SAP Worksheet #1—Title and Approval Page

Final

Sampling and Analysis Plan Site Inspection of Per- and Polyfluoroalkyl Substances and Additional Characterization of 1,4-Dioxane, and Vinyl Chloride in Groundwater and Drinking Water for Remedial Design Refinement

Area 6, Ault Field

Naval Air Station Whidbey Island, Oak Harbor, Washington

Contract Task Order 4041

November 2017

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Northwest

Under the

NAVFAC CLEAN 9000 Program
Contract N62470-16-D-9000

Prepared by

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Bellevue, Washington

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SAP Worksheet #1—Title and Approval Page (continued)

Approval Signatures:

Kenneth Bowers
Naval Facilities Engineering Command Atlantic
Quality Assurance Officer

Other Approval Signatures:

Kendra Leibman
Naval Facilities Engineering Command Northwest
Remedial Project Manager

David Einan
United States Environmental Protection Agency Region 10
Remedial Project Manager

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Executive Summary

CH2M HILL, Inc. (CH2M) prepared this document under the Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), Comprehensive Long-term Environmental Action—Navy (CLEAN) 9000 Contract N62470-16-D-9000, Contract Task Order (CTO) 4041, in accordance with the Navy's Uniform Federal Policy Sampling and Analysis Plan policy guidance to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses. This Sampling and Analysis Plan (SAP) outlines both on-Base and off-Base sampling activities for Area 6, part of Ault Field on Naval Air Station Whidbey Island (NASWI), Oak Harbor, Washington. NASWI is located at the northern end of Whidbey Island along the shoreline of the Strait of Juan de Fuca just north of Oak Harbor, Washington (**Figure 1**). There are two waste disposal areas within the site: Area 6 landfill, which received Naval wastes between 1969 and the mid-1990s; and a former industrial waste disposal area (Site 55), which received liquid hazardous waste at a time when regulatory requirements had not been established (between 1969 and the early 1980s) (**Figure 2**).

Aqueous film forming foam (AFFF) is a firefighting substance that suppresses combustion by coating the fuel source of the fire (preventing contact with oxygen). AFFF has historically been used at NASWI (Area 31 [former runway fire training school], Area 16 [Ault field runway ditches]), and the Outlying Field [Coupeville, Washington], see **Figure 1**) (CH2M, 2016), resulting in the presence of per- and polyfluoroalkyl substances (PFAS) in groundwater. Although it is unknown whether AFFF was used or disposed of at Area 6 and whether PFAS are present in the underlying groundwater system, the history of waste disposal at the site suggests that it is possible.

It is known from previous investigations that volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) are present in groundwater beneath Area 6 at concentrations exceeding their respective cleanup levels (CULs) (**Figures 3 and 4**). The most recent interpretations of the VOC and SVOC plumes suggest that vinyl chloride (VC) and 1,4-dioxane have migrated off-Base at concentrations exceeding the respective CULs. As shown on **Figure 3**, the off-Base extent of the 1,4-dioxane groundwater plume has not been delineated to the CUL of 0.44 microgram per liter (µg/L) (Sealaska, 2017). Although the off-Base extent of VC has been estimated as delineated to the CUL of 0.1 µg/L, the interpretation is based on a limited dataset and additional information regarding off-Base VC concentrations are needed to fully delineate the plume (**Figure 4**). VOCs and SVOCs, excluding 1,4-dioxane, are currently being treated with a groundwater extraction, treatment, and recharge (GETR) system installed in 1995 (URS-AECOM, 2016). Currently, effluent from the GETR is discharged to land surface on the southern side of the Area 6 composting facility (**Figure 2**). The effluent flows to the north, following a natural surface water drainage, ultimately discharging to a swale north of Ault Field Road. The GETR system was not designed to treat 1,4-dioxane because 1,4-dioxane was not identified in the groundwater until 2003. An upgrade to the GETR system is currently being designed and will incorporate an advanced oxidation unit that will remediate both VC and 1,4-dioxane. However, oxidation has the potential to increase concentrations of PFAS if PFAS precursors (compounds that may be transformed into PFAS) are present. If PFAS and/or PFAS precursors are present, additional GETR system modifications will need to be incorporated into the design.

The objective of the first phase of the investigation is to determine the presence or absence of PFAS and PFAS precursors in on-Base groundwater at Area 6, which will be accomplished by sampling on-Base groundwater monitoring wells as well as sampling the existing treatment system influent and effluent for both PFAS and PFAS precursors. The objectives of the second phase of the investigation are to determine the extent of PFAS in off-Base drinking water and groundwater if detected on-Base and to delineate the off-Base extent of the 1,4-dioxane and VC plumes (including potential contribution of other potential sources of VOCs and SVOCs to groundwater, such as the Oak Harbor landfill), which will be accomplished by sampling off-Base drinking water and groundwater monitoring wells. Additionally, if PFAS are found on-Base, then the groundwater flow directions will be better defined in the northeastern and northwestern portions of Area 6 and the list of wells to be sampled for PFAS will be refined for follow on investigation. Residents with drinking water wells above the applicable action levels for perfluorooctane sulfonate, perfluorooctanoic acid, VC, and/or 1,4-dioxane will be supplied with bottled water and will be incorporated into the study of long-term solutions for affected residents being conducted in parallel to this sampling effort. Impacted areas will also be included in the development of a periodic monitoring plan for off-Base drinking water wells, currently being developed in a separate SAP document.

This SAP was developed in accordance with the following three guidance documents:

- *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)

This SAP consists of 37 worksheets specific to the scope of this investigation. All tables are embedded within the worksheets. All figures are included at the end of the document. Field standard operation procedures (SOPs) are included in **Appendix A**. Department of Defense Environmental Laboratory Accreditation Program Accreditation letters are included in **Appendix B**. Laboratory SOPs are included in **Appendix C**.

The laboratory information cited in this SAP is specific to TestAmerica, Seattle, Washington and Vista Analytical Laboratory, El Dorado Hills, California. If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the Navy for approval.

SAP Worksheets

Appendixes

Tables

Figures

Acronyms and Abbreviations

±	plus or minus
%RSD	percent relative standard deviation
>	more than
≤	less than or equal to
°C	degree Celsius
µg/L	microgram per liter
AFFF	aqueous film-forming foam
AHA	activity hazard analysis
AM	Activity Manager
amu	atomic mass unit
bgs	below ground surface
CA	corrective action
CAS	Chemical Abstract Service
CCV	continuing calibration verification
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	chemicals of concern
CTI-URS	CTI-URS JV LLC
CTO	Contract Task Order
CUL	cleanup level
DCA	1,1-dichloroethane
DCE	1,1-dichloroethene
DL	detection limit
DoD	Department of Defense
DQI	data quality indicator
DV	data validation
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
FD	field duplicate
FTL	Field Team Leader
g/L	grams per liter
GETR	groundwater extraction, treatment, and recharge
H&S	health and safety
HQ	hazard quotient
HSM	Health and Safety Manager
HSP	Health and Safety Plan
HSU	hydrostratigraphic unit
ICAL	initial calibration
ID	identification

IS	internal standards
ISC	Instrument Sensitivity Check
LCS	laboratory control sample
LCL	lower confidence limit
LHA	Lifetime Health Advisory
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
mL	milliliter
MPC	measurement performance criteria
MS	matrix spike
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
N/A	not applicable
NASWI	Naval Air Station Whidbey Island
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NTR	Navy Technical Representative
PAL	project action limit
PC	Project Chemist
PFC	perfluorinated compound
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFBS	perfluorobutane sulfonate
PM	Project Manager
POC	point of contact
PQL	project quantitation limit
PQO	project quality objective
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QM	Quality Manager
QSM	Quality Systems Manual
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RSL	regional screening level
SAP	Sampling and Analysis Plan
SBO	safe behavior observation
SME	Subject Matter Expert
SOP	standard operating procedure
SSC	Site Safety Coordinator

STC	Senior Technical Consultant
SVOC	semivolatile organic compound
TBD	to be determined
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TM	task manager
TOP	total oxidizable precursor
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Area 6, Ault Field, Naval Air Station Whidbey Island (NASWI), Washington

Operable Unit/Solid Waste Management Unit: 1

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) 4041

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)
2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act
3. This document is a Tier 1 project-specific SAP. The approval entities are Naval Facilities Engineering Command (NAVFAC) Northwest Remedial Project Manager (RPM) and NAVFAC Atlantic Quality Assurance Officer (QAO).
4. List dates of scoping sessions that were held:

Scoping Session	Date
Scoping session to select on-Base groundwater sampling locations	August 1, 2017
Scoping session to select off-Base sampling strategy	August 4, 2017
Scoping session to revise off-Base sampling strategy	September 25, 2017

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

Resolution. 2016. DRAFT *Project-Specific Sampling and Analysis Plan, Off-Site Wells*, *Area 6*. Naval Air Station Whidbey Island, Oak Harbor, Washington.
CH2M. 2017a. *Final Sampling and Analysis Plan Investigation of Perfluorinated Compounds in Drinking Water Naval Air Station Whidbey Island*. January.
CH2M. 2017b. *Sampling and Analysis Plan Investigation of Perfluorinated Compounds in Drinking Water Outlying Landing Field Coupeville.* Naval Air Station Whidbey Island, Coupeville, Washington. January.

