer needed during the course of field operations may be demobilized before the final project completion date. The following will occur before demobilization:

SAP Worksheet #14—Summary of Project Tasks (continued)

- Chain-of-custody records will be reviewed to verify that all samples were collected as planned and submitted for appropriate analyses.
- Restoration of the site to an appropriate level (for example, repair of deep ruts from drilling equipment) will be verified by the CH2M FTL.
- All equipment will be inspected, packaged, and shipped to the appropriate location.

SAP Worksheet #15-1—Reference Limits and Evaluation Table

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.1.1 Table B-15)
Matrix: Groundwater

Analyte	CAS No.	Lifetime Health Advisory	RSLs Tapwater (HQ = 0.1), May 2019 (µg/l)	ADEC Groundwater cleanup levels (µg/l)	Project Action Level[a] (µg/l)	Project QL Goal[a,b] (µg/l)	Laboratory Specific Limits (µg/l)			Accuracy Control Limit (%R)[c]		Precision Control Limit (% RPD)
							LOQs	Limit of Detection (LODs)	Detection Limits (DLs)			
PFOS	1763-23-1	0.07	0.040	0.40	0.040	0.02	0.005	0.0005	0.00019	40	144	30
PFOA	335-67-1	0.07	0.040	0.40	0.040	0.02	0.005	0.0005	0.00018	49	141	30
PFBS	375-73-5	NC[d]	40	NC[d]	40	20	0.005	0.0005	0.00013	56	134	30
NEtFOSAA	2991-50-6	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.001	0.00049	51	131	30
NMeFOSAA	2355-31-9	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.002	0.00056	50	146	30
PFDA	335-76-2	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0005	0.00016	59	135	30
PFDoA	307-55-1	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0005	0.00018	75	131	30
PFHpA	375-85-9	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0005	0.00016	48	136	30
PFHxS	355-46-4	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0004	0.00011	52	128	30
PFHxA	307-24-4	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0005	0.00019	51	137	30
PFNA	375-95-1	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.001	0.00026	58	122	30
PFTeDA	376-06-7	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.001	0.00025	42	158	30
PFTrDA	72629-94-8	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0005	0.00015	42	148	30
PFUnA	2058-94-8	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.001	0.00029	64	134	30
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0004	0.0002	70	130	30
ADONA	919005-14-4	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0004	0.00018	70	130	30
11Cl-PF3OUdS	763051-92-9	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0004	0.00018	70	130	30
9-chlorohexadecafluoro-3-oxanone-1-sulfonic (9Cl-PF3ONS)	756426-58-1	NC[d]	NC[d]	NC[d]	NC[d]	0.005	0.005	0.0004	0.0001	70	130	30

Notes:

[a] While the lifetime health advisories for PFOS and PFOA (0.070 µg/L) are not PALs for this project because there is no current drinking water exposure for groundwater, it is included in this table to ensure the laboratory can meet the most conservative screening level available in the event land use changes or additional information becomes available, making this level relevant to project decisions. Refer to **Worksheets #10 and 11** for a detailed discussion on development of PALs.

[b] The Project QL Goal is 1/2 the PAL, the PAL, or the Laboratory Specific LOQ, as applicable.

[c] In-house laboratory limits is the basis for laboratory control sample (LCS) and MS/MSD limits.

[d] NC: No criteria for this compound.

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.1.1 Table B-15)
Matrix: Surface water

Analyte	CAS No.	Project QL Goal[a,b] (µg/l)	Laboratory Specific Limits (µg/l)			Accuracy Control Limit (%R)		Precision Control Limit (% RPD)
			LOQs	Limit of Detection (LODs)	Detection Limits (DLs)			
PFOS	1763-23-1	0.005	0.005	0.0005	0.00019	40	144	30
PFOA	335-67-1	0.005	0.005	0.0005	0.00018	49	141	30
PFBS	375-73-5	0.005	0.005	0.0005	0.00013	56	134	30
NEtFOSAA	2991-50-6	0.005	0.005	0.001	0.00049	51	131	30
NMeFOSAA	2355-31-9	0.005	0.005	0.002	0.00056	50	146	30
PFDA	335-76-2	0.005	0.005	0.0005	0.00016	59	135	30
PFDoA	307-55-1	0.005	0.005	0.0005	0.00018	75	131	30
PFHpA	375-85-9	0.005	0.005	0.0005	0.00016	48	136	30
PFHxS	355-46-4	0.005	0.005	0.0004	0.00011	52	128	30
PFHxA	307-24-4	0.005	0.005	0.0005	0.00019	51	137	30
PFNA	375-95-1	0.005	0.005	0.001	0.00026	58	122	30
PFTeDA	376-06-7	0.005	0.005	0.001	0.00025	42	158	30
PFTrDA	72629-94-8	0.005	0.005	0.0005	0.00015	42	148	30
PFUnA	2058-94-8	0.005	0.005	0.001	0.00029	64	134	30
HFPO-DA	13252-13-6	0.005	0.005	0.0004	0.0002	70	130	30
ADONA	919005-14-4	0.005	0.005	0.0004	0.00018	70	130	30
11Cl-PF3OUdS	763051-92-9	0.005	0.005	0.0004	0.00018	70	130	30
9Cl-PF3ONS	756426-58-1	0.005	0.005	0.0004	0.0001	70	130	30

Notes:

[a] The Project QL Goal is the Laboratory Specific LOQ, as applicable.

[b] In-house laboratory limits are the basis for LCS and matrix spike/matrix spike duplicate (MS/MSD) limits.

SAP Worksheet #15-3—Reference Limits and Evaluation Table

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.1.1 Table B-15)
Matrix: Surface Soil and Subsurface Soil

Analyte[a]	CAS No.	RSLs Residential Soil (HQ = 0.1), May 2019 (µg/kg)	ADEC Soil Cleanup Levels (µg/kg)	Project Action Level[a] (µg/kg)	Project QL Goal[a,b] (µg/kg)	Laboratory Specific Limits (µg/kg)			Accuracy Control Limit (%R)[c]		Precision Control Limit (% RPD)
						LOQs	LODs	DLs			
PFOS	1763-23-1	130	3	3	3	5	2.5	0.27	50	130	30
PFOA	335-67-1	130	1.7	1.7	1.7	5	2.5	0.5	56	136	30
PFBS	375-73-5	130000	NC[d]	130000	65000	5	2.5	0.36	57	145	30
NEtFOSAA	2991-50-6	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.57	54	124	30
NMeFOSAA	2355-31-9	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	1.12	52	146	30
PFDA	335-76-2	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.27	55	141	30
PFDoA	307-55-1	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.24	62	134	30
PFHpA	375-85-9	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.44	60	128	30
PFHxS	355-46-4	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.22	52	132	30
PFHxA	307-24-4	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.33	45	135	30
PFNA	375-95-1	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.43	54	130	30
PFTeDA	376-06-7	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.63	34	162	30
PFTrDA	72629-94-8	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.28	51	127	30
PFUnA	2058-94-8	NC[d]	NC[d]	NC[d]	NC[d]	5	2.5	0.41	57	137	30
HFPO-DA	13252-13-6	NC[d]	NC[d]	NC[d]	NC[d]	5	2	0.57	70	130	30
ADONA	919005-14-4	NC[d]	NC[d]	NC[d]	NC[d]	5	1	0.32	70	130	30
11Cl-PF3OUdS	763051-92-9	NC[d]	NC[d]	NC[d]	NC[d]	5	1	0.4	70	130	30
9Cl-PF3ONS	756426-58-1	NC[d]	NC[d]	NC[d]	NC[d]	5	1	0.45	70	130	30

Notes:

Shading indicates cells where the LOD is greater than the Project Quantitation Limit (PQL) Goal.

[a] The PAL for soil is the lesser of the "RSLs Residential Soil" and the “ADEC Soil Cleanup Levels”. Refer to **Worksheets #10 and 11** for a detailed discussion on development of PALs.

[b] The Project QL Goal is 1/2 the PAL, the PAL, or the Laboratory Specific LOQ, as applicable.

[c] In-house laboratory limits is the basis for LCS and MS/MSD limits.

[d] NC: No criteria for this compound.

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SAP Worksheet #16—Project Schedule/Timeline Table

Activities	**Organization**	**Dates (Month/Year)**		**Deliverable**
		Anticipated Date(s) of Initiation	**Anticipated Date of Completion**	
SAP Schedule				
Draft SAP preparation	CH2M	December 2018	June 2019	Draft SAP
Chemist review	NAVFAC Atlantic	April 2019	May 2019	comments
RPM review	NAVFAC NW	April 2019	May 2019	comments
State RPM review	ADEC	June 2019	July 2019	
Final SAP	CH2M	July 2019	August 2019	Final SAP
Fieldwork Schedule				
Presampling preparation, subcontracting	CH2M	January 2019	August 2019	N/A
Monitoring Well Installation	CH2M, Subcontractor	August 2019	September 2019	N/A
Sampling	CH2M	August 2019	September 2019	N/A
Sample Analysis	Battelle	28-day turnaround time		Analytical data
Data management	CH2M	August 2019	November 2019	N/A
Reporting Schedule				
Reporting	CH2M	September 2019	May 2020	Internal Draft, Draft and Final SI Report

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SAP Worksheet #17—Sampling Design and Rationale

Table 17-1 presents the sampling strategy and rationale for the Airstrip Site.

Table 17-1. Sampling Strategy and Rationale – Airstrip Site – Building 136 and Potential Crash Sites A and B

Matrix	Depth of Samples	Analysis and Method	Number of Samples	Strategy and Rationale
Groundwater	Shallow[a]	PFAS (LC-MS/MS Compliant with QSM v5.1.1 Table B-15)	16	Groundwater samples will be collected from existing and new monitoring wells (**Figures 3 and 4**) at known or suspected AFFF release locations or downgradient of these locations. Samples will be collected from active zone groundwater only, because permafrost is continuous in this area and precludes vertical migration of groundwater.
Soil	Surface (0-6 inches bgs) Top of capillary fringe		22	Soil samples will be collected from two depths (the surface and the top of the capillary fringe in the unsaturated soil). Samples will be collected at three soil-boring-only locations south and west of Building 136 (**Figure 3**) (six soil samples) and at eight newly installed temporary monitoring well locations at the Potential Crash sites (**Figures 3 and 4**) (16 soil samples) where AFFF is known or is suspected to have been released. The presence of PFAS in the vadose zone could represent an ongoing source to groundwater.
Surface Water	Within 6 inches of the surface of Imikpuk Lake		5	Five surface water samples will be collected from Imikpuk Lake (**Figure 5**) to evaluate PFAS concentrations using the most current analytical method for surface water.

Notes:

[a] Depth of groundwater and soil samples collected at the top of the capillary fringe in the unsaturated soil will be determined upon installation of temporary monitoring wells or borings.

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SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location[c]	Sample ID	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
NARL-S05-TW01	NARL-S05-TW01-MMYY	Groundwater	Shallow[a]	PFAS	1	See **Worksheet #21**
NARL-S05-TW02	NARL-S05-TW02-MMYY				1	
NARL-S05-TW03	NARL-S05-TW03-MMYY				1	
NARL-S05-TW04	NARL-S05-TW04-MMYY				1	
NARL-S05-TW05	NARL-S05-TW05-MMYY				2 (FD)	
	NARL-S05-TW05P-MMYY					
NARL-S05-TW06	NARL-S05-TW06-MMYY				1	
NARL-S05-TW07	NARL-S05-TW07-MMYY				1	
NARL-S05-TW08	NARL-S05-TW08-MMYY				1	
NARL-S05-WP-02B	NARL-S05-WP-02B -MMYY		Middle of well screen		2 (FD)	
	NARL-S05-WP-02BP-MMYY					
NARL-S05-WP-10	NARL-S05-WP-10-MMYY				1	
NARL-S05-WP-11	NARL-S05-WP-11-MMYY				1	
NARL-S05-WP-12	NARL-S05-WP-12-MMYY				1	
NARL-S05-WP-16	NARL-S05-WP-16-MMYY				3 (MS/MSD)	
	NARL-S05-WP-16-MMYY-MS					
	NARL-S05-WP-16-MMYY-SD					
NARL-S05-WP-18	NARL-S05-WP-18-MMYY				1	
NARL-AFAS-WP-20	NARL-AFAS-WP-20-MMYY	Groundwater	Middle of well screen	PFAS	1	See **Worksheet #21**
NARL-AFAS-WP-21	NARL-AFAS-WP-21-MMYY				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location[c]	Sample ID	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
Soil Samples						
NARL-S05-SO01	NARL-S05-SS01-000H	Soil	Surface (0-6 inches bgs) Top of the capillary fringe[a]	PFAS	1	See **Worksheet #21**
	NARL-S05-SB01-TDBD				1	
NARL-S05-SO02	NARL-S05-SS02-000H				3 (MS/MSD)	
	NARL-S05-SS02-000H-MS					
	NARL-S05-SS02-000H-SD					
	NARL-S05-SB02-TDBD				1	
NARL-S05-SO03	NARL-S05-SS03-000H				2 (FD)	
	NARL-S05-SS03P-000H					
	NARL-S05-SB03-TDBD				1	
NARL-S05-SO04	NARL-S05-SS04-000H				1	
	NARL-S05-SB04-TDBD				1	
NARL-S05-SO05	NARL-S05-SS05-000H				1	
	NARL-S05-SB05-TDBD				2 (FD)	
	NARL-S05-SB05P-TDBD					
NARL-S05-SO06	NARL-S05-SS06-000H				1	
	NARL-S05-SB06-TDBD				1	
NARL-S05-SO07	NARL-S05-SS07-000H				1	
	NARL-S05-SB07-TDBD				1	
NARL-S05-SO08	NARL-S05-SS08-000H				1	
	NARL-S05-SB08-TDBD				3 (MS/MSD)	
	NARL-S05-SB08-TDBD-MS					

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location[c]	Sample ID	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
	NARL-S05-SB08-TDBD-SD					
NARL-S05-SO09	NARL-S05-SS09-000H				1	
	NARL-S05-SB09-TDBD				1	
NARL-S05-SO10	NARL-S05-SS10-000H				2 (FD)	
	NARL-S05-SS10P-000H					
	NARL-S05-SB10-TDBD				1	
NARL-S05-SO11	NARL-S05-SS11-000H				1	
	NARL-S05-SB11-TDBD				1	
Surface Water Samples						
NARL-S05-SW02	NARL-S05-SW02-MMYY	Surface Water	Within 6 inches of the surface of Imikpuk Lake[b]	PFAS	1	See **Worksheet #21**
	NARL-S05-SW02P-MMYY				2 (FD)	
NARL-S05-SW03	NARL-S05-SW03-MMYY				3 (MS/MSD)	
	NARL-S05-SW03-MMYY-MS					
	NARL-S05-SW03-MMYY-SD					
NARL-S05-SW04	NARL-S05-SW04-MMYY				1	
NARL-S05-SW05	NARL-S05-SW05-MMYY				1	
NARL-S05-SW06	NARL-S05-SW06-MMYY				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location[c]	Sample ID	Matrix	Depth	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
Field QC						
NARL-S05-QC	NARL-S05-FRB01-MMDDYY	QC	N/A	PFAS	1 per site	See **Worksheet #21**
	NARL-S05-EB01-MMDDYY				One per day for decontaminated equipment. One per event for disposable equipment.	