SAP Worksheet #2—SAP Identifying Information (continued)

6. List organizational partners (stakeholders) and connection with lead organization:
    - NASWI – Base stakeholder
    - Naval Facilities Engineering Command (NAVFAC) Northwest (NW) – Navy Technical Representative (NTR), Steve Skeehan, and Remedial Project Manager (RPM), Kendra Leibman
    - NAVFAC LANT – Project Chemist, Kenneth Bowers
    - United States Environmental Protection Agency (USEPA) Region 10 – Technical Representative, Dave Einan
    - Island County Public Health – Technical Representative, Doug Kelly
    - City of Oak Harbor – Technical Representative, Arnie Peterschmidt
7. Lead organization:
    - Department of the Navy (Navy)
8. If any required SAP elements or required information are not applicable (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	RPM	NAVFAC Northwest	(360) 396-0022	kendra.leibman@navy.mil
Steve Skeehan	NTR	NAVFAC Northwest	(360) 396-1114	steve.skeehan@navy.mil
Kenneth Bowers	NAVFAC QAO	NAVFAC Atlantic	To be determined (TBD)	kenneth.bowers@navy.mil
Rebecca Maco	Project Manager/Activity Manager (PM/AM)	CH2M	(425) 233-3392	rebecca.maco@ch2m.com
Peter Lawson	Senior Technical Consultant (STC)	CH2M	(530) 229-3383	peter.lawson@ch2m.com
Susan Moore	Quality Manager (QM)	CH2M	(206) 779-4176	susan.moore@ch2m.com
Laura Cook	Subject Matter Expert (SME)	CH2M	(757) 671-6214	laura.cook@ch2m.com
Heather Perry	Task Manager (TM)	CH2M	(530) 229-3276	heather.perry@ch2m.com
Janna Staszak	Program SAP Quality Reviewer	CH2M	(757) 518-9666	janna.staszak@ch2m.com
Anita Dodson	Program Chemist/SAP Reviewer	CH2M	(757) 671-6218	anita.dodson@ch2m.com
Tiffany Hill	Project Chemist (PC)	CH2M	(541) 768-3109	tiffany.hill@ch2m.com
To Be Determined (TBD)	Data Validator	TBD	TBD	TBD
TBD	Field Team Leader (FTL)	CH2M	TBD	TBD
Loren Kaehn	Health and Safety Manager (HSM)	CH2M	(208) 383-6212	loren.kaehn@ch2m.com
TBD	Site Safety Coordinator (SSC)	CH2M	TBD	TBD
Kristine Allen	Laboratory PM	TestAmerica Seattle, Washington	(253) 248-4970	kristine.allen@testamericainc.com
Martha Maier	Secondary Laboratory PM	Vista Analytical, El Dorado Hills, California	(916) 673-1520	mmaier@vista-analytical.com
Dave Einan	Technical Representative	USEPA	TBD	einan.david@epa.gov
Doug Kelly	Hydrogeologist	Island County Public Health	(360) 678-7885	d.kelly@co.island.wa.us
Arnie Peterschmidt	City Engineer	City of Oak Harbor	(360) 279-4525	apeterschmidt@oakharbor.org

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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
Rebecca Maco	CH2M/PM/AM	(425) 233-3392			
Peter Lawson	CH2M/STC	(530) 229-3383			
Susan Moore	CH2M/QM	(206) 779-4176			
Laura Cook	CH2M/SME	(757) 671-6214			
Heather Perry	CH2M/TM	(530) 229-3276			
Janna Staszak	CH2M/ Program SAP Quality Reviewer	(757) 518-9666			
Anita Dodson	CH2M/ Program Chemist/SAP Reviewer	(757) 671-6218			
Tiffany Hill	CH2M/PC	(541) 768-3109			
TBD	Data Validator	TBD			
TBD	FTL	TBD			
TBD	SSC	TBD			
Kristine Allen	TestAmerica Laboratory PM	(253) 248-4970			
Martha Maier	Vista Analytical Laboratory PM	(916) 673-1520			

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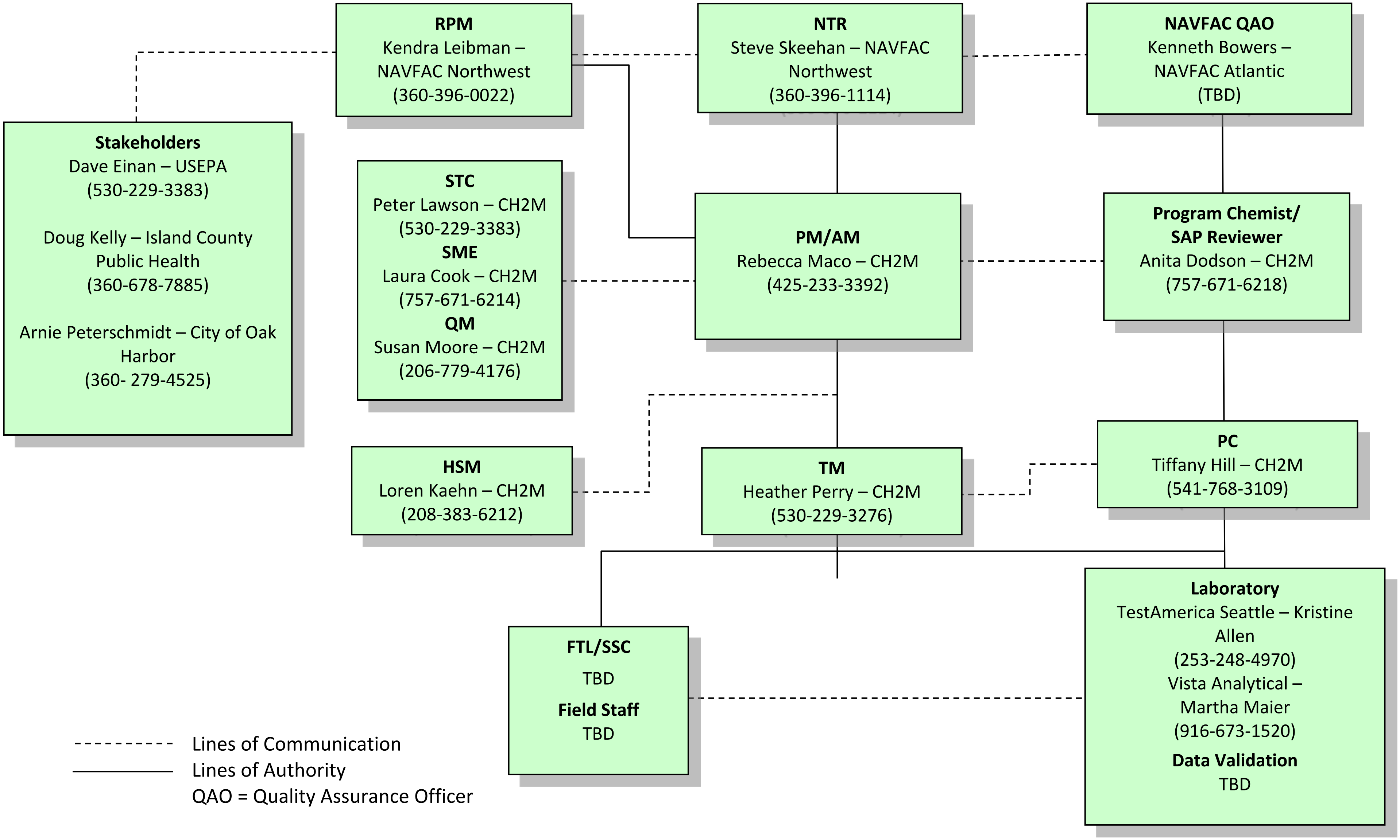
SAP Worksheet #5—Project Organizational Chart



RPM
Kendra Leibman – NAVFAC Northwest
(360-396-0022)

NTR
Steve Skeehan – NAVFAC Northwest
(360-396-1114)

NAVFAC QAO
Kenneth Bowers – NAVFAC Atlantic
(TBD)

Stakeholders
Dave Einan – USEPA
(530-229-3383)

Doug Kelly – Island County Public Health
(360-678-7885)

Arnie Peterschmidt – City of Oak Harbor
(360- 279-4525)

STC
Peter Lawson – CH2M
(530-229-3383)
SME
Laura Cook – CH2M
(757-671-6214)
QM
Susan Moore – CH2M
(206-779-4176)

PM/AM
Rebecca Maco – CH2M
(425-233-3392)

Program Chemist/ SAP Reviewer
Anita Dodson – CH2M
(757-671-6218)

HSM
Loren Kaehn – CH2M
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TM
Heather Perry – CH2M
(530-229-3276)

PC
Tiffany Hill – CH2M
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FTL/SSC
TBD
Field Staff
TBD

Laboratory
TestAmerica Seattle – Kristine Allen
(253-248-4970)
Vista Analytical – Martha Maier
(916-673-1520)
Data Validation
TBD

- - - - Lines of Communication
—— Lines of Authority
QAO = Quality Assurance Officer

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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Communication with Base representatives, RPM, and CH2M FTL/SSC)	NTR	Steve Skeehan	steve.skeehan@navy.mil (360) 396-1114	Primary point of contact (POC) in field for Navy; can delegate communication to other internal POCs.
Communication with Base, NTR, CH2M PM/AM, USEPA RPM, and other stakeholders	RPM	Kendra Leibman	kendra.leibman@navy.mil (360) 396-0022	Primary POC for facility; can delegate communication to other internal or external POCs. CH2M PM will notify RPM by email or telephone call within 24 hours for field changes affecting the scope.
Communication regarding overall project status and implementation and primary POC with RPMs and project team	CH2M PM/AM	Rebecca Maco	rebecca.maco@ch2m.com (425) 233-3392	Oversees project and will be informed of project status by the Task Manager. If field changes occur, PM will work with the RPM to 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. All information and materials about the project will be forwarded to the Navy, as necessary, POC for FTL, Task Manager, and STC.
Quality issues during and technical communications for project implementation and data interpretation	CH2M STC	Peter Lawson	peter.lawson@ch2m.com (530) 229-3383	Contact the QM regarding quality issues during project implementation. The QM will report to the PM and the RPM. Contact STC regarding questions and issues encountered in the field and 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 before Base and Navy discussions and reporting review.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure, Pathway, and so forth.
Quality issues during and technical communications for project implementation and data interpretation	CH2M QM	Susan Moore	susan.moore@ch2m.com (206) 779-4176	Contact the QM regarding quality issues during project implementation. The QM will report to the PM and the RPM.
Technical communications for project implementation and data interpretation	CH2M SME	Laura Cook	laura.cook@ch2m.com (757) 671-6214	Contact SME regarding questions and issues encountered in the field, input on data interpretation, as needed. SME will have 24 hours to respond to technical field questions as necessary. Additionally, SME will review the data as necessary before Base and Navy discussions and reporting review.
Health and safety (H&S)	CH2M HSM	Loren Kaehn	loren.kaehn@ch2m.com (208) 383-6212	Responsible for generation of the Health and Safety Plan (HSP) and approval of the activity hazard analyses (AHAs) before the start of fieldwork. The PM will contact the HSM as needed regarding questions and 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 HSP. Will report H&S incidents and near-misses to the PM as soon as possible.
Stop Work Order	CH2M PM/AM CH2M FTL Field Team Members	Rebecca Maco TBD TBD	rebecca.maco@ch2m.com (425) 233-3392 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 Northwest can stop work at any time.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure, Pathway, and so forth.
Work plan changes in field	FTL	TBD	TBD	Documentation of deviations from the work plan will be made in the field logbook, and the PM will be notified immediately. Deviations will be made only with approval from the PM. The PM will communicate changes to the RPM.
Field changes/field progress reports	FTL	TBD	TBD	Documentation of field activities and work plan deviations (made with the approval of STC and/or QAO) in field logbooks; provide daily progress reports to PM.
Reporting laboratory data quality issues	Analytical Laboratory Project Managers	Kristine Allen Martha Maier	kristine.allen@testamericainc.com (253) 248-4970 mmaier@vista-analytical.com (916) 673-1520	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported within 2 days to the PC by the laboratory.
Analytical corrective actions (CAs)	PC	Tiffany Hill	tiffany.hill@ch2m.com (541) 768-3109	Any CAs for analytical issues will be determined by the FTL and/or the PC and reported to the PM within 4 hours. The PM will ensure SAP requirements are met by field staff for the duration of the project.
Data tracking from field collection to database upload Release of analytical data	PC	Tiffany Hill	tiffany.hill@ch2m.com (541) 768-3109	Tracks data from sample collection through database upload daily. No analytical data can be released until the PC validates and approves the data. 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 or would cause significant delay in project schedule.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure, Pathway, and so forth.
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 7 calendar days.
Field CAs	FTL, PM/AM, and TM	TBD Rebecca Maco Heather Perry	TBD rebecca.maco@ch2m.com (425) 233-3392 heather.perry@ch2m.com (530) 229-3276	Field 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 FTL will notify the PM and the PM may notify the Technical Representative and RPM of any field issues that would negatively affect the schedule or the ability to meet project data quality objectives.

SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Kendra Leibman	RPM	NAVFAC Northwest	Oversees project for Navy and provides Base-specific information and coordinates with NASWI.
Steve Skeehan	NTR	NAVFAC Northwest	Oversees fieldwork, provides Base-specific information, and coordinates with NASWI.
Rebecca Maco	PM/AM	CH2M	Oversees and manages program activities.
Peter Lawson	STC	CH2M	Provides senior technical support for project approach and execution. Provides QA oversight.
Susan Moore	QM	CH2M	Provides senior technical support for project approach and execution. Provides QA oversight.
Laura Cook	SME	CH2M	Provides senior technical support for project approach and execution.
Anita Dodson	Program Chemist/SAP Reviewer	CH2M	Provides SAP project delivery support, reviews and approves SAP, and performs final data evaluation and QA oversight.
Janna Staszak	Program SAP Quality Reviewer	CH2M	Reviews and approves changes or revisions to the SAP.
Heather Perry	TM	CH2M	Oversees and manages project activities.
Tiffany Hill	PC	CH2M	Data management: Performs data evaluation and QA oversight, is the POC with laboratory and validator for analytical issues.
TBD	Data Validator	TBD	Validates laboratory data from an analytical standpoint prior to data use.
Loren Kaehn	HSM	CH2M	Prepares HSP and manages H&S for all field activities.
TBD	FTL	CH2M	Coordinates all field activities and sampling.
TBD	Field Staff	CH2M	Conducts field activities.
Kristine Allen Martha Maier	Laboratory PM	TestAmerica Seattle Vista Analytical	Manages samples tracking and maintains good communication with PC.
Terri Torres Anne Helak	Laboratory QAO	TestAmerica Seattle Vista Analytical	Responsible for audits, CA, and checks of QA performance within the laboratory.

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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 #9-1—Project Scoping Session Participants Sheet

Project Name: Investigation of Per- and Polyfluoroalkyl Substances in Groundwater, Area 6, Ault Field, NASWI **Projected Date(s) of Sampling:** 10/23/17 – 10/29/17 **PM:** Rebecca Maco	**Site Name**: Area 6, Ault Field, NASWI **Site Location:** Oak Harbor, Washington
Date of Session: August 1, 2017 **Scoping Session Purpose:** To finalize selection of on-Base sampling locations for the first phase of the field investigation	

Name	Title/Project Role	Affiliation	Phone #	Email Address
Kendra Leibman	RPM	NAVFAC Northwest	(360) 396-0022	kendra.leibman@navy.mil
Rebecca Maco	PM/AM	CH2M	(425) 233-3392	rebecca.maco@ch2m.com
Heather Perry	TM	CH2M	(530) 229-3276	heather.perry@ch2m.com

Comments

This scoping session was held to finalize selection of groundwater monitoring wells for inclusion in the on-Base PFAS sampling event (Phase 1). The objectives were to select locations with adequate spatial and vertical coverage such that the presence or absence of PFAS and PFAS precursors would be investigated in source areas, along groundwater plume centerlines, and along the southern administrative boundary as well as in different vertical hydrostratigraphic units (HSUs). PFAS precursor analysis via the total oxidizable precursor (TOP) Assay is included in the analytical suite for on-Base groundwater and groundwater extraction, treatment, and recharge (GETR) influent and effluent samples, to inform the GETR upgrade design. PFAS precursors can be transformed to PFAS via chemical reactions, such as the oxidation process that is planned to treat 1,4-dioxane.

Action Items

Not applicable.

Consensus Decisions

The final groundwater monitoring well locations selected during this scoping session are included on **Figure 5**. The rationale for the selection of the monitoring well locations is included in **Table 9-1**.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet (continued)

Table 9-1. Area 6, Ault Field Sampling Strategy and Rationale

Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen Interval	Rationale
P-4 (Vashon Till)	5 to 20 feet below ground surface (bgs)	This piezometer is located hydraulically upgradient of Area 6 in the shallowest HSU. The piezometer is constructed in an area that receives surface runoff from the Area 6 treatment plant. Analytical data will be used to evaluate the potential for infiltration of PFAS from treatment system effluent to the groundwater system.
6-S-07 (Vashon Advance Outwash)	28.5 to 38.5 feet bgs	This well is located hydraulically upgradient from Area 6 source areas in the shallowest, laterally extensive HSU. Analytical data will be used to evaluate the potential for migration of PFAS from upgradient sources in the shallow aquifer.
6-S-44 (Vashon Advance Outwash)	86 to 96 feet bgs	This well is constructed near the former industrial waste disposal area (Site 55) source area in the shallow aquifer. Analytical data will be used to evaluate whether past waste disposal practices at this source area resulted in releases of PFAS to the groundwater system.
6-S-14 (Vashon Advance Outwash)	145 to 155 feet bgs	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence along the centerline of the known 1,4-dioxane plume in the shallow aquifer.
6-I-01 (Whidbey Fm Unit 2)	163 to 177 feet bgs	This well is located slightly off the centerline of the known 1,4-dioxane plume and is hydraulically downgradient from industrial waste disposal area (Site 55). Analytical data can be used to evaluate presence or absence of PFAS in the intermediate aquifer.
6-D-05 (Whidbey Fm Unit 4)	193 to 203 feet bgs	This well is located slightly off the centerline of the known 1,4-dioxane plume and is hydraulically downgradient from industrial waste disposal area (Site 55). Analytical data can be used to evaluate presence or absence of PFAS in the deep aquifer.
MW-10 (Vashon Advance Outwash)	121 to 161 feet bgs	This well is located along the western margin of the Area 6 landfill. Analytical data will be used to evaluate whether the Area 6 landfill was a source of PFAS to the groundwater system (shallow aquifer).
6-S-17 (Vashon Advance Outwash)	127 to 137 feet bgs	This well is located at the southern (hydraulically downgradient end) of the Area 6 landfill. Analytical data will be used to evaluate whether the landfill was a source of PFAS to the groundwater system (shallow aquifer).
6-S-04 (Vashon Advance Outwash)	129.5 to 139.5 feet bgs	This well is located along the centerline of the known 1,4-Dioxane plume, near the southwest corner of Area 6 (shallow completion in a well pair with 6-D-01). Analytical data will be used to evaluate presence or absence and potential concentrations of PFAS migrating offsite in the shallow aquifer.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet (continued)

Table 9-1. Area 6, Ault Field Sampling Strategy and Rationale

Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen Interval	Rationale
6-S-19 (Vashon Advance Outwash)	143.5 to 163.5 feet bgs	This well is located along the centerline of the known 1,4-dioxane plume at the southern Area 6 boundary. Analytical data will be used to evaluate presence or absence and potential concentrations of PFAS migrating offsite in the shallow aquifer.
GETR Treatment Plant Influent	N/A	Analytical data from the blended GETR influent stream will be used to evaluate the presence or absence of PFAS and PFAS precursors entering the treatment system.
GETR Treatment Plant Effluent	N/A	Analytical data from the GETR effluent stream will be used to evaluate both the presence or absence of PFAS leaving the treatment system (which may subsequently infiltrate to the groundwater system). Comparison with PFAS concentrations from the influent samples can be used to evaluate whether treatment processes are increasing PFAS concentrations (by the transformation of PFAS precursors to PFAS).

Note:

A comprehensive well construction summary table for Area 6 monitoring wells is included in **Appendix D**.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet

Project Name: Investigation of Per- and Polyfluoroalkyl Substances in Groundwater, Area 6, Ault Field, NASWI **Projected Date(s) of Sampling:** 11/29/17 – 12/27/17 **PM:** Rebecca Maco			**Site Name**: Area 6, Ault Field, NASWI **Site Location:** Oak Harbor, Washington	
Date of Session: August 4, 2017 **Scoping Session Purpose:** To finalize the strategy for off-Base sampling during Phase 2 of the investigation				
Name	**Title/Project Role**	**Affiliation**	**Phone #**	**Email Address**
Kendra Leibman	RPM	NAVFAC Northwest	(360) 396-0022	kendra.leibman@navy.mil
Rebecca Maco	PM	CH2M	(425) 233-3392	rebecca.maco@ch2m.com
Heather Perry	Task Manager	CH2M	(530) 229-3276	heather.perry@ch2m.com
Christin Shacat	Project Team Member	CH2M	(808) 440-0259	christin.shacat@ch2m.com

Comments

This scoping session was held to finalize the strategy for selection of off-Base sampling locations. The objective of off-Base sampling is to delineate the lateral and vertical extent of the 1,4-dioxane and vinyl chloride (VC) plumes; to determine the off-Base extent of PFAS if detected in on-Base groundwater samples; and to determine if PFAS precursors are present in off-Base groundwater within the GETR capture zone if detected on-Base.

Action Items

- CH2M to reach out to Doug Kelly, of Island County Public Health, to get more information on Department of Health well location dataset.
- CH2M will draft letter to off-Base residents.
- Navy received requests from residents near Area 6 to have their wells sampled. Kendra Leibman to provide list for CH2M to cross reference with potential parcels.

Consensus Decisions

It was determined that requests to sample will be submitted to parcels with a drinking water supply well within a 1/2 mile of Area 6. Based on the responses, existing groundwater monitoring wells within a 1/2 mile of Area 6 may be included to augment and fill in gaps in the well network. PFAS precursor analysis will be included in the analytical suite for wells within the extent of the GETR capture zone (based on the results of numerical modeling). The objective for analyzing samples collected at wells within the GETR capture zone for precursors is to inform the GETR upgrade design. PFAS precursors can be transformed to PFAS via chemical reactions, such as the oxidation process that is planned to treat 1,4-dioxane. **Figure 6** presents the location of applicable land parcels that were identified for off-Base sampling consideration.