Notes:

[a] Depth of groundwater and soil samples collected at the top of the capillary fringe in the unsaturated soil will be determined upon installation of temporary monitoring wells or borings.

[b] Surface water samples will be collected as described in **Worksheet #14**.

[c] Sampling Location IDs will be field-determined.

AFAS= Air Force Airstrip (well installed to evaluate petroleum movement in the active zone water from the Navy's property to the Air Force property; sampling conducted under the Navy's long-term monitoring program)

FD = field duplicate

S05 = Site 5

SB = subsurface soil

SO = soil

SS = surface soil

SW = surface waterTW = temporary well

WP = well point (existing well)

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference[a]	Containers (number, size, and type)	Sample Volume[a] (units)	Preservation Requirements (chemical, temperature, light-protected)	Maximum Holding Time[a] (preparation and analysis)
Groundwater, Surface Water	PFAS	LC-MS/MS Compliant with QSM 5.1.1 Table B-15/ SOP 5-370-07, SOP 5-369-06	Two of 250 milliliter high density polyethylene (HDPE)	250 mL	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen	14 days, 28 days
Surface Soil, Subsurface Soil	PFAS	LC-MS/MS Compliant with QSM 5.1.1 Table B-15/ SOP 5-370-07, SOP 5-369-06	One 8 ounce HDPE Jar	30 g	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen	14 days, 28 days

Notes:

[a] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

[b] Provide the minimum sample volume or mass requirement if it differs from the container volume.

[c] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations[b]	No. of Field Duplicates	No. of MS/MSDs[a]	No. of Field Blanks	No. of Equip. Blanks[c]	Total No. of Samples to Lab
Groundwater	PFAS	16	2	1	3	3	26
Surface Water		5	1	1	1	1	10
Surface Soil		11	2	1	3	3	21
Subsurface Soil		11	1	1			14

Notes:

[a] Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.

[b] If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

[c] The number of equipment blanks is based on a fundamental assumption of the number of sampling days each site will require. It was assumed that the soil sampling will occupy a total of ten days. It was assumed that the groundwater sampling will occupy a total of one day.

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP- 001	Chain-of-Custody, rev. 10/2018	CH2M	Chain-of-custody form	N	
SOP-002	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using a WQP meter with Flow-through Cell, rev 10/2018	CH2M	Water Quality Meter with Flow-through Cell	N	
SOP-003	Water-Level Measurements, rev. 10/2018	CH2M	Water Level Meter	N	No Teflon components
SOP-004	Equipment Blank and Field Blank Preparation, rev. 10/2018	CH2M	Laboratory provided blank liquid and sample bottles	N	
SOP-005	Groundwater Sampling for Per- and Polyfluoroalkyl Substances, rev. 11/2018 – Draft Final	CH2M	Teflon-free tubing, Teflon-free bailer (if using bailer), PFAS-free pump, sample bottles (HDPE bottle with HDPE screw cap), laboratory pre-filled HDPE bottles containing field blank water, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	N	No Teflon components, PFAS-free shipping materials
SOP-006	Surface Water Sampling for Per- and Polyfluoroalkyl Substances, rev. 11/2018 – Draft Final	CH2M	Teflon-free tubing, PFAS-free pump, sample bottles (HDPE bottle with HDPE screw cap), laboratory pre-filled HDPE bottles containing field blank water, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	N	No Teflon components, PFAS-free shipping materials
SOP-007	Soil Sampling for Per- and Polyfluoroalkyl Substances, rev. 11/2018 – Draft Final	CH2M	Sample jars (HDPE bottle with HDPE screw cap), laboratory pre-filled HDPE bottles containing field blank water, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	N	No Teflon components, PFAS-free shipping materials
SOP-008	Packaging and Shipping Procedures for Low Concentration Samples, rev. 10/2018	CH2M	Plastic bags, ice, tape	Y	No Teflon supplies, Samples will be kept on ice until 1 hour prior to flight departure, Ice to be removed from sample cooler and inspected by hand by TSA with field team oversight, Following TSA inspection field team to oversee taping of cooler prior to loading onto aircraft, Samples to be inspected upon arrival to Anchorage, ice to be added to cooler promptly after departing the airport, Ice to be refreshed the following day and samples shipped to laboratory via FedEx.
SOP-009	Decontamination of Personnel and Equipment, rev. 03/2019	CH2M	For cleaning reusable equipment	N	
SOP-010	Disposal of Waste Fluids and Solids, rev. 11/2018	CH2M	Drum, tank, roll off	N	
SOP-011	Management of Liquid Waste containing Per- and Polyfluoroalkyl Substances, rev. 02/2019	CH2M	Drum, tank, HDPE sample bottles	N	No Teflon components, PFAS-free shipping materials
SOP-012	Sampling Contents of Tanks and Drums, rev. 10/2018	CH2M	HDPE sample bottles	N	No Teflon components, PFAS-free shipping materials
SOP-013	Locating and Clearing Underground Utilities, rev. 10/2018	CH2M	None	N	

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-014	General Guidance for Monitoring Well Installation, rev. 10/2018	CH2M	DPT Drill Rig	Y	Sampling rods and retractable stainless-steel without Teflon components. Polyethylene sampling tubing (not Teflon-lined) and stainless-steel foot valve. Biolube is acceptable substitute to drilling lube containing polytetrafluoroethylene (PFTE) or fluorine-containing substance. Direct push technology drill rig to be used. Well installation will be consistent with previous facility practices and ADEC guidance for short-term wells: The top of the 1-foot screen will be set just above the water table. The annular space between the borehole wall and well screen shall be backfilled with a sand filter pack (native sands) placed around the annular space of the well screen from the bottom of the boring and extend to a minimum height of 2 feet above the top of the well screen, if feasible. If the depth to active zone groundwater is too shallow to accommodate a full 2 feet of sand above the top of the screen and still provide for an adequate seal extending to ground surface (i.e., if the well is less than 5 feet in total depth), the filter pack will extend to a minimum of 1 to 2 inches above the of the well screen after settling. A bentonite seal, at least 1 foot thick, if feasible, will be placed above the top of the sand pack.
SOP-015	Decontamination of Drilling Rigs and Equipment, rev 10/2018	CH2M	DPT Drill Rig	N	
SOP-016	MultiRae PID, rev. 10/2018	CH2M	PID	N	
SOP-017	Civil Surveying, rev. 10/2018	CH2M	Surveying equipment	N	
SOP-018	Monitoring Well and Borehole Abandonment rev. 10/2018	CH2M	DPT Drill Rig, bentonite	N	
I-C-04	Groundwater Sampling from Temporary Wells (Piezometers), rev. 3/2015	NAVFAC NW	Teflon-free tubing, Teflon-free bailer (if using bailer), PFAS-free pump, sample bottles (HDPE bottle with HDPE screw cap), laboratory pre-filled HDPE bottles containing field blank water, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	N	No Teflon components

SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity[a]	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[b]	Comments
Horiba U-22 pH probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	pH reads 4.0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly	FTL	SOP-002	Appendix A
Horiba U-22 Specific conductance probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-002	Appendix A
Horiba U-22 Turbidity probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-002	Appendix A
Horiba U-22 DO and Temperature Probes	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-002	Appendix A
Horiba U-22	Maintenance – Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes pH reads 4.0 +/- 3% Conductivity reads 4.49 +/- 3% Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-002	Appendix A
Water Quality Meter	Calibrate probes using Auto-Calibration Standard Solution	Daily and as needed	Parameter specific per model/ instruction manual	Manufacturer technical support for calibration errors	FTL	SOP-002	Appendix A
Turbidimeter	Calibrate using Auto-Calibration Standards	Daily and as needed	Parameter specific per model/ instruction manual	Manufacturer technical support for calibration errors	FTL	SOP-002	Appendix A
PID	Calibrate using ambient air and isobutylene 100 parts per million calibration gas	Daily and as Needed	Parameter specific per model/instruction manual	Manufacturer technical support for calibration errors	FTL	SOP-017	Appendix A

Notes:

[a] Activities may include: calibration, verification, testing, and maintenance.

[b] Reference number from the Project Sampling SOP References table (**Worksheet #21**).

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Revisited if not Revised[a]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work?[1] (y/n)
5-369-06	PFAS Analytical; May 2018; Rev. 6		Definitive	Groundwater, Surface Water, Surface Soil, Subsurface Soil/PFAS	LC-MS/MS	Battelle	None	N
5-370-08	PFAS Sample Preparation; April 2019; Rev. 8		Definitive	Groundwater, Surface Water, Surface Soil, Subsurface Soil/PFAS	N/A	Battelle	None	N
6-010-18	Sample Receipt, Custody, and Handling; April 2018; Rev. 18		N/A	N/A	N/A	Battelle	None	N
5-114-09	The Storage and Disposal of Regulated and Non-Regulated Waste; January 2015; Rev. 9	July, 2018	N/A	N/A	N/A	Battelle	None	N

Notes:

[a] If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy QAO.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument[c]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[b]	SOP Reference[a]
LC-MS/MS (for PFAS)	Initial Calibration (ICAL)	At instrument set-up and after initial calibration verification (ICV) or continuing calibration verification (CCV) failure, prior to sample analysis. Calibration can be linear (minimum of 5 standards) or quadratic (minimum of 6 standards); weighting is allowed.	The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation). If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation. (Internal Standard Quantitation) S/N Ratio: ≥ 10:1 for all ions used for quantification. For analytes having a promulgated standard, (e.g., HA levels for PFOA and PFOS) the qualitative (confirmation) transition ion must have a S/N Ratio of ≥ 3:1. The %RSD of the RFs for all analytes must be <20%. Linear or nonlinear calibrations must have $r^2 \geq 0.99$ for each analyte. Analytes must be within 70-30% of their true value for each calibration standard. Isotope Dilution or Internal Standard Calibration is required for all analytes. External Calibration is not allowed.	Correct problem then repeat ICAL. Flagging is not appropriate. No samples shall be analyzed until ICAL has passed.	Analyst	5-369-06
	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. No samples shall be analyzed until calibration has been verified.	Correct problem, rerun ICV. If problem persists, repeat ICAL. Flagging is not appropriate.		
	Continuing Calibration Verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analytical sequence.	Concentration of analytes must range from the LOQ to the mid-level calibration concentration. Analyte concentrations must be within ±30% of their true value. Instrument Sensitivity Check (ISC) can serve as a bracketing CCV.	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 samples since last successful CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Results may not be reported without valid CCVs.		
	Tune Check	When the masses fall outside of the ±0.5 amu of the true value (as determined by the product ion formulas).	Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument and verify. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate. No samples shall be analyzed without a valid tune.		
	Mass Calibration	Initially prior to use and after performing major maintenance, as required to maintain documented instrument sensitivity and stability performance.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Entire range needs to be mass calibrated.	Flagging is not appropriate.		
	Mass Spectural Acquisition Rate	Each analyte, Extracted Internal Standard Analyte, and Injection Internal Standard Analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	Flagging is not appropriate.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument[c]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[b]	SOP Reference[a]
	Calibration, Calibration Verification, and Spiking Standards	All Analytes.	Standards containing both branched and linear isomers must be used when commercially available. If not available, the total response of the analyte must be integrated (i.e., accounting for peaks that are identified as linear and branched isomers) and quantitated using a calibration curve which includes the linear isomer only for that analyte (e.g., PFOA). Standards containing both branched and linear isomers are to be used during method validation to ensure the total response is quantitated for that analyte. Technical grade standards cannot be used for quantitative analysis.	Flagging is not appropriate.		
	Ion Transitions (Parent -> Product)	Prior to method implementation.	The chemical derivation of the ion transitions, both those used for quantitation and those used for confirmation, must be documented. Two transitions and the ion transition ratio per analyte shall be monitored and documented with the exception of PFBA and PFPeA. In order to avoid biasing results high due to known inferences for some transitions, the following transitions must be used for the quantification of the following 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 If these transitions are not used, the reason must be technically justified and documented (e.g., alternate transition was due to observed interferences).	Flagging is not appropriate.		
	Instrument Sensitivity Check (ISC)	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values. No samples shall be analyzed until ISC has met acceptance criteria. ISC can serve as the initial daily CCV.	Correct problem, rerun ISC. If problem persists, repeat ICAL. Flagging is not appropriate.		

Notes:

[a] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

[b] Name or title of responsible person may be used.

[c] DoD QSM v. 5.1.1 Table B-15 is the basis for specifications on this table.

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[b]	SOP Reference[a]
LC-MS/MS	Clean Curtain Plate	PFAS	Visual inspection of curtain plate for residue.	As needed when curtain plate has visible residue present	No visible residue on curtain plate	Remove and clean the instrument curtain plate	Analyst	5-369-06
	Preventative Maintenance	PFAS	Degradation of instrument performance	Every 6 months or when instrument performance deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards (IS) recovery within acceptance criteria on **Worksheet #28**	Service provider performs Preventative Maintenance and mass calibration. Run tune check. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		
	Replace analytical column	PFAS	Review peak shape, retention times, and peak separation on ICAL, ICC, and CCV samples.	Performed when chromatography deteriorates	ICAL within acceptance criteria on **Worksheet #24** and IS recovery within acceptance criteria on **Worksheet #28**	Replace analytical column. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		

Notes:

[a] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

[b] Name or title of responsible person may be used.