SAP Worksheet #9-3—Project Scoping Session Participants Sheet

Project Name: Investigation of Per- and Polyfluoroalkyl Substances in Groundwater, Area 6, Ault Field, NASWI **Projected Date(s) of Sampling:** 11/29/17 – 12/27/17 **PM:** Rebecca Maco	**Site Name**: Area 6, Ault Field, NASWI **Site Location:** Oak Harbor, Washington

Date of Session: September 25, 2017

Scoping Session Purpose: To revise the strategy for off-Base sampling during Phase 2 of the investigation and the project action limit (PAL) for VC.

Name	Title/Project Role	Affiliation	Phone #	Email Address
Kendra Leibman	RPM	NAVFAC Northwest	(360) 396-0022	kendra.leibman@navy.mil
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Heather Perry	Task Manager	CH2M	(530) 229-3276	heather.perry@ch2m.com

Comments

This scoping session took place during the weekly update teleconference. The team discussed revising the off-Base sampling radius with the consideration of groundwater flow directions and historical analytical results; the consensus decisions are presented below. The team additionally discussed changing the PAL for VC.

Action Items

- CH2M to incorporate changes to the off-Base sampling approach in the SAP and send revised Figure 6 to Kendra Leibman for approval. Following consensus on the changes, the revised SAP will be uploaded to NIRIS.
- CH2M to add a note to the documents uploaded to NIRIS on 9/22/17 to indicate that additional revisions are in process.
- RPM will discuss changes being made to the SAP with Navy chemist/SAP reviewer, Ken Bowers.
- Navy will contact residents that previously requested sampling and are not within the revised sampling radius to discuss the location of their parcel relative to the off-Base sampling area.

Consensus Decisions

It was determined that the off-Base sampling radius for PFAS (if detected on-Base), VC, and 1,4-dioxane would be modified as follows:

- South – Off-Base sampling requests will be sent to land owner parcels within a radius of ½ mile from the Area 6 boundary, as this is the direction of groundwater flow in the target aquifer.
- West – Off-Base sampling will be requested for parcels immediately adjacent to Area 6, as the 1,4-dioxane plume has not been delineated to the west and there is a potential local southwesterly component of groundwater flow in the northwestern portion of Area 6 in the target aquifer. The sampling radius initially extends to adjacent parcels.

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

- East – Off-Base sampling will not be conducted in this direction because groundwater flow in the target aquifer is predominantly to the south and analytical data from on-Base groundwater monitoring wells indicate that VC and 1,4-dioxane are nondetect along the eastern boundary of Area 6. It is assumed that PFAS (if present on-Base) would follow similar migration pathways as VC and 1,4-dioxane.
- Northeast – Off-Base sampling will be requested from the parcel immediately adjacent to Area 6. Limited sampling will be performed in this area, because the GETR effluent is currently discharged to a stream that flows to the north and under Ault Field Road.

Figure 6 was revised as described above and presents the location of applicable land parcels that were identified for off-Base sampling consideration.

An additional consensus decision was to modify the PAL for VC from the USEPA RSL for tap water, 0.019 µg/L, to the federal maximum contaminant level (MCL) of 2 µg/L. On August 10, 2017, the Navy and USEPA agreed to a slightly revised approach for VC. The forthcoming *Revised Draft Focused Feasibility Study* will state that the active treatment CUL for VC is 2 µg/L (i.e., that no further active treatment is required for VC). The federal MCL will also be used for decision making regarding providing alternate drinking water sources. The CUL for response complete (i.e., plume delineation/no long-term monitoring sampling required) is the Model Toxics Control Act (MTCA) Method B CUL of 0.29 µg/L modified for an excess cancer risk of 1 x 10^{-5}. This information will be included in the forthcoming ROD amendment.

The PALs for 1,4-dioxane will include the MTCA Method B CUL of 0.44 µg/L for the purposes of groundwater contaminant plume delineation and the USEPA LHA of 200 µg/L for the purposes of decision making regarding providing alternate drinking water sources[1].

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[1] The 1,4-dioxane PAL for decision making regarding providing alternate drinking water sources was subsequently changed to the modified for an excess cancer risk of 1 x 10^{-4}, 46 µg/L, based on stakeholder comments.

SAP Worksheet #9-4—Project Scoping Session Participants Sheet

Project Name: Investigation of Per- and Polyfluoroalkyl Substances in Groundwater, Area 6, Ault Field, NASWI **Projected Date(s) of Sampling:** 11/28/17 – 12/1/17 **PM:** Rebecca Maco	**Site Name**: Area 6, Ault Field, NASWI **Site Location:** Oak Harbor, Washington
Date of Session: November **Scoping Session Purpose:** To discuss and resolve stakeholder comments on the Draft Area 6 SAP.	

Name	Title/Project Role	Affiliation	Phone #	Email Address
Kendra Leibman	RPM	NAVFAC Northwest	(360) 396-0022	kendra.leibman@navy.mil
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Heather Perry	Task Manager	CH2M	(530) 229-3276	heather.perry@ch2m.com

Comments

This scoping session took place as part of a teleconference to discuss stakeholder comments on the Draft SAP. The team discussed the well locations suggested by stakeholders and added those listed in **Table 9-2** to the scope of the on-Base sampling effort.

Action Items

CH2M to incorporate changes to the on-Base sampling scope discussed during the teleconference in the Final SAP.

Consensus Decisions

The team agreed on a change to the on-Base sampling strategy for the deep aquifer system. As part of the SI effort, on-Base sampling will focus on the presence or absence of PFAS in the shallow aquifer system (the first hydrostratigraphic unit that could be impacted by infiltration from source areas) and the underlying intermediate aquifer. If PFAS is detected in the intermediate aquifer, evaluation of the presence/absence of PFAS in the deep aquifer would be performed as part of future characterization activities. This approach is consistent with the past sampling strategy for 1,4-dioxane where samples collected from intermediate aquifer wells between 2003 and 2006 were nondetect. Additional sampling at intermediate aquifer well 6-I-03 has been added to the scope of the SAP, and sampling of well 6-D-05 has been removed from the scope of the SAP.

Additionally, if PFAS are found on-Base, then the groundwater flow directions will be better defined in the northeastern and northwestern portions of Area 6 and the list of wells to be sampled for PFAS will be refined for follow on investigation.

Other additions to the sampling scope are included in **Table 9-2**.

SAP Worksheet #9-4—Project Scoping Session Participants Sheet (continued)

Table 9-2. Area 6, Ault Field Additional Area 6 Sampling Strategy and Rationale
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen Interval	Rationale
6-S-26 (Vashon Advance Outwash)	63.5 to 73.5 feet bgs	This well is located hydraulically upgradient from Area 6 source areas in the shallowest, laterally extensive HSU. The well is located near the surface water drainage that currently conveys GETR effluent to the north. Analytical data will be used to evaluate the potential for infiltration of PFAS from treatment system effluent to the groundwater system.
6-S-08 (Vashon Advance Outwash)	73 to 83 feet bgs	This well is located hydraulically upgradient from Area 6 source areas in the shallowest, laterally extensive HSU. The well is located in the north-central/eastern portion of Area 6. Analytical data will be used to evaluate PFAS presence or absence in this portion of the site.
6-S-31 (Vashon Advance Outwash)	73 to 83 feet bgs	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence in the higher concentration portion of the VOC/SVOC groundwater plumes along the western Area 6 boundary in the shallow aquifer.
6-I-03 (Whidbey Fm Unit 2)	166 to 176 feet bgs	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence in the higher concentration portion of the VOC/SVOC groundwater plumes along the western Area 6 boundary in the intermediate aquifer.

Note:

A comprehensive well construction summary table for Area 6 monitoring wells is included in **Appendix D**.

SAP Worksheet #10—Conceptual Site Model

Area 6 is located on Ault Field NASWI, Oak Harbor, Washington (**Figure 1**). **Figure 2** presents the site layout. A description and background summary of Area 6 is presented in **Table 10-1**.