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FTL (TBD)/CH2M
Sample Packaging (Personnel/Organization): FTL or Field Team Member (TBD)/CH2M
Coordination of Shipment (Personnel/Organization): FTL or Field Team Member (TBD)/CH2M
Type of Shipment/Carrier: Overnight/FedEx (see specifications in **Worksheet #21**)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receipt Personnel/ Battelle
Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/ Battelle
Sample Preparation (Personnel/Organization): Extractions Personnel/ Battelle
Sample Determinative Analysis (Personnel/Organization): Analyst/ Battelle
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Extracts may be disposed of 90 days after extraction.
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: Environmental Health and Safety Office/Battelle
Number of Days from Analysis: Samples may be disposed of 90 days after report mail date

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SAP Worksheet #27—Sample Custody Requirements Table

Sample Labeling

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservative, and sampler's initials. Labels will be applied to the jar to ensure that they do not separate.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled, as outlined above. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples than ≤10°C (storage in the laboratory will be ≤ 6°C) but not frozen. The Chain of Custody (COC) will also be placed into the cooler. Coolers will be shipped to the laboratory via methods described in **Worksheet #21**, with the airbill number indicated on the COC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

See the laboratories' sample handling SOPs: Sampling Receiving and Laboratory Information Management Systems (LIMS) Log-in; Waste Collection, Storage, and Disposal; and Sample Disposal for details on sample handling.

Sample Identification Procedures:

Upon opening the cooler, the receiving clerk signs the COC and then takes the temperature using the temperature blank (if absent, then a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's COC and any discrepancies or breakage is noted on the COC. Next, if any water samples require preservative, the clerk will check the pH values to see if they are in the acceptable pH range. The clerk will deliver the COC (and any other paperwork; e.g. temperature or pH QA notice) to the PM for LIMS entry and client contact (if needed).

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the COC. The laboratory will send sample log-in forms to EIS to check sample IDs and parameters are correct.

Chain-of-Custody Procedures:

COCs will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The COC will also have the sampler's name and signature. The COC will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Groundwater and Surface water
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM 5.1.1 Table B-15/SOP 5-369-06

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ 1/2 the LOQ.	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 acceptance criteria are not met after the highest standard which is not included in the calibration, the standard cannot be used to determine the highest concentration samples at which carryover does not occur. If acceptance criteria are not met after a sample, additional instrument blanks must be analyzed until acceptance criteria are met. Additional samples shall not be analyzed until acceptance criteria are met. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. The highest standard analyzed may not be analyzed as part of the calibration curve or following the calibration curve. If analyzed following the calibration curve, it is not used to extend out the calibration range. It is used only to document a higher concentration at which carryover still does not occur. if sample concentrations exceed this range and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed.	Analyst	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Extracted Internal Standard Analytes	Every field sample, standard, blank, and QC sample.	Added to sample prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of the true value.	If recoveries are acceptable for QC samples, but not field samples, the field samples must be reprepped and reanalyzed (greater dilution may be needed). If recoveries are unacceptable for QC samples, correct problem, and reanalyze all associated failed field samples. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative.		Precision/Accuracy/Bias	
Injection Internal Standard Analytes	Every field sample, standard, blank, and QC sample.	Added to aliquot of sample dilutions, QC samples, and standards prior to analysis. Peak areas must be within -50% to +50% of the area measured in the ICAL midpoint standard. On days when ICAL is not preformed, the peak areas must be within -50% to +50% of the peak area measured in the daily initial CCV.	If peak areas are not acceptable, analyze a second aliquot of the extract or sample if enough remains. If there is not enough extract, reanalyze the first aliquot. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags. Apply Q-flag and discuss in the Case Narrative. Alternate Injection Internal Standard Analytes are recommended when there is obvious chromatographic interference.		Precision/Accuracy/Bias	
Method Blank (MB)	One per preparatory batch.	No analytes detected >1/2 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. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Bias/Contamination	

SAP Worksheet #28-1—Laboratory QC Samples Table (continued)

Matrix: Groundwater and Surface water

Analytical Group: PFAS

Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM 5.1.1 Table B-15/SOP 5-369-06

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
LCS	One per preparatory batch.	Blank spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. 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. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS	1 per batch maximum of 20 samples	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).		Accuracy	
MSD	1 per batch maximum of 20 samples	For MSD: Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. RPD ≤ 30% (between MS and MSD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. The data shall be evaluated to determine the source of difference.		Accuracy/Precision	
Post Spike Sample	Only applies to aqueous samples prepared by serial dilution instead of SPE that have reported value of "<LOQ" for analyte(s).	Spike aliquot(s) of sample at the final dilution(s) reported for sample with all analytes that have reported value of "<LOQ" in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the "<LOQ" value). When analyte concentration are calculated as "<LOQ," the spike must recover within 70-130% of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70-130% acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met. Flagging is not appropriate. When analyte concentrations are calculated as "<LOQ," results may not be reported without acceptable post spike recoveries.		Accuracy/Precision	
LOD Verification	Quarterly for every analyte	Spike a quality system matrix at concentration 2-4x the DL. Must meet 3:1 S/N, or for data systems that do not measure noise, results must be at least 3 SDs greater than the mean method blank concentration.	If verification fails, the DL determination must be repeated and a LOD verification. Alternatively pass two consecutive LOD verification at a higher spike and set the LOD at the higher concentration.		Accuracy	
LOQ Verification	Quarterly for every analyte	Spike a quality system matrix at a concentration equal to or greater than the low point of the calibration curve.	Must meet laboratory specified precision and bias limits. If LOQ fails, repeat at a higher level until limits are met.		Precision/Bias	

Notes:

[a] DoD QSM v. 5.1.1 is the basis for specifications on this table.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Surface Soil and Subsurface Soil
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM 5.1.1 Table B-15/SOP 5-369-06

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ 1/2 the LOQ.	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 acceptance criteria are not met after the highest standard which is not included in the calibration, the standard cannot be used to determine the highest concentration samples at which carryover does not occur. If acceptance criteria are not met after a sample, additional instrument blanks must be analyzed until acceptance criteria are met. Additional samples shall not be analyzed until acceptance criteria are met. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. The highest standard analyzed may not be analyzed as part of the calibration curve or following the calibration curve. If analyzed following the calibration curve, it is not used to extend out the calibration range. It is used only to document a higher concentration at which carryover still does not occur. if sample concentrations exceed this range and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed.	Analyst	Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Extracted Internal Standard Analytes	Every field sample, standard, blank, and QC sample.	Added to sample prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of the true value.	If recoveries are acceptable for QC samples, but not field samples, the field samples must be reprepped and reanalyzed (greater dilution may be needed). If recoveries are unacceptable for QC samples, correct problem, and reanalyze all associated failed field samples. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative.		Precision/Accuracy/Bias	
Injection Internal Standard Analytes	Every field sample, standard, blank, and QC sample.	Added to aliquot of sample dilutions, QC samples, and standards prior to analysis. Peak areas must be within -50% to +50% of the area measured in the ICAL midpoint standard. On days when ICAL is not preformed, the peak areas must be within -50% to +50% of the peak area measured in the daily initial CCV.	If peak areas are not acceptable, analyze a second aliquot of the extract or sample if enough remains. If there is not enough extract, reanalyze the first aliquot. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags. Apply Q-flag and discuss in the Case Narrative. Alternate Injection Internal Standard Analytes are recommended when there is obvious chromatographic interference.		Precision/Accuracy/Bias	
MB	One per preparatory batch.	No analytes detected >1/2 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. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Bias/Contamination	

SAP Worksheet #28-2—Laboratory QC Samples Table (continued)

Matrix: Surface Soil and Subsurface Soil
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM 5.1.1 Table B-15/SOP 5-369-06

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS	One per preparatory batch.	Blank spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. 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. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Precision/Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS	1 per batch maximum of 20 samples	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).		Accuracy	
MSD	1 per batch maximum of 20 samples	For MSD: Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. RPD ≤ 30% (between MS and MSD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. The data shall be evaluated to determine the source of difference.		Accuracy/Precision	
Post Spike Sample	Only applies to aqueous samples prepared by serial dilution instead of SPE that have reported value of "<LOQ" for analyte(s).	Spike aliquot(s) of sample at the final dilution(s) reported for sample with all analytes that have reported value of "<LOQ" in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the "<LOQ" value). When analyte concentration are calculated as "<LOQ," the spike must recover within 70-130% of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70-130% acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met. Flagging is not appropriate. When analyte concentrations are calculated as "<LOQ," results may not be reported without acceptable post spike recoveries.		Accuracy/Precision	
LOD Verification	Quarterly for every analyte	Spike a quality system matrix at concentration 2-4x the DL. Must meet 3:1 S/N, or for data systems that do not measure noise, results must be at least 3 SDs greater than the mean method blank concentration.	If verification fails, the DL determination must be repeated and a LOD verification. Alternatively pass two consecutive LOD verification at a higher spike and set the LOD at the higher concentration.		Accuracy	
LOQ Verification	Quarterly for every analyte	Spike a quality system matrix at a concentration equal to or greater than the low point of the calibration curve.	Must meet laboratory specified precision and bias limits. If LOQ fails, repeat at a higher level until limits are met.		Precision/Bias	

Notes:

[a] DoD QSM v. 5.1.1 is the basis for specifications on this table.

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout.
Chain-of-Custody Records	Electronic .pdf copies in the project file. Hardcopy in the data validation report. Archived at project closeout.
Air Bills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
Corrective Action Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
PID	Recorded in Field Notebook. Stored in Data Warehouse
Water quality parameters collected during groundwater sampling	Recorded in Field Notebook. Stored in Data Warehouse
Various field measurements	Recorded in Field Notebook.
All field equipment calibration information	Recorded in Field Notebook.
Pertinent telephone conversations	Recorded in Field Notebook.
Field equipment maintenance records	Inspected by Field Team Leader. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package.
Standard Traceability Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Calibration Logs	Hardcopy in the full data package. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package. Archived at project closeout.
Run Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Maintenance, Testing, and Inspection Logs	Kept on file at the laboratory. Not maintained.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the data package. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Data Package Completeness Checklists	Hardcopy in the data validation report. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.

SAP Worksheet #29—Project Documents and Records Table (continued)

Document	Where Maintained
Extraction/Clean-up Records	Maintained by the laboratory.
Raw Data	Hardcopy in the full data package. Archived at project closeout.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Laboratory SOPs	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout.
Data Validation Reports	

In general, documents are stored at a CH2M HILL project office until they are archived.

CH2M HILL Project Office:

Maggie Radford/CH2M
1100 112th Avenue NE, Suite 500
Bellevue, WA 98004
(425)-233-3328

Hardcopy deliverables such as logbooks, COCs, etc. will be archived indefinitely at Iron Mountain:

Iron Mountain Headquarters

745 Atlantic Avenue
Boston, MA 02111
(800) 899-IRON

Following project completion, hardcopy deliverables including COCs and raw data, and data validation reports will be archived indefinitely at the Washington National Records Center:

Washington National Records Center

4205 Suitland Road
Suitland, Maryland 20746-8001
(301) 778-1550

SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person, and telephone number)	Backup Laboratory/Organization (name and address, contact person, and telephone number)
Groundwater, Surface Water, Surface Soil, Subsurface Soil	PFAS	Refer to **Worksheet #18**	PFAS by LC-MS/MS Compliant with QSM v5.1.1 Table B-15	28 Calendar-day TAT	Battelle 141 Longwater Drive, Suite 202 Norwell, MA 02061 Jonathan Thorn (781) 681-5565	Vista Analytical Laboratory Attn: Sample Receiving 1104 Windfield Way El Dorado Hills, California 95762 Martha Maier (916) 673-1520

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Field Performance Audit	In accordance with CLEAN program requirements	Int.	CH2M	TBD FTL CH2M	Maggie Radford PM/CH2M	Ali Salter-Blanc Task Manager CH2M	Paul Townley Activity Quality Manager CH2M
Offsite Laboratory Technical Systems Audit	Laboratories must have current DoD ELAP accreditation which will identify the period of performance.	Ext.	Laboratory Accreditation Body in accordance with Department of Defense ELAP	TBD Laboratory Accreditation Body	Zachary Willenberg Laboratory Quality Systems Manager Battelle	Zachary Willenberg Laboratory Quality Systems Manager Battelle	TBD Laboratory Accreditation Body

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (Name, Title, Org.)	Time Frame for Response
Field Performance Audit	Checklist and Written Audit Report	Maggie Radford PM/CH2M	Within 1 week of audit	Memorandum	TBD Field Team Leader CH2M Paul Townley Activity Quality Manager CH2M	Within 1 week of receipt of CA Form
Offsite Laboratory Technical Systems Audit	TBD by Perry Johnson Laboratory Accreditation	Zachary Willenberg Laboratory Quality Systems Manager Battelle	Within 2 months of audit	Memorandum	TBD by Perry Johnson Laboratory Accreditation	Within 2 months of receipt of initial notification.

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SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating corrective action ______________________________ Date ____________________________________

Description of problem and when identified: ____

____

____

____

Cause of problem, if known or suspected: ____

____

____

____

<u>Sequence of Corrective Action (CA):</u> (including date implemented, action planned and personnel/data affected) __________

____

____

____

____

____

CA implemented by: ____ Date: ________________________

CA initially approved by: ____ Date: ________________________

Follow-up date: ____

Final CA approved by: ____ Date: ________________________

Information copies to:

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SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.:______________________________ Date: ______________________________

Project Location:______________________________ Signature: ______________________________

Team Members:

Yes _ No _ 1) Is the approved work plan being followed?
Comments ____

____

Yes _ No _ 2) Was a briefing held for project participants?
Comments ____

____

Yes _ No _ 3) Were additional instructions given to project participants?
Comments ____

____

Sample Collection

Yes _ No _ 1) Is there a written list of sampling locations and descriptions?
Comments ____

____

Yes _ No _ 2) Are samples collected as stated in the Master SOPs?
Comments ____

____

Yes _ No _ 3) Are samples collected in the type of containers specified in the work plan?
Comments ____

____

Yes _ No _ 4) Are samples preserved as specified in the work plan?
Comments ____

____

Yes _ No _ 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments ____

____

SAP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes _ No _ 6) Are quality assurance checks performed as specified in the work plan?
Comments ____

____

Yes _ No _ 7) Are photographs taken and documented?
Comments ____

____

Document Control

Yes _ No _ 1) Have any accountable documents been lost?
Comments ____

____

Yes _ No _ 2) Have any accountable documents been voided?
Comments ____

____

Yes _ No _ 3) Have any accountable documents been disposed of?
Comments ____

____

Yes _ No _ 4) Are the samples identified with sample tags?
Comments ____

____

Yes _ No _ 5) Are blank and duplicate samples properly identified?
Comments ____

____

Yes _ No _ 6) Are samples listed on a chain-of-custody record?
Comments ____

____

Yes _ No _ 7) Is chain-of-custody documented and maintained?
Comments ____

____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Performance CA Memorandum	After field audit	1 week after audit, if necessary	CH2M FTL	Will be posted in project file.
QA Management Report/Technical Memorandum	Once results have been assessed for data usability	To be submitted with Final RI Report	CH2M	Will be posted in project file.