Table 10-1. Area 6 Area Description and Background
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Site Name	Area 6, Ault Field, NASWI, Oak Harbor, Washington
Study Area Description	Area 6 is a 260-acre tract in the southeastern corner of Ault Field. Area 6 is bordered by Ault Field Road to the north, State Highway 20 to the east, and the Oak Harbor landfill on the south and southwest (**Figure 2**). Privately-owned forested or logged land, and a commercial sand and gravel quarry operation, are located immediately west of Area 6. Various businesses such as auto repair shops, an auto salvage yard, storage facilities, the Auld Holland Inn, and a mobile home park are located west and south of Area 6. Private residences are located to the east, west, and south of Area 6.
Site History	There are two areas within Area 6 where wastes are known to have been disposed: • The former industrial waste disposal area (Site 55): This feature consisted of an acid disposal pit and an oily sludge pit (Foster, 2002). The acid disposal pit received approximately 300,000 to 700,000 gallons of acids caustics, and solvents between the 1970s and 1980s. The oily sludge pit received approximately 100,000 to 600,000 gallons of liquid sludge between 1969 and the mid-1970s. • The Area 6 landfill: This feature included 23 cut-and-fill trenches with native materials in between and received Navy waste from 1969 through the mid-1990s (Foster, 1997; URS, 1993; URS-AECOM, 2016). The landfill received both sanitary solid and industrial wastes (which may have contained hazardous constituents) from 1969 to 1983, Navy waste through 1992, yard waste and construction debris during 1993, and soil and sediments classified as non-hazardous (from other remedial actions) in 1995 and 1996 (Foster, 1997 and URS, 1993). There is no known disposal of regulated wastes since 1983 (URS, 1993). Aqueous film-forming foam (AFFF) has historically been used at Ault Field (Area 31, Area 16) and the Outlying Field in Coupeville (CH2M, 2016), resulting in the presence of PFAS in groundwater downgradient from these areas. Although it is unknown whether AFFF was used or disposed of at Area 6; the historical site use as a disposal area suggests that such is feasible. The 1993 Record of Decision (ROD) identified trichloroethene (TCE), 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), 1,1-dichloroethene (DCE), cis-1,2-DCE, and VC as chemicals of concern (COCs) in groundwater (Navy, Ecology, and EPA, 1993). The conclusions of the associated risk assessment were that concentrations of COCs in soils, sediments and surface water posed unacceptable ecological risks and that future migration of COCs in groundwater posed the greatest potential risk to human health. Remedial actions implemented following the 1993 ROD focused on minimizing the leaching of contaminants from the vadose zone to the groundwater system and capture/treatment of contaminated groundwater. In 2003, 1,4-dioxane was identified in groundwater at Area 6. The subsequent Focused Feasibility Study (URS-AECOM, 2016) listed the COCs that will be part of a ROD Amendment as: TCE, 1,1-DCE, VC, and 1,4-dioxane.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Area 6 Area Description and Background
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Current Use		Currently, Area 6 is mostly vacant and composed of a compost facility, an approximate 40-acre engineered landfill cap, and a stormwater detention basin. It also includes various groundwater monitoring and extraction wells and a groundwater treatment plant (URS, 2015). The off-Base land surrounding Area 6 is used for a combination of residential and commercial purposes. The City of Oak Harbor's primary source of water is through the City of Anacortes, which extracts and treats water from the Skagit River. There are also private and community drinking water wells downgradient and cross gradient of Area 6.
Site Status		The Area 6 landfill cap was constructed as part of the remedial action to prevent infiltration through the landfill that may result in leaching of contaminants to groundwater (Foster, 1997). An interim soil removal action was completed in 2001 at the former industrial waste disposal area (Site 55) to reduce the mass in the vadose zone source area; however, confirmation samples indicate that elevated concentrations of TCE in soil remain in place post-excavation (Foster, 2002). VOCs in groundwater, excluding 1,4-dioxane, are currently being treated with a GETR system constructed in 1995 (URS-AECOM, 2016). Currently, effluent from the GETR is discharged to land surface on the southern side of the Area 6 composting facility (**Figure 2**). The effluent flows to the north, following a natural surface water drainage, ultimately discharging to a swale north of Ault Field Road. The GETR system was not designed to treat 1,4-dioxane because the 1,4-dioxane was not identified in the groundwater until 2003. As such, 1,4-dioxane has been redistributed in the aquifer system via discharge of GETR effluent upgradient of the Area 6 source areas and subsequent infiltration to the groundwater system. An upgrade to the GETR is currently under development and will incorporate an advanced oxidation unit that will remediate both VC and 1,4-dioxane (CTI-URS, 2017).
Site Conditions	**Physical Characteristics**	Whidbey Island lies within the Puget lowland, a topographic and structural depression between the Olympic Mountains and the Cascade Range.
	Geology and Hydrogeology	Four glacial units have been identified at Area 6 and include, from youngest to oldest: the Vashon Recessional Outwash (thin and discontinuous layer of sand and gravel with some silt only present in the eastern part of Area 6 at the ground surface overlying the Vashon Till [CTI-URS, 2017]), which is interpreted as being predominantly unsaturated in Area 6 based on published cross-sections (URS-AECOM, 2016); Vashon Till (laterally extensive layer of silty, fine sand with some gravel, containing localized layers of clay or silt typically present and ground surface); Vashon Advance Outwash (coarse, gravelly sand that gradually becomes finer grained with depth with local layers of silty sand, silt, or clay); and Whidbey Formation Units 1 through 4 (alternating finer-grained and coarser-grained materials). **Figure 7** presents a north-south cross-section through Area 6 illustrating the relative thicknesses and vertical locations of the units. More detailed descriptions of the units can be found in CTI-URS, 2017 and URS, 2013. The U.S. Geological Survey has identified up to five major HSUs (aquifers) above bedrock in Island County, where NASWI is located, (Jones, 1985 and Sapik et al., 1988). The existing aquifer units are composed of sand or sand and gravel, while the adjacent confining layers are composed of till, glaciomarine drift, or nonglacial clay and silt.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Area 6 Area Description and Background

Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

		Perched, saturated zones may exist locally above noncontinuous areas of till or other clay-rich units. Three of these five upper aquifers have been identified at Area 6. • The shallow aquifer is an unconfined groundwater unit found in the Vashon Advance Outwash beneath Area 6. The former industrial waste disposal pits (Site 55) discharged directly into this unit. • The intermediate aquifer is a moderately continuous groundwater body found in the sandy unit that corresponds to the Whidbey Formation Unit 2. Near Area 6, this aquifer is confined below the silt and clay of Whidbey Formation Unit 1, which acts as an aquitard. • The deep aquifer is also a nearly continuous confined groundwater body found near Area 6. This aquifer is confined below the silt and clay of Whidbey Formation Unit 3 (which acts as an aquitard) and occupies a thick sand layer in Whidbey Formation Unit 4. Based on potentiometric maps presented in the Annual 2016-2017 Groundwater Long-Term Monitoring Report (Sealaska, 2017), the groundwater flow direction in the Vashon Advance Outwash (shallow aquifer) underlying Area 6 is predominantly to the south. There is a potential local southwesterly component of groundwater flow in the northwestern corner of Area 6. Groundwater flow direction in the Whidbey Formation Unit 2 (intermediate aquifer) is predominantly to the southeast; however, measurements from a subset of Area 6 monitoring wells (6-I-01, 6-I-03, and 6-I-08) suggest a local component of groundwater flow to the northeast (URS Consultants, 1993). Groundwater elevation data from wells completed in the Whidbey Formation Unit 4 (deep aquifer) suggest groundwater flow directions ranging from southeast to southwest (URS Consultants, 1993). Downward vertical hydraulic gradients exist at the site, with differences in groundwater elevations between the shallow and intermediate aquifer ranging from 5 to 20 feet and approximately 50 feet between the shallow and deep aquifer (CTI-URS, 2017). The majority of monitoring infrastructure at Area 6 is completed within the shallow aquifer (that is, wells with an "S" in the location names on **Figures 3** through **5**). There are limited readily available information regarding the subsurface characteristics of the off-Base area surrounding Area 6. Regionally, Whidbey Island consist of a thick sequence of glacial and interglacial deposits overlying lower permeability bedrock. The relatively continuous lithologic/hydrostratigraphic units described above likely extend off-Base. Before the off-Base drinking water sampling event (described in **Worksheet #11**), available information for off-Base wells will be compiled. Well construction and lithologic information will be synthesized during development and refinement of the conceptual site model during the data interpretation and presentation phase of the program.
Source Areas		Semivolatile organic compound (SVOC) and VOC source areas include the former industrial waste disposal area and the Area 6 landfill. AFFF has historically been used at Ault Field (Area 31, Area 16) and the Outlying Field in Coupeville (CH2M, 2016), resulting in the presence of PFAS in groundwater downgradient

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Area 6 Area Description and Background

Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

	from these areas. Although it is unknown whether AFFF was used or disposed of at Area 6; the historical site use as a disposal area suggests that such is feasible.
Nature and Extent	Previous investigations at NASWI have confirmed the presence of SVOCs and VOCs in groundwater exceeding CULs; however, the presence of PFAS in groundwater at Area 6 is unknown. The results of routine groundwater monitoring at Area 6 suggest the presence of two groundwater SVOC and VOC plumes at Area 6 (Sealaska, 2017). The first plume is referred to as the western groundwater plume, which originates from the former industrial waste disposal area (**Figures 3** and **4**). Multiple VOCs were detected at concentrations exceeding risk levels in the western groundwater plume, including TCE, 1,1,1-TCA, 1,1-DCE, and one SVOC, 1,4-dioxane. The second plume is referred to as the southern groundwater plume which originates from the capped Area 6 landfill (**Figures 3** and **4**). Although the extent of these individual plumes are distinguishable for other COCs (Sealaska, 2017), the western and southern 1,4-dioxane plumes are comingled (**Figure 3**). The most recent interpretations of the groundwater plumes suggest that VC and 1,4-dioxane have migrated off-Base at concentrations exceeding the respective CULs, that the off-Base extent of 1,4-dioxane has not been delineated to the west or south, and that the interpretation of the off-Base extent of VC is based on limited data (**Figure 3**) (Sealaska, 2017). As such, additional delineation of 1,4-dioxane and VC is warranted. With respect to the vertical distribution of VOCs in the aquifer system, the 1993 Remedial Investigation Report (URS Consultants, 1993) concluded that the majority of groundwater contamination (COCs exceeding the respective screening level) was present in the shallow aquifer. Concentrations of detected COCs in the intermediate aquifer were either infrequent or near the detection limit; therefore, the presence in groundwater could not be confirmed. Subsequent sampling of intermediate aquifer wells between 1994 and 2006 has yielded similar results (nondetected results with limited reporting limits [RLs] exceeding the screening levels for VC, 1,1-DCE, TCE, and 1,4-dioxane). Results of remedial investigations in 1991 concluded that the deep aquifer had not been impacted by operations at Area 6 (Navy, Ecology, and USEPA, 1993). Detected concentrations at one deep monitoring well (6-D-04) were found to be the result of leaky casing joints allowing for groundwater from the shallow aquifer to enter the well. The well was subsequently pumped (to capture groundwater that leaked from the shallow aquifer) and abandoned. Groundwater samples for COCs have not been collected from deep aquifer monitoring wells since 1991 and 1,4-dioxane has not been analyzed in deep aquifer monitoring well samples. The current long-term groundwater monitoring program is focused on the shallow aquifer (Sealaska, 2017).
Migration Pathways	• Leaching of PFAS, VOCs, and/or SVOCs (i.e., 1,4-dioxane) currently or historically present in the former industrial waste disposal area and/or the Area 6 landfill from soil and/or waste to groundwater • Transport via advection/dispersion in groundwater
Potential Receptors/ Exposure Routes	Current and future users of drinking water wells in areas near Area 6 (ingestion)

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Area 6 Area Description and Background
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Data Needs	• Analytical PFAS data to evaluate the presence or absence of PFAS in groundwater at and downgradient of Area 6 that could pose a risk to off-Base receptors and/or require modifications to the GETR upgrade design. • Analytical data regarding the presence or absence of PFAS precursors in groundwater within the on-Base GETR capture zone, that is currently under development by the design team, that could be transformed to PFAS during GETR treatment processes, thereby increasing the overall concentration of PFAS. • Analytical data regarding the relative PFAS concentration in the GETR influent and effluent samples is needed to determine if PFAS is being conveyed through the current treatment stream. • Because 1,4-dioxane and VC have migrated off-Base, analytical data regarding the concentrations and extent of 1,4-dioxane and VC in off-Base groundwater that may pose a risk to off-Base receptors and/or require modifications to the GETR upgrade design is needed.

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

Problem Statement (Data Quality Objective)

The use of AFFF at Ault Field and the Outlying Field has been documented during previous studies (CH2M, 2016); however, it is unknown whether the substance has been used or disposed of at Area 6. Given the site history of Area 6 as a waste disposal area, disposal of AFFF is possible. It currently unknown whether PFAS are present in the on-Base and off-Base groundwater and drinking water supply above the USEPA Lifetime Health Advisory (LHA) and/or regional screening level (RSL) within and downgradient of Area 6. Information regarding the presence and lateral/vertical extent of PFAS are necessary to evaluate the risk to off-Base receptors and to inform the design of the Area 6 GETR upgrade that is currently underway. This upgrade will add oxidation to the treatment process to facilitate removal of 1,4-dioxane from groundwater. Such a process could increase the concentrations of PFAS in the groundwater system by oxidation of PFAS precursors, if present. Information regarding the presence of PFAS precursors in on-Base groundwater is needed to further inform the design of the Area 6 GETR upgrade.