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SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Verification Input[a]	Description	Internal/External[b]	Responsible for Verification (name, organization)
Step 1			
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Internal	FTL (TBD)/CH2M
COCs and Shipping Forms	COC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC will be initialed by the reviewer, a copy of the COC retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Internal/External	FTL (TBD)/CH2M PC: Juan Acaron/CH2M
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.	External	PC: Juan Acaron/CH2M
Documentation of Laboratory Method Deviations	Laboratory method deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative that becomes part of the final hardcopy data package.	Internal/External	PC: Juan Acaron/CH2M
Electronic Data Deliverables	Electronic data deliverables will be compared against hardcopy laboratory results (10% check).	External	PC: Juan Acaron/CH2M
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and are applicable to the data packages.	External	Data Validator: TBD
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Internal	Laboratory QA Officer (Battelle)
Laboratory Data	The data will be verified for completeness by the PC. In order to ensure completeness, electronic data deliverables (EDDs) will be compared to the SAP. This is a verification that all samples were included in the laboratory data and that correct analyte lists were reported.	External	PC: Juan Acaron/CH2M
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	Internal	PM: Maggie Radford/CH2M PC: Juan Acaron/CH2M
CA Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	External	PM: Maggie Radford/CH2M PC: Juan Acaron/CH2M
Step IIa			
Laboratory Methods	During the pre-validation check, ensure the laboratory analyzed samples using the correct methods specified in the SAP. If methods other than those specified in the SAP were used, the reason will be determined and documented.	External	PC: Juan Acaron/CH2M
Target Compound List and Target Analyte List	During the pre-validation check, ensure the laboratory reported all analytes from each analysis group as described in **Worksheet #15**. If the target compound list is not correct, then it must be corrected prior to sending the data for validation. Once the checks are complete, the project manager is notified via email.	External	PC: Juan Acaron/CH2M
Reporting Limits	Ensure the laboratory met the project-designated quantitation limits as described in **Worksheet #15**. If limits were not met, the reason will be identified and documented.	External	PC: Juan Acaron/CH2M
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	External	Data Validator: TBD
Step IIb			
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	External	Data Validator: TBD
Raw Data	10 percent Stage 4 review of raw data to confirm laboratory calculations and manual integrations. For a recalculated result, the DV attempts to re-create the reported numerical value. The laboratory is asked for clarification if a discrepancy is identified which cannot reasonably be attributed to rounding. In general, this is outside 5% difference. The remaining 90 percent of data will receive Stage 2B review.	External	Data Validator: TBD

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Verification Input[a]	Description	Internal/External[b]	Responsible for Verification (name, organization)
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	Internal	FTL (TBD)/CH2M
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	External	Data Validator: TBD
Documentation of field QC Sample Results	Establish that all required SAP QC samples were run and met limits.	Internal	PC: Juan Acaron/CH2M Data Validator: TBD
Step 2b: Analytical Data Validation			
PFAS[c]	Analytical methods and laboratory SOPs will be evaluated against QA/QC criteria to ensure compliance, as presented in this SAP. QA/QC criteria for field QC samples are presented in **Worksheet #12**. LOQs, LODs, and DLs are presented in Worksheet #15. QA/QC criteria for calibrations are presented in Laboratory SOPs (referenced in **Worksheet #23**). QA/QC criteria for laboratory QC samples are presented in **Worksheet #28**. Data may be qualified if QA/QC exceedances have occurred. Guidance and qualifiers from "United States Department of Defense General Data Validation Guidelines" (DoD, 2018) will be applied as appropriate. As specific modules for the analytical methods in this project are published, the data validators will refer to those modules for guidance. In the meantime, if specific guidance is not given for these methods in the General Data Validation Guidelines, the data validator may adapt the guidance from "USEPA National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.4)" (540-R-2017-002; January 2017). Although there are no PFAS samples being analyzed by EPA 537.1, the data validator may reference "EPA Data Review and Validation Guidelines for Perfluroalkyl Substances (PFASs) Analyzed Using EPA Method 537" (USEPA, 2018) as needed.	External	Data Validator: TBD

Notes:

Should CH2M find discrepancies during the verification or validation procedures above, an email documenting the issue will be circulated to the internal project team, and a Corrections to File Memo will be prepared identifying the issues and the corrective action needed. This memo will be sent to the laboratory, or applicable party, and maintained in the project file

[a] Verification (Step I) is a completeness check that is performed before the data review process continues to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated is in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against measurement performance criteria in the SAP (both sampling and analytical).

[b] Internal or external is in relation to the data generator.

[c] Manual validation is planned and qualifiers are then applied to the electronic data deliverable. Validation will be 90% Stage 2B and 10% Stage 4

SAP Worksheet #37—Usability Assessment

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

Non-detected site contaminants will be evaluated to ensure that PQL goals in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.

During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, J+, J-, or UJ. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the investigation report

- J = Analyte present. Reported value may or may not be accurate or precise.
- UJ = Analyte not detected. QL may be inaccurate or imprecise.
- J+ = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
- J- = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
- X = Result recommended for rejection by the data validator. Result not reliable.
- R = Rejected result, team decision. Result not reliable.

If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the most conservative value will be used for project decisions.

Additional qualifiers that may be given by the validator are:

- B = Not detected substantially above the level reported in laboratory or field blanks.
- N = Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts
- NJ = Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
- U = Not detected.

Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the EDD. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.

Field and laboratory precision will be compared as RPD between the two results.

Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be compared to a 95 percent completeness goal and will be reconciled with measurement performance criteria following validation and review of data quality indicators.

SAP Worksheet #37—Usability Assessment (continued)

If significant biases are detected with laboratory QA/QC samples they will be evaluated to assess impacts on decision-making. Low biases will be described in detail as they represent a possible inability to detect compounds that may be present at the site.

If significant deviations are noted between laboratory and field precision the cause will be further evaluated to assess impact on decision making.

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

- Data tables will be produced to reflect detected and non-detected analytes. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation will be provided as part of the SI Report.
- The SI Report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the Navy and stakeholders who will evaluate the data usability according to project objectives.

References

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Figures

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LEGEND

● Former NARL Barrow

Figure 1
Base Location Map
Sampling Analysis Plan for PFAS
Former NARL Barrow, Utqiaġvik, Alaska

0 75 150
Miles
1 inch = 150 mile

N

Figure 2
Base Layout Map
Sampling Analysis Plan for PFAS
Former NARL Barrow, Utqiaġvik, Alaska

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LEGEND

- ● Existing Monitoring Well (No Sample)
- ● Proposed Groundwater Sample at Existing Monitoring Well
- ○ Proposed Temporary Monitoring Well Installation
- ▲ Proposed Surface Water Sample
- ○ Proposed Soil Sample
- → Groundwater Flow Direction
- ⇢ Anticipated Surface Water Drainage Direction
- - - Surface Drainage Feature
- — Containment Berm
- ▢ Potential PFAS Source Areas
- ▢ Current Navy Property Boundary

Figure 3
Proposed Sample Locations:
Building 136 and Potential Crash Area A
Sampling Analysis Plan for PFAS
Former NARL Barrow, Utqiaġvik, Alaska

0 150 300 Feet
1 inch = 300 feet
N

DRAFT

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LEGEND

- - ➤ Anticipated Groundwater Flow Direction

▭ Potential PFAS Source Areas

⌐ ┘ Current Navy Property Boundary

○ Proposed Temporary Monitoring Well Installation

● Proposed Soil Sample

Figure 4
Proposed Sample Locations:
Potential Crash Site B
Sampling Analysis Plan for PFAS
Former NARL Barrow, Utqiaġvik, Alaska

0 100 200
Feet
1 inch = 200 feet
N

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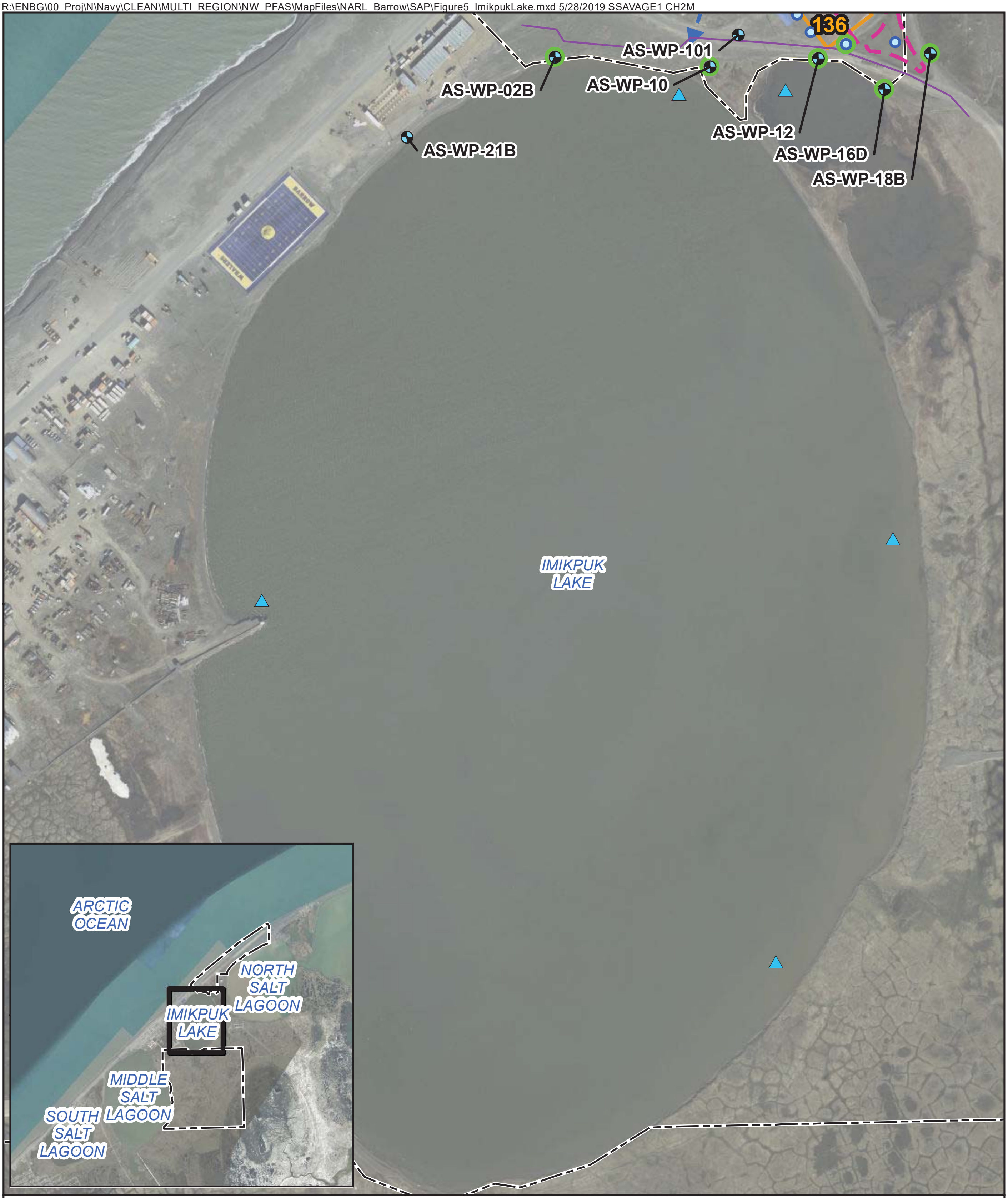

LEGEND

- ➤ Anticipated Surface Water Drainage Direction
- Surface Drainage Feature
- Containment Berm
- ▭ Potential PFAS Source Areas
- Current Navy Property Boundary
- ◕ Existing Monitoring Well (No Sample)
- ◕ Proposed Groundwater Sample at Existing Monitoring Well
- ○ Proposed Temporary Monitoring Well Installation
- ▲ Proposed Surface Water Sample
- ○ Proposed Soil Sample

Figure 5
Proposed Sample Locations:
Imikpuk Lake
Sampling Analysis Plan for PFAS
Former NARL Barrow, Utqiaġvik, Alaska

0 225 450
Feet
1 inch = 450 feet
N

Appendix A

Field Standard Operating Procedures – CH2M and NAVFAC

GROUNDWATER SAMPLING FROM TEMPORARY WELLS (PIEZOMETERS)

1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of the U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and/or their contractors pertaining to the collection of groundwater samples from temporary wells (also known as piezometers).

2.0 PROCEDURES

Before starting fieldwork, review the sampling procedures checklist shown in Attachment I-C-4-1.

2.1 EQUIPMENT

The following items are required for sampling groundwater from temporary wells:

- Well keys
- Bolt cutters and extra locks
- Water level indicator
- Assorted tools, such as a knife and screwdriver
- Polyvinyl chloride (PVC), Teflon, or stainless steel reusable or disposable bailer (bottom filling for sampling and purging); submersible pump or other appropriate pump
- Generator or 12-volt battery, if electric pump is to be used
- Clean nylon line or wire line (for deep wells) for lowering bailer into well
- Thermometer, pH meter (with automatic temperature compensation), and conductivity meter, or meter containing a combination of these three
- Conductivity and pH buffer calibration solutions for the meters
- Plastic squeeze bottles filled with deionized water and other decontamination chemicals as required for analyses being performed
- Polyethylene or glass container (for field parameter measurements)
- Paper towels or other chemically clean wipes such as Kimwipes
- Calculator
- Weatherproof, bound field logbook with numbered pages
- Permanent/indelible black ink pens
- Waterproof and permanent marker
- 55-gallon drum, holding tank, or 5-gallon buckets for storing purged water (if necessary)
- Plastic sheeting (for placing around well)
- Appropriate decontamination equipment as specified in SOP III-I, *Equipment Decontamination.*

- Sample jars, labels, and chain-of-custody forms. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.

2.2 EQUIPMENT DECONTAMINATION

If not using disposable, non-reusable sampling equipment, before any purging or sampling begins, decontaminate all bailers and other purging or sampling equipment following the procedures specified in the SOP III-I, *Equipment Decontamination*, for sampling equipment decontamination.