Historical waste disposal practices have resulted in the release of VOCs and SVOCs to the aquifer system that have generated groundwater contaminant plumes. The interpretation of the 1,4-dioxane and VC groundwater plumes based on data collected in winter 2017 (**Figures 3** and **4)** indicate that these constituents have migrated off-Base at concentrations exceeding the respective CULs, that the off-Base extent of the 1,4-dioxane plume has not been delineated to the west or south, and that the interpreted off-Base extent of VC is based on a limited dataset (Sealaska, 2017). Data regarding the concentrations and off-Base extent of 1,4-dioxane and VC are needed to evaluate the risk to off-Base receptors and/or to inform the GETR upgrade design. Additionally, the City of Oak Harbor landfill is located south (downgradient) of Area 6. It is unknown whether this feature is contributing VOCs and/or SVOCs to the groundwater system. Data are needed from wells upgradient and downgradient of the landfill to evaluate the feature as a potential source area.

The objectives of this investigation are to:

- Determine the presence or absence of PFAS above the LHA and/or RSL in groundwater at Area 6
- Investigate the extent of PFAS in off-Base groundwater if detected on-Base
- Delineate the off-Base extent of the known 1,4-dioxane and VC groundwater plumes.

The objectives, environmental questions, general investigation approaches, and project quality objectives (PQOs) are described in **Table 11-1** and are based on the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006). The sampling approach, including numbers of samples and a full list of analytes, is provided in **Worksheet #17**. Planned sample locations are shown on **Figures 5** and **6**.

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

Table 11-1. Problem Quality Objectives

Objectives	Study Question	General Investigation Approach	PQO
Evaluate the presence or absence of PFAS (including precursors) in groundwater at Area 6 and determine downgradient extent of PFAS in groundwater/drinking water if detected on-Base.	Are PFAS present in Area 6 groundwater such that modifications to the GETR design would be required? If PFAS are present in the groundwater at Area 6, do they extend offsite and, if so, what is the off-Base extent hydraulically downgradient from the site that requires interim measures and/or modifications to GETR design to mitigate risks to off-Base receptors? Are PFAS precursors, which could be transformed to PFAS during GETR treatment processes, present within the on-Base groundwater capture zone of the GETR such that modifications to the design upgrade may be needed?	Groundwater samples will be collected from on-Base groundwater monitoring wells as well as from the GETR influent and effluent streams. Samples will be analyzed via USEPA Modified Method 537 for 14 PFAS prescribed in the method and for PFAS precursors via the TOP Assay. **Figure 5** presents the proposed groundwater monitoring well sampling locations. The sampling rationale and counts are outlined in **Worksheets #17** and **#18**. If PFAS are detected in groundwater samples collected from Area 6 monitoring wells, requests to sample drinking water wells will be sent to land parcel owners within 1/2 mile south of the Area 6 property boundary and to land parcel owners immediately adjacent to the Area 6 property boundary to the west, northwest, and northeast (**Figure 6**). The drinking water wells of respondents will be analyzed via USEPA Method 537 for 14 PFAS prescribed in the method. Samples will be collected from Navy-leased groundwater monitoring wells south of the Area 6 boundary and will be analyzed via USEPA Modified Method 537 for 14 PFAS prescribed in the method (**Figure 5**). **Figure 5** presents the location of groundwater monitoring wells south of Area 6. The sampling rationale and counts are outlined in **Worksheets #17** and **#18**. Based on the results of the first phase of off-Base sampling, an additional 1/2-mile step-out downgradient of perfluorooctane sulfonate (PFOS) and/or perfluorooctanoic acid (PFOA) LHA exceedances may be required.	If PFAS are not present in on-Base groundwater at Area 6, no further action will be taken with regard to PFAS at Area 6. If PFAS are found to be present in on-Base groundwater at Area 6, such information will be used to inform the GETR upgrade design and off-Base drinking water and groundwater monitoring wells will be sampled for PFAS to determine the off-Base extent that may require interim measures and/or longer-term solutions. Additionally, if PFAS are found on-Base, then the groundwater flow directions will be better defined in the northeastern and northwestern portions of Area 6 and the list of wells to be sampled for PFAS will be refined for follow on investigation. If data collected at off-Base drinking water and groundwater monitoring wells within off-Base sampling area shown on **Figure 6** indicate that concentrations of PFAS are not present at levels above the LHA and/or RSL, residences with detected PFAS would be considered in the development of a periodic monitoring plan for off-Base drinking water wells (to evaluate temporal and spatial variability), currently being developed in a separate SAP document. If data collected at off-Base drinking water or groundwater monitoring wells within either the preliminary off-Base sampling area shown on **Figures 5 and 6** or the step-out sampling radius (if required) indicate that concentrations of PFAS are present at concentrations above the LHA and/or RSL, such information will be incorporated into the GETR upgrade design and impacted residents will be supplied with bottled water and will be incorporated into the study of long-term solutions for affected residents being conducted in parallel to this sampling effort. Impacted areas will also be included in the development of a periodic monitoring plan for off-Base drinking water wells, currently being developed in a separate SAP document. If TOP Assay results indicate that PFAS precursors, which could be transformed to PFAS via oxidation processes, are not present in on-Base groundwater at Area 6, such information will be used to inform the GETR design processes. If TOP Assay results indicate that PFAS precursors, which could be transformed to PFAS via oxidation processes, are present in on-Base groundwater, such information will be incorporated into the GETR design process.

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

Table 11-1. Problem Quality Objectives

Objectives	Study Question	General Investigation Approach	PQO
Delineate the hydraulically downgradient (off-Base) extent of the 1,4-dioxane and VC groundwater plumes.	What are the hydraulically downgradient (off-Base) extents of the 1,4-dioxane and VC groundwater plumes that may pose a risk to off-Base receptors and/or require modifications to the GETR design upgrades? Is the City of Oak Harbor landfill contributing mass to the 1,4-dioxane and VC groundwater plumes?	Requests to sample drinking water wells will be sent to land parcel owners within 1/2 mile south of the Area 6 property boundary and to land parcel owners immediately adjacent to the Area 6 property boundary to the west, northwest, and northeast (**Figure 6**). Samples will be collected from Navy-leased groundwater monitoring wells south of the Area 6 boundary (including wells upgradient and downgradient of the City of Oak Harbor landfill). Samples will be collected from groundwater monitoring and drinking water wells of respondents and will be analyzed via SW-846 Method SW8260C for VC and SW-846 Method 8270D-SIM for 1,4-dioxane. **Figure 5** presents the location of groundwater monitoring wells south of Area 6 and **Figure 6** presents the distribution of land parcels with drinking water wells within the off-Base sampling radius. The sampling rationale and counts are outlined in **Worksheets #17** and **#18**. Based on the results of the first phase of off-Base sampling, an additional 1/2 mile step-out downgradient of VC and/or 1,4-dioxane exceedances may be required.	If data collected from off-Base drinking water and/or groundwater monitoring wells within the off-Base sampling area shown on **Figure 6** are sufficient to delineate the lateral and vertical extent of 1,4-dioxane and VC exceeding the CULs, no further action/investigation will be required and the data will be used to help inform the upgrade to the GETR. If data collected from off-Base drinking water and/or groundwater monitoring wells within the off-Base sampling area shown on **Figure 6** are not sufficient to delineate the lateral and vertical extent of 1,4-dioxane and VC exceeding the CULs, the data will be used to help inform the upgrade to the GETR and additional sampling of drinking water wells within a larger step-out area will be conducted. If data collected from off-Base drinking water wells indicate that VC and/or 1,4-dioxane are present at concentrations above the MCL (VC) or LHA (1,4-dioxane), residents will be supplied with bottled water and will be incorporated into the study of long-term solutions for affected residents being conducted in parallel to this sampling effort. Impacted areas will also be included in the development of a periodic monitoring plan for off-Base drinking water wells, currently being developed in a separate SAP document. If data collected at off-Base drinking water wells indicate that concentrations of VC and/or 1,4-dioxane are present at concentrations above the MCL (VC) or LHA (1,4-dioxane), residences' drinking water wells will be resampled in a follow-up sampling event to evaluate temporal and spatial variability under this SAP. If data collected from groundwater samples at the City of Oak Harbor landfill do not show an increase in 1,4-dioxane or VC concentrations between upgradient and downgradient wells, the feature is likely not contributing mass to the underlying groundwater plumes; however, additional sampling may be incorporated into the long-term groundwater monitoring program to evaluate temporal trends. If data collected from groundwater samples at the City of Oak Harbor landfill show an increase in 1,4-dioxane or VC concentrations between upgradient and downgradient wells, the feature may be contributing mass to the underlying groundwater plumes. Such information would be incorporated into future decision making and additional sampling may be incorporated into the long-term groundwater monitoring program to evaluate temporal trends.

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

What are the Project Action Limits?

Project Action Limits (PALs) are media-specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and determine if further evaluation or action is needed to address concentrations of chemicals present onsite. The following list summarizes the PALs applicable to groundwater, drinking water, and GETR influent/effluent.

- USEPA LHA for PFOA and PFOS: 0.07 microgram per liter (µg/L), unless both chemicals are detected, then 0.07 µg/L is the LHA for the cumulative concentration of the two chemicals
- USEPA RSL for perfluorobutane sulfonates (PFBS): 400 µg/L (based on a hazard quotient [HQ] = 1.0)
- PALs currently do not exist for the remaining 11 PFAS compounds. At the time of drafting this SAP, there are no USEPA RSLs or any state regulatory screening levels available. Per Navy policy, data need to be collected for all 14 analytes listed in USEPA Method 537 rev. 1.1
- PFAS precursors do not have explicit screening levels, the presence or absence of the compounds will be quantified based on the pre-oxidation and post-oxidation PFAS concentrations via the TOP Assay
- 1-4-Dioxane: MTCA Method B CUL of 0.44 µg/L for the purposes of groundwater contaminant plume delineation. Modified MTCA Method B CUL of 46 µg/L (modified for an excess cancer risk of 1×10^{-4}) for the purposes of decision making regarding providing alternate drinking water sources.
- Vinyl Chloride: Modified MTCA Method B CUL of 0.29 µg/L (modified for an excess cancer risk of 1×10^{-5}) for the purposes of contaminant plume delineation. USEPA federal MCL of 2 µg/L for the purposes of decision making regarding active treatment or providing alternate drinking water sources.

Who will use the data and for what will the data be used?

Data will be used by the Navy, its contractors, and the other stakeholder agencies to address the environmental questions and PQOs listed in **Table 11-1**.

What types of data are needed?

Refer to **Table 11-1**.

Are there special data quality needs, field or laboratory, to support environmental decisions?

None.

Where, when, and how should the data be collected and generated? Who will collect the data?

CH2M field staff will collect the samples and make field observations during the investigation. Sampling locations are shown on **Figures 5** and **6** but are subject to relocation during the investigation based on field observations after consultation with the project team and the NAVFAC Northwest RPM. The data will be collected and the investigation conducted as outlined in **Worksheets #14, #17,** and **#18,** and in accordance with the project schedule outlined in **Worksheet #16**. The data will be collected following the standard operating procedures (SOPs) presented in **Worksheet #21**.

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SAP Worksheet #12-1—Measurement Performance Criteria Table – Field QC Samples

Matrix: Drinking Water and Groundwater
Analytical Group: VOCs and SVOCs
Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Matrix Spike(MS)/Matrix Spike Duplicate (MSD)	VOCs, SVOCs	One per 20 samples	Accuracy/Precision	See **Worksheet #28**.
Field Duplicate (FD)		One per 10 samples	Precision	Relative percent difference (RPD) < 30%
Field Blank	VOCs, SVOCs	One per site per week for samples collected for VOCs and SVOCs.	Bias/Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Cooler Temperature Indicator	VOCs, SVOCs	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 degrees Celsius (°C), not frozen
Trip Blank	VOCs	One per cooler containing samples for volatiles analysis	Bias/Contamination	No target analytes detected > 1/2 LOQ

Note:
> = greater than
< = less than
≤ = less than or equal to
°C = degree Celsius

SAP Worksheet #12-2—Measurement Performance Criteria Table – Field QC Samples

Matrix: Groundwater, GETR Influent, GETR Effluent

Analytical Group: PFAS (including TOP Assay[a]), VOCs[b], SVOCs[b]

Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Matrix Spike(MS)/Matrix Spike Duplicate (MSD)	PFAS VOCs, SVOCs	One per 20 samples	Accuracy/Precision	See **Worksheet #28**.
Field Duplicate (FD)		One per 10 samples	Precision	Relative percent difference (RPD) < 30%
Field Reagent Blank	PFAS	One per site per day of sampling for PFAS.	Bias/Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Field Blank	VOCs, SVOCs	One per site per week for samples collected for VOCs and SVOCs		No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Cooler Temperature Indicator	PFAS VOCs, SVOCs	One per cooler	Accuracy/Representativeness	Temperature ≤ 6 (°C), not frozen
Equipment Blank		One per day for decontaminated equipment; one per lot for disposable equipment	Bias/Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Trip Blank	VOCs	One per cooler containing samples for volatiles analysis	Bias/Contamination	No target analytes detected > 1/2 LOQ

Notes:

[a] On-Base groundwater samples and the GETR influent/effluent samples will be analyzed for PFAS precursors via the TOP Assay.

[b] Off-Base groundwater samples will be analyzed for VOCs (VC) and SVOCs (1,4-dioxane).

SAP Worksheet #12-3—Measurement Performance Criteria Table – Field QC Samples

Matrix: Drinking Water
Analytical Group: PFAS
Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Matrix Spike(MS)/Matrix Spike Duplicate (MSD)	PFAS	One per 20 samples	Accuracy/Precision	See **Worksheet #28**.
Field Duplicate (FD)		One per 10 samples	Precision	Relative percent difference (RPD) < 30%
Field Reagent Blank		One per property, per well where drinking water sampled for PFAS only.	Bias/Contamination	No analytes detected > 1/3 limit of quantitation (LOQ). If detected greater than 1/3, any samples with detections will need to be resampled and reanalyzed; however, decision making and/or action (i.e., providing an alternate drinking water source) may proceed in advance of the resampling and re-analysis.
Cooler Temperature Indicator		One per cooler	Accuracy/Representativeness	Temperature ≤ 10°C, not frozen

Note:

> = greater than
< = less than
≤ = less than or equal to
°C = degree Celsius

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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
Drinking water sources	CH2M. Drinking Water Source Verification Technical Memorandum. 2016.	Desktop data search performed by CH2M in September 2016 using available historical documents and public records to identify off-Base, potentially impacted, drinking water sources.	Identify drinking water sources	None
Historical analytical and groundwater elevation data from Area 6 monitoring well network.	Sealaska. 2017. *Annual 2016-2017 Groundwater Long-Term Monitoring Report for Operable Unit 1 Area 6 and Operable Unit 5 Area 31*. CTI-URS. 2017. *Draft 30 Percent Basis of Design Report for Southern and Western GETR System Remedial Designs Area 6*.	These reports summarize the site history, geology, hydrogeology, and historical data collected at Area 6.	Facilitate selection of on-Base and off-Base sampling location by providing insight on groundwater flow directions and the vertical/ spatial distribution of groundwater contamination.	None

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SAP Worksheet #14—Summary of Project Tasks

Pre-sampling Tasks

- Subcontractor procurement
  - Analytical laboratory
  - Data Validator
- Fieldwork scheduling
- Coordination with NASWI for site access and security.

Sampling Tasks

Applicable field book and forms should be filled out completely each day.

- Groundwater Samples
  - Samples will be collected in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.
  - Groundwater samples will be collected from monitoring wells following the sampling protocol as specified in **Worksheet #18**.
- GETR Influent/Effluent Samples
  - Samples will be collected in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.
  - GETR influent/effluent samples will be collected from treatment system following the sampling protocol as specified in **Worksheet #18**.
- Drinking Water Samples
  - Samples will be collected in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.
  - Drinking water samples will be collected from properties following the sampling protocol as specified in **Worksheet #18**.
  - Drinking water samples will be collected, if possible, at a tap or spigot prior to treatment or filtering. Samples will be collected after 3 to 5 minutes of flushing.

Analyses and Testing Tasks

- The subcontracted analytical laboratory will process and prepare samples for analyses, and will analyze all on-Base samples PFAS with the TOP Assay in accordance with **Worksheets #18** and **#19**. All off-Base samples will be analyzed for 1-4-dioxane and VC in accordance with **Worksheets #18** and **#19**. If PFAS are detected in on-Base samples, off-Base groundwater samples within the upgraded GETR extraction zone and all drinking water samples within the off-Base sampling area will also be analyzed for PFAS in accordance with **Worksheets #18** and **#19**.

Quality Control Tasks

- Implement SOPs for field and laboratory activities being performed.
- QC samples are described on **Worksheets #12** and **#20**.

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

Secondary Data

- See **Worksheet #13**.

Data Validation, Review, and Management Tasks

- See **Worksheets #34** through **#36** for discussion of data management procedures.

Documentation and Reporting

- A summary of field activities as well as a data evaluation will be documented in a technical memorandum and submitted to the Base RPM and the NTR for review and approval.

Assessment/Audit Tasks

- **Worksheets #31** and **#32**.

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

Matrix: Drinking Water

Analytical Group: PFAS

Analyte	Chemical Abstract Service (CAS) Number	USEPA Lifetime Health Advisory (µg/L)	RSLs Tapwater HQ = 1.0 (June 2017) (µg/L)	PQL Goal[a] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[b] (%)		
					LOQs (µg/L)	**LODs (µg/L)**	**DLs (µg/L)**	**LCL**	**UCL**	**RPD**
Perflurooctane Sulfonate (PFOS)[c]	1763-23-1	0.07	--	0.01	0.01	0.005	0.00104	70	130	30
Perfluoro-n-octanoic acid (PFOA)[c]	335-67-1	0.07	--	0.01	0.01	0.005	0.00108	70	130	30
Perfluorobutane sulfonate (PFBS)[c]	375-73-5	--	400	0.01	0.01	0.005	0.000443	70	130	30
Perfluorohexanoic acid (PFHxA)	307-24-4	--	--	0.01	0.01	0.005	0.000663	70	130	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	--	--	0.01	0.01	0.005	0.000533	70	130	30
Perfluorohexane sulfonate (PFHxS)	355-46-4	--	--	0.01	0.01	0.005	0.000415	70	130	30
Perfluorononanoic acid (PFNA)	375-95-1	--	--	0.01	0.01	0.005	0.00144	70	130	30
Perfluorodecanoic acid (PFDA)	335-76-2	--	--	0.01	0.01	0.005	0.00128	70	130	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	--	--	0.01	0.01	0.005	0.000255	70	130	30
Perfluorododecanoic acid (PFDoA)	307-55-1	--	--	0.01	0.01	0.005	0.000952	70	130	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	--	--	0.01	0.01	0.005	0.000943	70	130	30
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	--	--	0.01	0.01	0.005	0.000777	70	130	30
N-Ethylperfluoro-1-octancesulfonamidoacetic acid (EtFOSAA)	2991-50-6	--	--	0.01	0.01	0.005	0.00193	70	130	30
N-Methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	--	--	0.01	0.01	0.005	0.00304	70	130	30
PFOA + PFOS (calculated)[d]	--	0.07	--	--	--	--	--	--	--	--

Notes:

[a] The project quantitation limit (PQL) goal is equal to the laboratory LOQ. Limits are verified quarterly and are subject to change. If any limits change that impact project screening limits, the Navy RPM will be notified.

[b] Accuracy and precision limits follow USEPA Method 537 Revision 1.1 per Navy policy.

[c] PALs are available for PFOS, PFOA, and PFBS. No other criteria are available or applicable to the remaining analytes. The analytes have been included to follow Navy policy.

[d] If both PFOS and PFOA are detected, the combined concentration must be less than 0.07 µg/L. Otherwise, the chemicals will be compared to the USEPA LHA of 0.07 µg/L individually.

DL = detection limit
LCL = lower confidence limit
LCS = laboratory control sample
LOD = limit of detection
RPD = relative percent difference
UCL = upper confidence limit

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

Matrix: Drinking Water, Groundwater, Influent, Effluent

Analytical Group: SVOCs

Analyte	Chemical Abstract Service (CAS) Number	Modified MTCA Method B Cleanup Level[a] (µg/L)	MTCA Method B Cleanup level (µg/L)	RSLs Tapwater HQ = 1.0 (June 2017) (µg/L)	PQL Goal[b] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[c] (%)		
						LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)	LCL	UCL	RPD
1-4-Dioxane	123-91-1	46	0.44	0.46	0.22	0.1	0.03	0.011	40	140	20

Notes:

[a] The MTCA Method B CUL has been modified for an excess cancer risk of 1 x 10^{-4}.

[b] The PQL goal is half the lesser of applicable screening levels.