2.3 INSTRUMENT CALIBRATION

Before going into the field, verify that field instruments are operating properly. The pH and conductivity meters require calibration prior to use every day. Record calibration times and readings in the field log book. Specific instructions for calibrating the instruments are given in the manufacturer's manual; additional information may also be available in SOP I-D-7, *Field Parameter Measurement.*

2.4 WELL VOLUME CALCULATIONS

Use the appropriate equation to calculate the volume of water inside a well of any diameter:

Volume of water in casing (gal) = 12 x water column (ft.) x π (pi) x (well radius in inches)^2 x 0.0043

Volume of water in annulus (gal) = 12 x water column (ft.) x π (pi) x [(borehole radius in inches)^2 - (well radius in inches)^2] x 0.0043

Multiply the volume of one well casing volume by 3 to obtain the minimum volume of water to be purged.

2.5 WELL PURGING

The purpose of well purging is to remove stagnant water from the well so that a sample of water representative of the aquifer (or portion of aquifer) can be obtained. Unless the project plans state otherwise, before a sample is taken, purge the well a minimum of three well casing volumes. Ensure that water parameters (pH, conductivity) have stabilized or the well is bailed dry. Purge the well on the same day that samples are taken. Handle purged well water according to the protocols outlined in the SOP I-A-7 for investigation-derived waste management.

Before well purging begins, perform the following procedures:

1. Note the conditions of the area around the well. Place plastic sheeting around the well.
2. Open the well.
3. Note the condition of the well cap and casing.
4. Measure the depth of the static water level to the nearest 0.01-foot and the top of PVC well casing at the northernmost point or some other pre-marked point.
5. Measure the total well depth from the same point used to measure the water level.
6. Calculate the volume of water in the well casing in gallons, based on feet of water and casing diameter.
7. Obtain an initial sample from the bailer for field measurements of temperature, conductivity, and pH, and for observation of water quality.
8. Remove three volumes of water from the casing with a bailer or pump (refer to Attachment I-C-4-3 and Attachment I-C-4-4). Techniques for low-flow groundwater sampling can be referenced in SOP I-C-5, Low-Flow Groundwater Purging and

Sampling. Measure temperature, conductivity, and pH for each well volume removed to determine water parameter stability. For low-flow sampling, measure temperature, conductivity, and pH every 5 minutes (for 20 to 30 minutes) until the water parameters have stabilized.

9. When evacuating a well using a pump, place the pump intake as follows:
    - At the bottom of the screened interval, for low-recovery wells (wells that can be pumped dry)
    - At two-thirds of the way down the screen length for low-flow sampling
    - At the top of the water column for high-recovery wells (little drawdown with pumping)
10. If the well is bailed or pumped dry during evacuation, assume that all stagnant water has been removed and the well is ready to be sampled. If recovery is very slow, obtain samples as soon as sufficient water is available in the well.

2.6 SAMPLE COLLECTION

Collect samples for chemical analysis within 8 hours after purging is completed. For low-recovery wells, collect the sample immediately after a sufficient volume is available. The following sampling procedure is to be used at each well:

1. Assemble sampling equipment. Use either new nylon rope for each well for each sampling event or decontaminated stainless steel cable on a reel. Do not use any type of adhesive tape to secure the rope or twine knot. The adhesive may contain chemical constituents that could contaminate the water that is being sampled.
2. Complete the identification labels for sample containers for each well.
3. Use a new pair of disposable gloves at each sample collection location.
4. Lower bailer slowly and gently into contact with the water in the well. If additional volume of water is required to fill all the sample containers, the bailer will be lowered to the same depth in the well each time.
5. Retrieve bailer smoothly and drain water slowly into the sample containers. Attachment I-C-4-5 provides instructions for filtering the samples that require dissolved metals analysis.
6. Fill individual sample containers. The first samples to be collected should be for the analysis of volatile organic compounds (VOCs).
7. Fill VOC sample vials completely so the water forms a convex meniscus at the top, then cap so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles that would indicate airspace. If air bubbles are observed in the sample, discard the sample vial and repeat the procedure.
8. Record time of sampling.
9. Replace and lock well cap.
10. Document field activities, including the chain-of-custody documentation, in accordance with SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures.*

The well sampling order depends on expected levels of contamination in each well, if known, determined prior to sampling. Sampling should progress from the least contaminated to the most contaminated well.

2.7 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLES

Field QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. The frequency of

QA/QC sample collection and the types of QA/QC samples required are described in the project plans. All QA/QC samples are labeled with identification numbers and sent to the analytical laboratory “blind” with the other samples. Refer to the SOP III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody Procedures.*

3.0 DOCUMENTATION

The following information for groundwater sampling is included in the field logbook and/or a groundwater sampling data form (Attachment I-C-4-2):

- Date
- Time
- Weather
- Personnel on site
- Site location description
- General observations
- Well designation and well location
- Condition of the well
- Initial static water level and total well depth
- Calculations (e.g., calculation of purged volume)
- Number of well volumes purged
- Volume of water purged before sampling
- Conductivity, temperature, dissolved oxygen, turbidity and pH during purging
- Decontamination information
- Date and time of sampling
- Person performing sampling
- Number of samples taken
- Sample IDs associated with each well sampled
- Preservation of samples
- Analyses that will be performed by the laboratory
- Record of any QA/QC samples
- Any irregularities or problems that may have a bearing on sampling quality
- Unusual events
- Visitors to the site

All entries in the field logbook must be printed in black ink and legible.

4.0 REFERENCES

SOP I-A-7, IDW Management
SOP I-C-5, Low-Flow Groundwater Purging and Sampling
SOP I-D-7, Field Parameter Measurement
SOP III-E, Record Keeping, Sample Labeling and Chain-of-Custody Procedures
SOP III-I, Equipment Decontamination

5.0 ATTACHMENTS

Attachment I-C-4-1	Groundwater Sampling From a Piezometer, Checklist of Procedures
Attachment I-C-4-2	Groundwater Sampling Data Form
Attachment I-C-4-3	Hand Bailer Sampling Technique
Attachment I-C-4-4	Pump Sampling Technique

Attachment I-C-4-5 Dissolved Metals Sample Collection

Attachment I-C-4-1
Groundwater Sampling From a Piezometer
Checklist of Procedures

- ☐ Have access agreements been obtained? Has permission been granted to mobilize on site?
- ☐ What site facilities are available during the groundwater sampling event?
    - ☐ Restrooms
    - ☐ Water
    - ☐ Telephone
- ☐ Are the temporary well locations clear of all ground cover (i.e., bushes, brush)?
- ☐ Are locations identified on a grid map or relative to other site marking?

Attachment I-C-4-2
Groundwater Sampling Data Form

Project Number: ______________________ Date: ______________________

Location: ______________________ Time: ______________________

Well Number: ______________________ Climatic Conditions: ______________________

Initial Measurements: Static Water Level: ______________
Total Depth: ______________

Well Purging: Length of Saturated Zone: ______________linear feet
Volume of Water to be Evacuated: ______________gals./linear ft. x
Linear feet of Saturation x Casing Volumes* = ______________gallons
Method of Removal: ______________________
Pumping Rate: ______________ gallons/minute

Well Purge Data:

DATE/ TIME	GALLONS REMOVED	pH	SP. COND.	D.O.	REDOX	TURBIDITY

Sample Withdrawal Method: ______________________
Appearance of Sample: Color ______________________
Turbidity ______________________
Sediment ______________________
Other ______________________

Laboratory Analysis Parameters and Preservatives: ______________________
____

Number and Types of Sample Containers Used: ______________________
____

Sample Identification Number(s): ______________________
____

Decontamination Procedures:______________________
____

Notes: ______________________
____

Sampled by:______________________
Samples delivered to:______________________
Date/Time:______________________
Transporters: ______________________

* Capacity of casing (gallons/linear foot): 2”-0.16, 4”-0.65, 6”-1.47, 8”-2.61, 10”-4.08, 12”-5.87

Attachment I-C-4-3
Hand Bailer Sampling Technique

Prior to the start of the field work, review the type of contaminants expected to be encountered and the type of bailer materials being employed to ensure that the materials are compatible with the types of anticipated contaminants and to ensure that the samples will not be cross-contaminated by construction materials (e.g., plastics typically will introduce phthalates into the sample). The types of bailer and material used for construction are specified in the project plans. Preferred materials of construction are polytetrafluorethylene (PTFE) and stainless steel, but other materials may be used if determined to be compatible. Disposable bailers are typically constructed of polyethylene or polyvinyl chloride and may not be compatible with the types of contaminants expected to be encountered. Sampling of the well can begin after the well has been evacuated of the required volume of water. Normally, sampling will be conducted within 2 hours of completion of purging.

1. Cover the area surrounding the well with plastic sheeting so that the bailer cord does not contact the ground surface and transfer potentially contaminated soil particles into the well.
2. Select an appropriate bailer for the size of the well to be sampled. If non-dedicated equipment is used in the sampling process, field staff will decontaminate the equipment according to the SOP for equipment decontamination prior to each use.
3. Use a dedicated length of rope or cord for each purging or sample collection. Typically, a rope made of polyethylene or other nonreactive material, or stainless steel cable on a reel, is used for the bailer cord.
4. Fasten the rope securely to the top of the bailer in such a way as to prevent the loss of the bailer down the well. Ensure that the rope or cord employed is strong enough to prevent breakage when subjected to the weight of the full bailer. Firmly attach the end of the rope that is not attached to the bailer to the well monument or other surface feature to prevent the loss of the bailer and rope down the well.
5. Lower the bailer into the water slowly to avoid aerating the water and losing volatile contaminants. Under no circumstances will a bailer be allowed to fall freely into the water. Lower the bailer into the water opposite the well screen and then retrieve it to the surface.
6. After the bailer is retrieved to the surface, slowly transfer the water into the appropriate sample containers. Fill the sample containers for volatile organics analyses (VOA) first. Fill each VOA vial completely so that the water mounds at the top of each vial, and then place the cap carefully on the vial. Check each vial for headspace bubbles by inverting the vial and tapping it against the hand. If bubbles are present, select a new vial and fill it according to the same procedure until no headspace is indicated.
7. Fill the remaining sample containers by repeated trips into the well with the bailer. Fill sample containers for analyses other than volatile organics to the shoulder of the container to allow for addition of preservatives and for expansion and contraction of the sample.

Attachment I-C-4-4
Pump Sampling Technique

1. Insert an electrical water level probe into the well to determine static water level.
2. Where the static water level is above the top of the well screen, install the pump so that the pump intake is not more than 1 foot below the top of the screen.
3. Where the static water level is below the top of the well screen, carefully sound the bottom of the well with the probe. The difference between recorded well depth and measured well depth is probably from accumulated silt. Carefully install the pump so the bottom of the pump is not less than 1 foot above the measured bottom of the well. This prevents the pump from becoming silted into the well, and prevents silt from being pulled into the groundwater sample.
4. For low-flow sampling, place pump two-thirds of the way down screen.
5. Using the adjustment on the pump control box, initialize pumping at a minimum rate and slowly increase the rate until observable drawdown is measured using the water level probe. If permeability or pumping information is available from previous studies, calculate estimated pumping rate before starting field sampling.
6. Maintain an ideal pumping rate, i.e., a rate that does not create a drawdown in the well of over 0.5 foot. However, judgment must be used in balancing ideal conditions against completion of the project. Refer questions to the Site Manager.
7. At the completion of well purging, record time and water level measurements during the recovery of water level to static conditions.
8. Conduct well sampling with the pump at a flow rate not exceeding 0.2 to 0.3 liter per minute. Use a 0.45-micron in-line filter to collect samples for analyses of dissolved inorganics; all other samples should be unfiltered.
9. Pump samples directly into appropriate sample containers and preserve per the SOP III-F for sampling containers, preservation, and maximum holding times.

Attachment I-C-4-5
Dissolved Metals Sample Collection

1. Collect a groundwater sample from the well.
2. Prior to containerizing the sample, filter the groundwater using a disposable 0.45-micron filter.
3. Introduce the filtered groundwater into the sample container (with preservative) immediately after filtering, or filter the water directly into the sample container.
4. If the filter becomes clogged or filtering is severely impeded by sediment particles in the filter, replace the filter with an unused (new) filter. Ensure that used filters are not used on samples collected later in the field investigations.

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV. Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project – Name of project site.

- Sample Identification - The unique sample number identifying this sample.

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 05/21/17).

- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name or initials of the sampler.
- Remarks - Any pertinent additional information.

The field team should always follow the sample ID system prepared by the Project Chemist and reviewed by the Project Manager.

Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include ***only*** the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample locations in photographs, an easily read sign with the appropriate sample location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler**. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used and enter the airbill number under "Remarks," in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

V Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VI Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Meter with Flow-Through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality meter for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Monitoring System with flow-though cell (Horiba, YSI, In-Situ, Ion Science, etc)
- Calibration Standard Solution(s) (provided by rental company)
- Deionized water in spray bottle

III. Procedures and Guidelines

A. General Parameters and Specifications:

Note: the general parameters listed below may not be available for every type of meter used. Please refer to the specific meter's manual to determine meter's range of measurement and accuracy.

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 ^{o}C	+/- 1.0 ^{o}C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day’s use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution. Refer to the specific instrumentation manual for the proper calibration methods.

C. Sample Measurement:

The water quality probes are inserted into a flow-through cell, and the purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere. The flow-through cell should be positioned out of direct sunlight to reduce solar heating, and wrapped in aluminum foil to minimize heat loss or gain.

As water passes through the flow-through the flow cell, press MEAS to obtain readings or the readings are displayed on the meter for each parameter (dependent on the type of meter used). Record the water quality parameter data in a field notebook.

Once the parameters have stabilized (see *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III* or *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV* depending on project site location), remove the tubing from the bottom port of the flow-through cell.

Never collect a groundwater sample for laboratory analysis from the flow-through cell. Rinse the flow-through cell between wells to remove any sediment buildup within the cell.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gauges in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers).*

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a solid tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically, this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also, when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gauges may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gauge is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two or three (lab dependent) 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a submersible pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

DRAFT FINAL STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Groundwater Sampling for Per- and Polyfluoroalkyl Substances (PFAS)

I. Purpose and Scope

This SOP provides guidelines for groundwater sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with QSM 5.1 Table B-15. This SOP should be used in conjunction with approved region-specific groundwater sampling SOPs which provide methods for general and low-flow groundwater sampling. In cases in which information in this SOP conflicts with region-specific groundwater sampling SOPs, this SOP will supersede the information in the general SOPs.

Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

Equipment and Materials Required

- If installing wells, ensure driller does not use polytetrafluoroethylene (PFTE)-containing drill lube or other drilling lubes containing PFAS. Biolube has been determined to be an acceptable drilling lube for installing wells where PFAS may be of concern. Additionally, Waterra surge blocks have been confirmed to not contain PFAS and may be used for development.
- Groundwater sampling equipment
  - PFAS-free tubing (avoid Teflon, Viton, PTFE and other fluorinated compounds)
    - High density polyethylene tubing (unlined)
    - If Masterflex tubing is needed for peristaltic pumps, Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
  - PFAS-free Bailer (if using a bailer[1])
  - PFAS-free Pump such as:
    - Geotech PFAS-free Portable Bladder Pump (note, most bladder pumps include a Teflon-lined bladder, but Geotech currently has one model which is Teflon-free).
    - Panacea P120 or P125. The P200 Stainless Steel Pump may also be used, but the standard model contains Teflon at the tube connection. If you are using this Panacea model, you must request one with the "PTFE-free thread sealant option."
    - Waterra stainless foot-valve
    - QED Sample Pro

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[1] Geotech and Waterra offer PFAS free bailer options

  - Monsoon or Mega Monsoon submersible pump
  - Grundfos Rediflo2 (this pump contains small Teflon components, but has not been shown to leach, it is less preferable than the other options)
  - Peristaltic pump (may be suitable for shallow locations)
- Groundwater sample containers (high density polyethylene [HDPE] bottle with HDPE screwcap), sample bottles should not be glass as glass may sorb PFAS. Sample bottle caps should not contain Teflon. Notify your project manager (PM) if bottles provided by the lab are glass or contain Teflon parts.
- Laboratory prepared deionized, certified PFAS-free water for field blank collection
- PFAS-free shipping supplies (labels [if available][2], coolers, and ice)
- Loose leaf paper without waterproof coating or a spiralbound notebook (not waterproof)
- Metal clip board (if using loose-leaf paper)
- Pen (not Sharpie)
- Nitrile or latex gloves

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect groundwater samples should not contain any fluorinated compounds, Teflon, or synthetic rubber with fluoropolymer elastomers (e.g., Viton).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings
- New clothing that has been washed fewer than six times

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

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[2] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

III. Procedures and Guidelines

Wash hands with dish detergent before sampling and don nitrile gloves. Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine

Follow Navy CLEAN SOPs for low-flow or conventional groundwater sample collection, depending on site requirements.

Sample Collection

Once water quality parameters have stabilized for low-flow purging, samples can be collected. For conventional purging, if water quality parameters do not stabilize, a minimum of 3 well volumes must be purged prior to sample collection.

The steps to be followed for sample collection are as follows:

1. Ensure that the end of the tubing does not touch the ground or equipment. Remove the cap from the sample bottle. Position the sample bottle under the end of the tubing.
2. Fill the bottle. Samples do not need to be collected headspace free.
3. Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling. Pack the sample on ice immediately for shipment to the offsite laboratory. Avoid packing materials that may contain fluorine. Unpublished research has allowed us to generate a list of packing materials which do not contain fluorine. Please contact Bill Diguiseppi or Laura Cook for recommendations (because the research is not ours, it cannot be released externally at this time).

Equipment Decontamination

Whenever possible, use disposable equipment when collecting groundwater samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

Use of Water Quality Equipment and Water Level Indicators

Water quality meters typically do not contain PFAS. However, consistent with general sampling SOPs, disconnect the water quality meter prior to sampling. Some water level indicators do contain small polyvinylidene fluoride (a PFAS constituent for which we do not currently monitor) or less frequently, Teflon, components, but we have not noted cross contamination from water level indicators at any sites. The Durham Geoslope Water Level Indicators and the Solinst Model 101 with the P2 meter have been shown to be fluorine free.

V. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/ Tandem Mass Spectrometry (LC/MS/MS).* September.

United States Navy, 2017. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs).* September

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic acid.* September*.*

DRAFT FINAL STANDARD OPERATING PROCEDURE – NAVY CLEAN PROGRAM

Surface Water Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose and Scope

This SOP provides guidelines for surface water sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with QSM 5.1 Table B-15. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Materials and Equipment

Equipment and Materials Required

- Open tube sampler
- Dip sampler
- Weighted bottle sampler (no glass)
- Hand pump without Teflon components
- Van Dorn sampler (Kemmerer cannot be used as it has Teflon caps)
- Depth-integrating sampler
- Peristaltic pump and PFAS-free tubing
  - High density polyethylene tubing (unlined)
  - Masterflex tubing such as Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
- Sample containers (high density polyethylene [HDPE] with HDPE screw cap [no Teflon caps])
- PFAS-free labels (if available[1]) and shipping materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard
- Pen (not Sharpie)
- Nitrile or Latex gloves (Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine)
- Meters for specific conductance, temperature, pH, and dissolved oxygen

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[1] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

Equipment and materials used to collect surface water samples should not contain any fluorinated compounds including Teflon or synthetic rubber with fluoropolymer elastomers (e.g. Viton). Neoprene and rubber waders should not be an issue, however, check with your PFAS subject matter expert (SME) during field preparation to ensure all equipment is free of fluorine-containing components.

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect groundwater samples should not contain any fluorinated compounds, Teflon, or synthetic rubber with fluoropolymer elastomers (e.g., Viton).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings
- New clothing that has been washed fewer than six times

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Wash hands with dish detergent before sampling and don nitrile gloves. Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine.

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment* as well as this SOP (see below). Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Once the area has been determined to be free of materials potentially containing PFAS, follow the methods for surface water sample collection described below.

Surface water samples are collected manually by submerging a clean stainless steel or polypropylene container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline provided the bottle or bottle cap does not contain Teflon. The most common sampler types are sealable bottles, pond samplers, peristaltic pumps, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. A specific type of weighted bottle sampler is the Van Dorn and is acceptable in most instances. The Kemmerer weighted bottle sampler cannot be used for PFAS sampling due to the Teflon caps.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time. Fill all sample containers. Affix labels after sample containers are closed; collect only one sample at a time to avoid mislabeling.
5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

Equipment Decontamination

Whenever possible, use disposable equipment when collecting surface water samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

Use of Water Quality Equipment

Water quality meters typically do not contain PFAS. However, consistent with general sampling SOPs, disconnect the water quality meter prior to sampling.

References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)*. September.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic acid.* September.

DRAFT FINAL STANDARD OPERATING PROCEDURE – NAVY CLEAN PROGRAM

Soil Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose

This SOP provides guidelines for soil sample collection and handling for samples that will be analyzed for per- and polyfluoroalkyl substances (PFAS) via LC/MS/MS Compliant with QSM 5.1 Table B-15. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

Equipment and Materials Required

- A hand auger or other device that can be used to remove the soil from the ground. Stainless steel tools, carbon steel tools, or steel DPT tooling with acetate sleeves are preferred for PFAS sampling. Avoid any sampling materials containing PFAS (such as Teflon, Viton, PTFE, or other fluorinated compounds). Any plastic sampling materials should be evaluated thoroughly before selection to ensure they are fluorine-free.
- A stainless steel spatula or fluorine-free disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit
- PFAS-free labels (if available[1]) shipping materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard (if using loose-leaf paper)
- Pen (not Sharpie)
- Personal protection equipment (rubber or latex gloves, boots, etc.). Check with your SME prior to selecting PPE to ensure there are no fluorine-containing components.
- Sample jars (sample jars should be made of high density polyethylene (HDPE) as glass jars may sorb PFAS, please notify the project manager [PM] if glass jars are provided by the lab). Sample containers should not contain Teflon lids.
- Laboratory-prepared deionized, certified PFAS-free water for field blank collection

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[1] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect soil samples should not contain any fluorinated compounds including Teflon or synthetic rubber with fluoropolymer elastomers (e.g. Viton).

If a driller is supporting collection of soil samples in split spoons or acetate DPT sleeves, ensure the driller has not used and will not use drilling lube containing polytetrafluoroethylene (PTFE) or any other fluorine-containing substance. Biolube has been determined to be an acceptable substitute.

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings
- New clothing that has been washed fewer than six times

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Once the area has been determined to be free of materials potentially containing PFAS, these steps can be followed to collect the soil samples:

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

   1. For samples on a grid:

      a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the field notebook/clipboard.

      b. Proceed to sample the points on the grid line.

      c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

    d. Proceed to sample the points on the grid line as described in Section C below.
    e. Make sure to stake location after sample collection in case professional surveying is to be completed.
    f. Repeat 1c and 1e above until all samples are collected from the area.
    g. Or, a GPS unit can be used to identify each location based on map coordinates, if available.

2. For non-grid samples:
    a. Use measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).
    b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.
    c. Proceed to sample as described in Section C below.
    d. Make sure to stake location after sample collection in case professional surveying is to be completed.
    e. Repeat 2a through 2d above until all samples are collected from the area.
    f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point may be deleted from the program. The FTL will contact the CH2M HILL PM immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples using hand tools:

1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoop to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks if the disposable scoops have been confirmed by your project PFAS subject matter expert (SME) to be PFAS free.

2. If sampling:
    a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.
    b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Record lithologic description and any pertinent observations (such as discoloration) in the field notebook/clipboard.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. Homogenize cuttings in the pan using a decontaminated stainless steel utensil.

7. Transfer sample for analysis into appropriate containers with a decontaminated utensil. Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling.

8. Immediately upon collection, all samples for chemical analysis are to be placed in a closed container on ice unless it is not possible to do so. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible.

9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

E. To collect Samples Using DPT Methods

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*. Ensure that decontamination water used is PFAS free (do not use water from fire hydrants on-base for steam cleaning unless the water has been demonstrated to be free of PFAS).

2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.

3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.

4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).

5. Fill all sample containers, using a decontaminated or dedicated sampling implement. Label the containers and immediately place samples on ice for shipment to the laboratory.

6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP Decontamination of Personnel and Equipment and ensure decontamination water is from a PFAS-free water source.

7. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

Equipment Decontamination

Whenever possible, use disposable equipment when collecting soil samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)*. September.

United States Navy, 2017. Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs). September.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic acid.* September

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under Jacobs Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated Jacobs HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- Strapping tape
- Contractor bags
- Absorbent pads or equivalent
- Resealable bags
- Bubble bags (for glass bottle ware)
- Bubble wrap (if needed)
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with absorbent pads or similar material.
- Place a contractor bag inside the cooler.

B. Affix appropriate adhesive sample labels to each container. Protect with clear packing tape.

C. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks. Cross check CoC to ensure all samples are present.

D. Seal each glass sample bottle within a separate bubble bag (VOCs grouped per sample location). Sample labels should be visible through the bag. Whenever possible, group samples per location for all analytes and place in resealable bags. Make sure to release as much air as practicable from the bag before sealing.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in resealable bags and placed on and around the containers.

G. Fill remaining spaces with bubble wrap if needed.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear packing tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with clear packing tape to avoid seals being able to be peeled from the cooler.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Scan airbill receipt and CoC and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result, only employees who are trained under Jacobs Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated Jacobs HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® and water solution
- Concentrated (V/V) pesticide grade isopropanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep equipment from touching the ground
3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.
4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.
5. Rinse with 1 gallon of 10% isopropanol solution pumped through the pump. (DO NOT USE ACETONE). (Optional)
6. Rinse with 1 gallon of tap water. (deionized water may be substituted for tap water)
7. Rinse with 1 gallon of deionized water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and isopropanol solution (DO NOT USE ACETONE). (Optional)
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, Liquinox® solution (optional), and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or frac tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or roll-offs or frac tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. Check with the Environmental Manager (EM) assigned to the project prior to sample collection for frequency and analysis. Unless otherwise specified by the EM, the drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. Additional analysis may be required by your EM.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Analysis pending labels should be used initially. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to frac tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents as per instruction from the project EM. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills. The drums should be staged such that the labels are all visible and there should be enough room to walk between rows of drums if applicable.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Contact the project Environmental Manager prior to containerizing waste to determine containerization method and sampling frequency and analysis.
- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Management of Liquid Waste Containing Per- and Polyfluoroalkyl Substances (PFAS)

I. Purpose and Scope

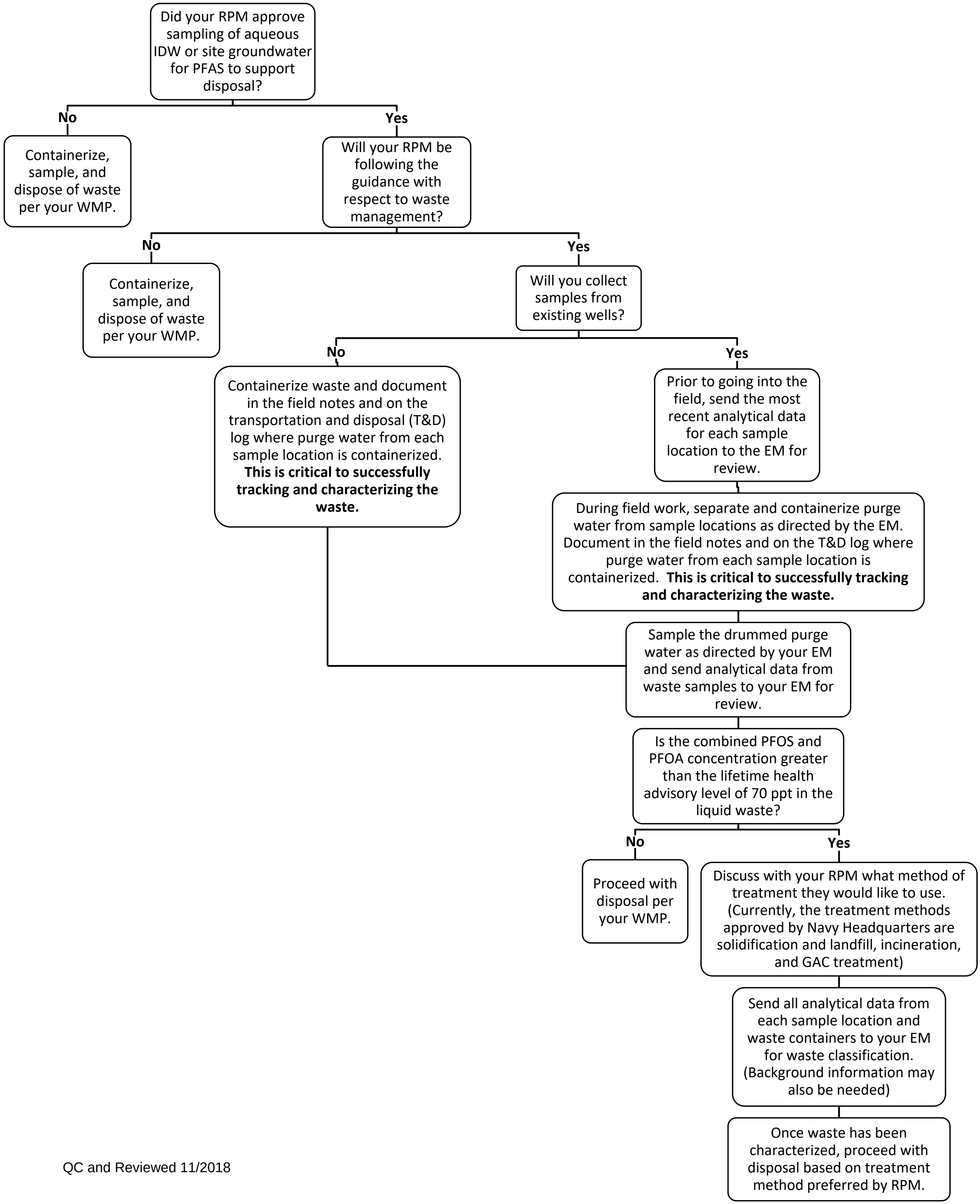
This SOP provides guidelines for managing waste containing per- and polyfluoalklyl substances (PFAS) in accordance with the *Interim Per- and Polyfluoralkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/September 2017 Update* (guidance). This SOP should be used in conjunction with an Environmental and/or Waste Management Plan (EMP and/or WMP) approved by your Environmental Manager (EM). If you do not have a site-specific EMP, please contact your EM.

Standard procedures for managing liquid waste during PFAS investigation are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000.

Currently, PFAS are not regulated as a hazardous waste in US EPA regulations (state and territory rules may vary). Treatment of liquid waste containing PFAS, as recommended by the guidance, is a client directed action. When and how it is implemented will be left to the discretion of the individual RPMs. These project specific actions will be communicated with the Project Manager (PM) and/or Activity Manager (AM).

II. Procedures and Guidelines

The following flowchart outlines the procedures required to manage liquid waste during PFAS investigations. Any deviations from this procedure must be approved by the EM.



QC and Reviewed 11/2018

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, and then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

III. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with a Multi RAE or equivalent may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

IV. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safety plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

V. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.

8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.

9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).

11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.
3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.
4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.
5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.
2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.
3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.
4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)
5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.
6. Sample each trailer compartment.
7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

<u>Drum</u>

Glass tube – Procedure 1

COLIWASA — Procedure 2

<u>Storage Tank and Tank Trailer</u>

COLIWASA — Procedure 2
Bacon Bomb — Procedure 3
Gravity Corer — Procedure 4
(for bottom sludge)

VI. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

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U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites – A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

Environmental Surveillance Procedures, Quality Control Program, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

X. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for “waste,” so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.
9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless-steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside 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. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, 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. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.

2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

3. 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 the 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.

4. 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.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.
6. Carefully discharge the sample into a suitable 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.
7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

Uses

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

Procedures for Use

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked “NON SPARKING” is encouraged. However, the use of a “NON SPARKING” wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way

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[1] Taken from EPA Training Course: “Sampling for Hazardous Materials,” U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader 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 pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4- foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, “sprayers” may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be “staged,” or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this 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/lid 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.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time- consuming and is the major drawback of this device. 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.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness 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.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C.**

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These "dig permit" requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1)** ***a 20-ft radius of the XX proposed soil boring locations*** **(OR)** ***within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint** ***(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) ***The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.***

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

   The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1] Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2] Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Steve Saville/KNV

Home Office Phone – 720-261-5367

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

STANDARD OPERATING PROCEDURE

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells, Installation of Surface-Cased Monitoring Wells, Installation of Bedrock Monitoring Wells,* and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double-cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless-steel may be required under certain contaminant conditions.
4. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.

5. A record of the finished well construction will be compiled.

6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- 2″ monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.

- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).

- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless-steel) screen with threaded bottom plug and riser.

- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.

- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base of the well to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.

Screen Size Opening (Inches)	Screen Size Slot Number	Typical Sand Pack Mesh Size (U.S. Standard Sieve Number)
0.005	5	100
0.010	10	20 to 40
0.020	20	10 to 20
0.030	30	10 to 20

- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.

- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.

- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage. A grout density scale is recommended for determining the correct density. See attached grout volume and weights chart for calculation of grout volume.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.

- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis and transport the drums to a designated site for storage.

V. Attachments

Grout Volume and Weights Chart

VI. Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox®
- Buckets
- Brushes
- Isopropanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM–Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

   Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

   a. Rinse with tap water
   b. Rinse with de-ionized water
   c. Solvent rinse with isopropanol (Optional)
   d. Rinse with de-ionized water

2. Probes

   Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, PID equipment, the probe will be wiped with clean paper-towels or cloth wetted with isopropanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

STANDARD OPERATING PROCEDURE

Multi RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Multi RAE PID in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information on the field operation and general maintenance of the Multi RAE PID. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Carbon Monoxide Sensor (CO) - Carbon Monoxide concentration in ppm.

Volatile Organic Compound (VOC) – VOC concentration in ppm

Lower Explosive Limit (LEL) - Combustible gas is expressed as a percent of the lower explosive limit.

Hydrogen Sulfide Sensor (H_2S) - Hydrogen Sulfide concentration in ppm.

Oxygen Sensor (OXY) - Oxygen concentration as a percentage.

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

IV. Procedures

The PID operates on the principle that most organic compounds and some inorganic compounds are ionized when they are bombarded by high-energy ultraviolet light. The air sample is drawn across a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique photoionization potential (PIP). When the UV light energy is greater than the ionization potential of the chemical, ionization will occur. All PID readings are relative to the calibration gas, usually isobutylene.

It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For environments where background readings are high, factory zero calibration gas should be used.

Note: For volatile and semi-volatile compounds, knowing the PIP is critical in determining the appropriate instrument to use when organic vapor screening. Consult the QAPP and manufacturer's manual to determine that the proper instrument has been selected for the contaminate vapors of interest. If an expected compound at a site has a PIP less than 11.7 eV, it is possible to use a PID. If the ionization potential is greater than 11.7eV, a flame-ionization detector is required.

The following subsections will discuss Mini RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

For Multi RAE configured with O_2, LEL, H_2S, CO, sensors and a 10.6 eV PID Lamp.

Start up Instrument

- Press **Mode** button
- Observe displays:

On!……..

Multi RAE
Version X.XX

Model Number
SN XXXX

Date Time
Temp

Checking Sensor
Ids….

VOC Installed

CO Installed

H_2S Installed

OXY Installed

LEL Installed

H_2S VOC CO
LEL OXY

Alarm Limits=

XX XX.X XX
XX High XX.X

XX XX.X XX
XX Low XX.X

XX XX.X XX
STEL

XX XX.X XX
TWA

Battery = X.XV
Shut off at 4.2V

User Mode=

Alarm Mode=

Datalog Time Left

Datalog Mode

Datalog Period

Unit ready in…..
10 Seconds

- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the **[N/-]** key first, then while depressing the **[N/-]**, depress the **[Mode]** key also and depress both keys for 5 seconds.
- Display will read:

Calibrate
Monitor?

- Press the **[Y/+]** key
- Display will read:

Fresh Air
Calibration?

- If “Zero Air” is necessary, attach the calibration adapter over the inlet port of the Multi RAE Monitor and connect the other end of the tube to the gas regulator (HAZCO loaner regulator LREG.5, RAE Systems P/N 008-3011 or suitable .5 LPM regulator) on the Zero Air bottle (HAZCO P/N SGZA, RAE P/N 600-0024). If no Zero Air is available, perform the Fresh Air Calibration in an area free of any detectable vapor.
- Press the **[Y/+]** key
- Display will read:

Zero….
In progress…

CO Zeroed!
Reading = X

VOC Zeroed!
Reading = X

LEL Zeroed!
Reading = X

OXY Zeroed!
Reading = X

Zero Cal done!

H_2S Zeroed!
Reading = X

In each of the above screens, “X” is equal to the reading of the sensor before it was zeroed.

- Display will then read:

Multiple Sensor
Calibration?

- Press the **[Y/+]** key
- The display shows all of the pre-selected sensors and the “OK?” question:

CO H_2S
LEL OK? OXY

- Apply calibration gas – use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 – using a .5 LPM regulator and direct tubing.
- Press the **[Y/+]** key. Display will read:

Apply Mixed gas

Calibration
In progress …

- The display will count down showing the number of remaining seconds:

CO cal’ed
Reading=50

H_2S cal’ed
Reading=25

LEL cal’ed
Reading=50

OXY cal’ed
Reading=20.9

Calibration done
Turn off gas!

- Display will read:

Single Sensor
Calibration?

- Press the **[Y/+]**.
- Display will read:

CO VOC H_2S
LEL pick? OXY

- Attach 100 ppm Isobutylene (HAZCO P/N r-SGISO or Rae P/N 600-0002) using a 1.0 LPM regulator (HAZCO P/N LR10HS or Rae P/N 008-3021). Open regulator.
- Press the **[Mode]** key once, the V of VOC will be highlighted.
- Press the **[Y/+]**. The display will read:

Apply VOC Gas

Calibration
In progress…

- The display will count down showing the number of remaining seconds:, then display:

VOC cal’d
Reading=100

Calibration done
Turn off gas!

Single Sensor
Calibration?

- Press **[Mode]** key twice to return to main screen.

- **CALIBRATION IS COMPLETE!**

B. Operation

Due to the Multi RAE having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 9 to 14.

C. Site Maintenance

After each use, the meter should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

Function	Frequency
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

V. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g, Multi RAE had wide range fluctuations during air monitoring activities.)

VI. References

Multi RAE Plus Multiple Gas Monitor User Manual, RAE Systems, Revision B1, November 2003.

STANDARD OPERATING PROCEDURE

Civil Surveying

I. Purpose and Scope

The SOP describes survey procedures to be used on CLEAN projects. Modified third-order survey procedures will be used for most surveying. Geographic Positioning System techniques will be used for measurement of some horizontal coordinates. These procedures are general guidelines only and are in no way intended to replace the specifications in the surveyor's subcontract.

II. Records and Definitions

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field identification number and environmental settings. Graphite pencils or waterproof ballpoint pens should be used. Erasing is not acceptable; use a single-strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work. Field notebooks will be available on site.

The following terms are defined to clarify discussion in this SOP:

- North American Datum (NAD) -The standard geodetic datum on the North American continent.
- National Geodetic Vertical Datum (NGVD) - The vertical-control datum used (1929 or later) by the National Geodetic Survey for vertical control.
- Horizontal Control - Horizontal location of an object from surveyed corners or other features on permanent land monuments in the immediate site area. Will be based on North American Datum (NAD) 1983 and state plane grid systems.
- Vertical Control - Vertical location of an object compared to the adjacent ground surface.
- Bench Mark - Precisely determined elevation above or below sea level. May also have horizontal control (northing, easting) determined for location.

III. Surveying

Horizontal Survey

Horizontal angular measurements shall be made with a 20-second or better theodolite or transit. When using a 20-second instrument the horizontal angles shall be turned four times (two each direct and inverted) with the mean of the fourth angle being within 5 seconds of the mean of the second angle. When using a 10-second or better instrument the angles shall be doubled (once each direct and inverted), with the mean of the second angle within 5 seconds of the first angle. The minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a calibrated steel tape corrected for temperature and tension or a calibrated electronic distance meter (EDM). When using an EDM the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 20 seconds of arc deviation from the horizontal plane. Horizontal locations will be surveyed to within 0.05-foot of the true location.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

The horizontal location will be referenced to NAD83 and the appropriate state plane grid system.

Some horizontal coordinates will be measured using Geographic Positioning System (GPS) equipment. This approach will be used in particular for determining the coordinates of surface-water and sediment sampling locations, and may be used also for determining the locations of piezometers and monitoring wells. The GPS survey will be performed by staff trained in the use of the equipment and will conform to guidance provided by the manufacturer.

Vertical Survey

When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent benchmark. If practical, level circuits should close on a known benchmark other than the starting benchmark. The following criteria shall be met in conducting the survey:

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.
- Rod readings shall be made to 0.01-foot and estimated to 0.005-foot.
- Elevations shall be adjusted and recorded to 0.01-foot.

Temporary benchmarks (TBMs) shall be established and referenced for future use. All TBMs shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBMs shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc.

(Horizontal traverse stations will not be considered as a TBM but may be used as a permanent turning point.)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step One—Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
- Step Two—Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule.
- Step Three—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.
- Step Four—The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Piezometer and Monitoring-Well Surveys

Piezometer and monitoring-well locations will be surveyed only after the installation of the protective casing, which is set in concrete. The horizontal plane survey accuracy is ±0.05-foot and is measured to any point on the protective-casing cover. The vertical plane survey must be accurate to ±0.01-foot. The following two elevations will be measured at piezometers and monitoring wells:

- Top of the piezometer or well riser (not on the protective casing), preferably on the north side
- Ground surface, preferably on the north side of the well

If no notch or mark exists, the point at which the elevation was measured on the inner casing shall be described so that water-level measurements may be taken from the same location.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is ± 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

Exhibit A

STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

Traverse

Max Number of bearing courses between azimuth checks	30
Astronomical bearings: standard error of results	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000

Leveling

Levels error of closure per loop in feet	0.05 $\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

STANDARD OPERATING PROCEDURE

Monitoring Well and Borehole Abandonment

I. Purpose and Scope

The purpose of this procedure is to outline equipment and methods that will be used for abandoning monitoring wells. Temporary or permanent monitoring wells or boreholes should be abandoned, or sealed, in order to prevent the borehole or well from as acting as a conduit and/or to prevent cross contamination between hydrogeologic units. Abandoning surface casings installed for double-cased wells also is discussed.

The purpose; location; groundwater quality; age; condition of the well, borehole, or any surface casing; potential for groundwater contamination and cross contamination between water-bearing units; and well, borehole, or surface-casing construction should be considered to determine if a borehole or monitoring well should be abandoned. State-specific requirements for well abandonment should be reviewed and consulted along with this SOP; such requirements may be included in the well permit, if such documents are required. Adequate information to define the former well or borehole location should be collected and maintained in the project files to ensure that the location can be relocated in the future, if necessary.

Please refer to State specific regulations or guidelines to determine if specific abandonment methods are required for the State or Territory the project site is located.

II. Equipment and Materials

- Drilling rig with appropriate equipment
- Pure, additive-free powdered bentonite for grout
- Cement-Bentonite Grout. Proportion 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.
- Tremie pipe
- Containerization for well riser, casing, and/or cuttings produced if riser and casing are drilled out and for water displaced from the well, borehole, or surface casing during abandonment.

III. Procedures and Guidelines

Boreholes and monitoring wells may be abandoned by sealing in place using grout or by removing or drilling out the well riser and sealing the remaining borehole. Surface casings may be abandoned by similar means.

A. Leaving the Well Screen and Riser and Sealing In-Place

Monitoring wells known to be constructed with an impermeable annular space seal may be abandoned by leaving the well riser in place and sealing the well by filling with grout.

1. The monitoring well screen and casing should be split or "ripped" prior to emplacement of the grout slurry whenever possible. This can be accomplished through the use of a casing splitting tool and drill rig. The splitting tool is attached to the lead drill rod and pushed down through the center of the monitoring well. As the tool is forced down, the splitting tool splits the PVC well casing and screen. This will allow better penetration of the grout slurry into the former annular space of the borehole and provide a more thorough grout seal.
2. Boreholes and monitoring wells should be completely filled with cement grout, bentonite-cement grout, bentonite grout, or concrete. The sealant should be delivered as a slurry which is pumped via a tremie pipe from the bottom of the borehole/monitoring well.
3. Following the completion of the grouting, the monitoring well stick-up or flush mounted protective cover and ground surface seal should be removed and the well riser should be cut off at least 24 inches below the ground surface. The location should then be finished at ground surface with like material (e.g., asphalt or concrete for paved areas and soil or sod in dirt or grass areas).

B. Well Riser Removal or Drilling Out and Sealing the Remaining Borehole

Monitoring wells that are not known to be constructed with an impermeable annular space seal should be abandoned by removing the well riser, if possible, or drilling out the well riser and then sealing the remaining borehole.

1. Prior to abandonment, the monitoring well stick-up or flush-mounted protective cover and ground surface seal should be removed.
2. The well riser may be removed by pulling on the riser or by overdrilling around the riser and then pulling the riser out of the ground. If it is not possible to remove the well riser, the well riser may be drilled over and removed from the borehole in pieces as the augers are removed from the borehole as borehole cuttings. The diameter of the auger used for the overdrilling should be at a minimum, the same size or larger than the diameter of the borehole to ensure that all of the well material is removed.
3. After the well riser is removed or drilled out, the remaining borehole should be sealed according to Section A above.

C. Surface Casing Removal for Double-Cased Wells and Sealing the Remaining Borehole

1. In the event that a surface casing is present around the well riser, information on the construction of the surface casing should be obtained, if possible. A decision must be made as to whether or not to remove the surface casing. If the

integrity is uncertain, then the surface casing may be serving as a mode of cross connection. However, the assumption is that the surface casing does not fully penetrate the confining layer into which it is set, so it is often appropriate to leave it in place and abandon the well inside of it. The available information on the surface casing and its age and appearance should be considered in making this decision.

2. Any work to abandon the surface casing should be done after the well riser and screen have been removed and the borehole grouted up to the bottom of the surface casing. Otherwise, soil, groundwater, and possibly contamination may fall down the surface-casing borehole into the well borehole.
3. If the decision is made to leave the casing, it can be grouted up according to Section A above and the aboveground part of the surface casing and any concrete pad removed.
4. If the decision is made to remove the surface casing, typically the surface casing should be overdrilled with a large auger and then removed. The borehole then is sealed according to Section A above. Alternatively, if the integrity of the annular seal appears to be poor, the surface casing may be removed by inserting an extraction tool in the surface casing, engaging it into the sides of the casing, and removing the casing accordingly. Again, the borehole then is sealed according to Section A above.

IV. Attachments

None.

V. Key Checks and Items

- Know the state or local regulations associated with abandoning the well or borehole
- Know the construction details of the well, surface casing, or borehole so that sound decisions can be made
- If well-construction materials are being removed from the borehole, remove as much as possible so that the borehole can be adequately grouted up
- Use a tremie pipe to ensure proper placement of grout
- Be sure the well or borehole is sealed completely to the surface
- Control IDW
- Maintain well- and borehole-location records in the project files

Appendix B
Laboratory DoD ELAP Accreditation Letter

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.1.1 February 2018 and is accredited is accordance with the:

United States Department of Defense
Environmental Laboratory Accreditation Program
(DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
November 17, 2016	December 20, 2018	February 28, 2021
Revision Date:	*Accreditation No.:*	*Certificate No.:*
March 27, 2019	91667	L18-588-R2

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 537.1	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
Drinking Water	EPA 537.1	LC/MS/MS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
Drinking Water	EPA 537.1	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
Drinking Water	EPA 537.1	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluorononanoic acid (PFNA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Drinking Water	EPA 537.1	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Drinking Water	EPA 537.1	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic Acid (3:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (5:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (7:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-octanesulfonamide (PFOSA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (Adona)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9CI-PF3ONS)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11CI-PF3OUdS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Sodium perfluoro-1-pentanesulfonate (PFPeS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-nonanesulfonate (PFNS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-heptanesulfonate (PFHpS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorohexane sulfonate (4:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorooctane sulfonate (6:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorodecane sulfonate (8:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-butanoic Acid (PFBA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-pentanoic acid (PFPeA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorononanoic acid (PFNA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

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141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-decanesulfonate (PFDS)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,3',4,5-Hexachlorobiphenyl (BZ 129)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ 180)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ 183)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ 138)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',6,6'-Heptachlorobiphen yl (BZ 184)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ 187)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,5'-Pentachlorobiphenyl (BZ 87)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,5'-Tetrachlorobiphenyl (BZ 44)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ 153)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,5,5'-Pentachlorobiphenyl (BZ 101)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,5'-Tetrachlorobiphenyl (BZ 49)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',5,5'-Tetrachlorobiphenyl (BZ 52)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',5-Trichlorobiphenyl (BZ 18)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3,3',4',6-Pentachlorobiphenyl (BZ 110)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3',4,4',5-Pentachlorobiphenyl (BZ 118)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3',4,4'-Tetrachlorobiphenyl (BZ 66)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4,4'-Trichlorobiphenyl (BZ 28)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDD
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDE
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDT
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-Dichlorobiphenyl (BZ 8)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4',5-Pentachlorobiphenyl (BZ 126)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4'-Tetrachlorobiphenyl (BZ 77)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDD
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDE
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDT
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Aldrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	alpha-BHC (alpha-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	alpha-Chlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	beta-BHC (beta-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Chlorpyrifos
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	cis-Nonachlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Decachlorobiphenyl (BZ 209)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	delta-BHC
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Dieldrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan II
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan I
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan sulfate
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin aldehyde
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin ketone
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	gamma-Chlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Heptachlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Heptachlor epoxide
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Hexachlorobenzene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Methoxychlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Mirex
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Oxychlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	trans-Nonachlor
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	1-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	1-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ 194)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (BZ 207)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',6,6'-Octachlorobiphenyl (BZ 197)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',6-Heptachlorobiphenyl (BZ 171)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (BZ 208)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6-Octachlorobiphenyl (BZ 198)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6'-Octachlorobiphenyl (BZ 199)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5'-Heptachlorobiphenyl (BZ 172)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6,6'-Octachlorobiphenyl (BZ 200)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ 201)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6-Heptachlorobiphenyl (BZ 173)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ 174)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5',6-Heptachlorobiphenyl (BZ 175)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5',6'-Heptachlorobiphenyl (BZ 177)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5'-Hexachlorobiphenyl (BZ 130)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,6,6'-Heptachlorobiphenyl (BZ 176)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,6-Hexachlorobiphenyl (BZ 131)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4-Pentachlorobiphenyl (BZ 82)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,5',6,6'-Octachlorobiphenyl (BZ 202)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,5',6-Heptachlorobiphenyl (BZ 178)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6,6'-Heptachlorobiphenyl (BZ 179)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6-Hexachlorobiphenyl (BZ 134)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6'-Hexachlorobiphenyl (BZ 135)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5-Pentachlorobiphenyl (BZ 83)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',6,6'-Hexachlorobiphenyl (BZ 136)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',6-Pentachlorobiphenyl (BZ 84)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3'-Tetrachlorobiphenyl (BZ 40)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ 203)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ 180)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ 183)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5-Hexachlorobiphenyl (BZ 137)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ 138)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ 184)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6-Hexachlorobiphenyl (BZ 139)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6'-Hexachlorobiphenyl (BZ 140)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4'-Pentachlorobiphenyl (BZ 85)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5,5',6-Heptachlorobiphenyl (BZ 185)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ 187)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ 141)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,5'-Hexachlorobiphenyl (BZ 146)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,6,6'-Heptachlorobiphenyl (BZ 188)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5',6-Hexachlorobiphenyl (BZ 149)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5',6-Hexachlorobiphenyl (BZ 144)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5'-Pentachlorobiphenyl (BZ 87)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5'-Pentachlorobiphenyl (BZ 97)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',6-Pentachlorobiphenyl (BZ 91)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4-Tetrachlorobiphenyl (BZ 41)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4'-Tetrachlorobiphenyl (BZ 42)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5,5',6-Hexachlorobiphenyl (BZ 151)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5,5'-Pentachlorobiphenyl (BZ 92)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5',6-Pentachlorobiphenyl (BZ 95)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5-Tetrachlorobiphenyl (BZ 43)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5'-Tetrachlorobiphenyl (BZ 44)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,6'-Tetrachlorobiphenyl (BZ 46)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,6-Tetrachlorobiphenyl (BZ 45)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3-Trichlorobiphenyl (BZ 16)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ 153)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ 154)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5-Pentachlorobiphenyl (BZ 99)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',6,6'-Hexachlorobiphenyl (BZ 155)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',6-Pentachlorobiphenyl (BZ 100)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4'-Tetrachlorobiphenyl (BZ 47)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5,5'-Pentachlorobiphenyl (BZ 101)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5-Tetrachlorobiphenyl (BZ 48)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5'-Tetrachlorobiphenyl (BZ 49)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6,6'-Pentachlorobiphenyl (BZ 104)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6'-Tetrachlorobiphenyl (BZ 51)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6-Tetrachlorobiphenyl (BZ 50)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4-Trichlorobiphenyl (BZ 17)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5,5'-Tetrachlorobiphenyl (BZ 52)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5,6'-Tetrachlorobiphenyl (BZ 53)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5-Trichlorobiphenyl (BZ 18)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',6,6'-Tetrachlorobiphenyl (BZ 54)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',6-Trichlorobiphenyl (BZ 19)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2'-Dichlorobiphenyl (BZ 4)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,5',6-Octachlorobiphenyl (BZ 205)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,6-Heptachlorobiphenyl (BZ 190)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5',6-Heptachlorobiphenyl (BZ 191)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5-Hexachlorobiphenyl (BZ 156)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 157)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',6-Hexachlorobiphenyl (BZ 158)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5,5',6-Heptachlorobiphenyl (BZ 193)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5,6-Hexachlorobiphenyl (BZ 163)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5',6-Hexachlorobiphenyl (BZ 164)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',6-Pentachlorobiphenyl (BZ 110)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4'-Tetrachlorobiphenyl (BZ 56)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',5,6-Hexachlorobiphenyl (BZ 166)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',5-Pentachlorobiphenyl (BZ 114)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5-Pentachlorobiphenyl (BZ 118)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5'-Pentachlorobiphenyl (BZ 123)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',6-Pentachlorobiphenyl (BZ 115)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4'-Tetrachlorobiphenyl (BZ 60)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4'-Tetrachlorobiphenyl (BZ 66)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5,5'-Pentachlorobiphenyl (BZ 124)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5',6-Pentachlorobiphenyl (BZ 125)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4',5-Tetrachlorobiphenyl (BZ 63)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,5-Tetrachlorobiphenyl (BZ 67)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5-Tetrachlorobiphenyl (BZ 70)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4',6-Tetrachlorobiphenyl (BZ 64)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',6-Tetrachlorobiphenyl (BZ 71)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4'-Trichlorobiphenyl (BZ 22)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4-Trichlorobiphenyl (BZ 25)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4'-Trichlorobiphenyl (BZ 33)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',5-Trichlorobiphenyl (BZ 26)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,5-Trimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,6-Trichlorobiphenyl (BZ 24)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',6-Trichlorobiphenyl (BZ 27)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3-Dichlorobiphenyl (BZ 5)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3'-Dichlorobiphenyl (BZ 6)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4',5-Tetrachlorobiphenyl (BZ 74)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4',6-Tetrachlorobiphenyl (BZ 75)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4'-Trichlorobiphenyl (BZ 28)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,5-Trichlorobiphenyl (BZ 29)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4',5-Trichlorobiphenyl (BZ 31)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,6-Trichlorobiphenyl (BZ 30)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4',6-Trichlorobiphenyl (BZ 32)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDD
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDE
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDT
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4-Dichlorobiphenyl (BZ 7)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-Dichlorobiphenyl (BZ 8)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,5-Dichlorobiphenyl (BZ 9)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,6-Dimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Chlorobiphenyl (BZ 1)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Chloronaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4',5-Pentachlorobiphenyl (BZ 126)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4'-Tetrachlorobiphenyl (BZ 77)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,5,5'-Pentachlorobiphenyl (BZ 127)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',5,5'-Tetrachlorobiphenyl (BZ 80)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3'-Dichlorobiphenyl (BZ 11)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4,4',5-Tetrachlorobiphenyl (BZ 81)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4,4'-Trichlorobiphenyl (BZ 37)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4-Dichlorobiphenyl (BZ 12)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4'-Dichlorobiphenyl (BZ 13)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,6-Dimethylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	4,4'-Dichlorobiphenyl (BZ 15)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	4-Chlorobiphenyl (BZ 3)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Acenaphthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Acenaphthylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(a)anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(a)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(b)thiophene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(e)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Biphenyl
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Chrysene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	cis-Decalin
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Decachlorobiphenyl (BZ 209)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenz(a,h)anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenzofuran
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenzothiophene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Fluoranthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Fluorene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	lndeno(l,2,3-cd)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Naphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Perylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Phenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Pyrene

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Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	trans-Decalin

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Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 3510 C	Separatory Funnel	Prep
Aqueous	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Aqueous	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Solid	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	NOAA NOS ORCA 71	Orbital Shaker	Prep
Tissue	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Tissue	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Tissue	NOAA NOS ORCA 71	Tissuemizer	Prep