[c] Accuracy and precision limits follow Department of Defense (DoD) Quality Systems Manual (QSM) v5.1.

DL = detection limit

LCL = lower confidence limit

LCS = laboratory control sample

LOD = limit of detection

RPD = relative percent difference

UCL = upper confidence limit

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

Matrix: Drinking Water, Groundwater, Influent, Effluent

Analytical Group: VOCs

Analyte	Chemical Abstract Service (CAS) Number	USEPA Federal MCL (µg/L)	Modified MTCA Method B Cleanup level[a] (µg/L)	PQL Goal[b] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[c] (%)		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)	LCL	UCL	RPD
Vinyl Chloride	75-01-4	2.0	0.29	0.0095	0.02	0.015	0.013	59	140	30-LCS; 35 MS/MSD

Notes:

[a] The MTCA Method B CUL has been modified for an excess cancer risk of 1 x 10^{-5}

[b] The PQL goal is half the lesser of applicable screening levels. The method LOD is less than the lowest screening criteria.

[c] Accuracy and precision limits follow laboratory in-house limits for low-level method.

DL = detection limit

LCL = lower confidence limit

LCS = laboratory control sample

LOD = limit of detection

MCL = maximum contaminant level

RPD = relative percent difference

UCL = upper confidence limit

SAP Worksheet #15-4—Reference Limits and Evaluation Table

Matrix: Groundwater, Influent, Effluent

Analytical Group: PFAS

Analyte	Chemical Abstract Service (CAS) Number	USEPA Lifetime Health Advisory (µg/L)	RSLs Tap water HQ = 1.0 (June 2017) (µg/L)	PQL Goal[a] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[b] (%)		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)	LCL	UCL	RPD
Perfluorooctanoic acid (PFOA)[c]	335-67-1	0.07	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorooctane Sulfonate (PFOS)[c]	1763-23-1	0.07	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorobutane sulfonate (PFBS)[c]	375-73-5	--	400	0.008	0.008	0.005	0.00218	70	130	30
Perfluorohexanoic acid (PFHxA)	307-24-4	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorohexane sulfonate (PFHxS)	355-46-4	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorononanoic acid (PFNA)	375-95-1	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorodecanoic acid (PFDA)	335-76-2	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorododecanoic acid (PFDoA)	307-55-1	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	--	--	0.008	0.008	0.005	0.00218	70	130	30
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	--	--	0.008	0.008	0.005	0.00218	70	130	30
N-Ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	--	--	0.008	0.008	0.005	0.00218	70	130	30

SAP Worksheet #15-4—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater, Influent, Effluent

Analytical Group: PFAS

Analyte	Chemical Abstract Service (CAS) Number	USEPA Lifetime Health Advisory (µg/L)	RSLs Tap water HQ = 1.0 (June 2017) (µg/L)	PQL Goal[a] (µg/L)	Laboratory Limits (µg/L)			LCS and MS/MSD Recovery Limits and RPD[b] (%)		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)	LCL	UCL	RPD
N-Methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	--	--	0.008	0.008	0.005	0.00218	70	130	30
PFOA + PFOS (calculated)[d]	--	0.07	--	--	--	--	--	--	--	--

Notes:

[a] The PQL goal is equal to the laboratory LOQ. Limits are verified quarterly and are subject to change. If any limits change that impact project screening limits, the Navy RPM will be notified.

[b] Accuracy and precision limits follow laboratory in-house limits per DoD QSM v5.1 Table B-15.

[c] PALs are available for PFOS, PFOA, and PFBS. No other criteria are available or applicable to the remaining analytes. The analytes have been included to follow Navy policy.

[d] If both PFOS and PFOA are detected, the combined concentration must be less than 0.07 µg/L. Otherwise, the chemicals will be compared to the USEPA Lifetime Health Advisory of 0.07 µg/L individually.

DL = detection limit

LCL = lower confidence limit

LCS = laboratory control sample

LOD = limit of detection

RPD = relative percent difference

UCL = upper confidence limit

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SAP Worksheet #16—Project Schedule/Timeline Table

Activities	Organization	Dates (MM/DD/YY)		Deliverable
		Anticipated Date of Initiation	**Anticipated Date of Completion**	
SAP Schedule				
Internal Draft SAP preparation	CH2M	7/13/2017	8/30/2017	Internal Draft SAP
Navy SAP review	NAVFAC Northwest	8/31/2017	9/13/2017	Comments
Draft SAP preparation	CH2M	9/14/2017	10/9/2017	Draft SAP
Stakeholder Review	Various	10/10/2017	11/16/2017	Comments
Final SAP	CH2M	11/17/2017	11/27/2017	Final SAP
Sampling Schedule				
On-Base Sampling	CH2M	11/28/2017	12/5/2017	N/A
Analytical Data	Subcontractor	7-day turnaround time		
Off-Base Sampling (round 1)	CH2M	2/7/2018	2/13/2018	N/A
Off-Base Sampling (round 2)	CH2M	4/16/2018	5/14/2018	N/A
Analytical Data	Subcontractor	7-day turnaround time		
Data Management	CH2M	TBD	TBD	N/A
Reporting	CH2M	TBD	TBD	Final Site Investigation Report

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SAP Worksheet #17—Sampling Design and Rationale

Table 17-1. Area 6, Ault Field Sampling Strategy and Rationale
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen Interval	Analysis and Method	Number of Samples[a]	Rationale
On-Base Sampling				
P-4 (Vashon Till)	5 to 20 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This piezometer is located hydraulically upgradient of Area 6 in the shallowest HSU. The piezometer is constructed in an area that receives surface runoff from the Area 6 treatment plant. Analytical data will be used to evaluate the potential for infiltration of PFAS from treatment system effluent to the groundwater system.
6-S-07 (Vashon Advance Outwash)	28.5 to 38.5 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically upgradient from Area 6 source areas in the shallow aquifer. Analytical data will be used to evaluate the potential for migration of PFAS from upgradient sources.
6-S-26 (Vashon Advance Outwash)	63.5 to 73.5 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically upgradient from Area 6 source areas in the shallowest, laterally extensive HSU. The well is located near the surface water drainage that currently conveys GETR effluent to the north. Analytical data will be used to evaluate the potential for infiltration of PFAS from treatment system effluent to the groundwater system.
6-S-08 (Vashon Advance Outwash)	73 to 83 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically upgradient from Area 6 source areas in the shallowest, laterally extensive HSU. The well is located in the north-central/eastern portion of Area 6. Analytical data will be used to evaluate t PFAS presence or absence in this portion of the site.
6-S-44 (Vashon Advance Outwash)	86 to 96 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is constructed near the former industrial waste disposal area (Site 55) source area in the shallow aquifer. Analytical data will be used to evaluate whether past waste disposal practices at this source area resulted in releases of PFAS to the groundwater system.
6-S-31 (Vashon Advance Outwash)	73 to 83 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence in the higher concentration portion of the VOC/SVOC groundwater plumes along the western Area 6 boundary in the shallow aquifer.
6-S-14 (Vashon Advance Outwash)	145 to 155 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence along the centerline of the known 1,4-dioxane plume in the shallow aquifer.
6-I-01 (Whidbey Fm Unit 2)	163 to 177 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located slightly off the centerline of the known 1,4-dioxane plume and is hydraulically downgradient from industrial waste disposal area (Site 55). Analytical data can be used to evaluate presence or absence of PFAS in the intermediate aquifer.
6-I-03 (Whidbey Fm Unit 2)	166 to 176 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located hydraulically downgradient from the former industrial waste disposal area (Site 55). Analytical data will be used to evaluate PFAS presence or absence in the higher concentration portion of the VOC/SVOC groundwater plumes along the western Area 6 boundary in the intermediate aquifer.
MW-10 (Vashon Advance Outwash)	121 to 161 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located along the western margin of the Area 6 landfill. Analytical data will be used to evaluate whether the Area 6 landfill was a source of PFAS to the groundwater system (shallow aquifer).
6-S-17 (Vashon Advance Outwash)	127 to 137 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located at the southern (hydraulically downgradient end) of the Area 6 landfill. Analytical data will be used to evaluate whether the landfill was a source of PFAS to the groundwater system (shallow aquifer).
6-S-04 (Vashon Advance Outwash)	129.5 to 139.5 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located along the centerline of the known 1,4-dioxane plume, near the southwest corner of Area 6 (shallow completion in a well pair with 6-D-01). Analytical data will be used to evaluate presence or absence and potential concentrations of PFAS migrating offsite in the shallow aquifer.
6-S-19 (Vashon Advance Outwash)	143.5 to 163.5 feet bgs	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	This well is located along the centerline of the known 1,4-dioxane plume at the southern Area 6 boundary. Analytical data will be used to evaluate presence or absence and potential concentrations of PFAS migrating offsite in the shallow aquifer.
GETR Treatment Plant Influent	N/A	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	Analytical data from the blended GETR influent stream will be used to evaluate the presence or absence of PFAS and PFAS precursors entering the treatment system.

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Area 6, Ault Field Sampling Strategy and Rationale
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen Interval	Analysis and Method	Number of Samples[a]	Rationale
GETR Treatment Plant Effluent	N/A	PFAS USEPA Method 537 rev. 1.1- Modified in conjunction with the TOP Assay	1	Analytical data from the GETR effluent stream will be used to evaluate both the presence or absence of PFAS leaving the treatment system (which may subsequently infiltrate to the groundwater system). Comparison with PFAS concentrations from the influent samples can be used to evaluate whether treatment processes are increasing PFAS concentrations (by the transformation of PFAS precursors to PFAS).
Off-Base Sampling				
MW-05 (Vashon Advance Outwash)	127 to 132 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and hydraulically upgradient of the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
6-S-27 (Vashon Advance Outwash)	120 to 130 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and hydraulically upgradient of the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
6-S-28 (Vashon Advance Outwash)	146 to 166 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and hydraulically upgradient of the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
MW-06 (Vashon Advance Outwash)	124 to 129 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
MW-01 (Vashon Advance Outwash)	121 to 126 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
MW-02 (Vashon Advance Outwash)	90 to 95 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
MW-03B (Vashon Advance Outwash)	109 to 114 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary and the City of Oak Harbor landfill in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
6-S-42 (Vashon Advance Outwash)	110 to 130 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located hydraulically downgradient from the Area 6 boundary in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
6-S-43 (Vashon Advance Outwash)	110 to 130 feet bgs	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located near the centerline of the known 1,4-dioxane plume south of the Area 6 boundary in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.
6-DW-38A	Unknown[b]	PFAS (USEPA Method 537 rev. 1.1 – Modified) 1-4-dioxane and VC	1	This well is located along the centerline of the known 1,4-dioxane plume south of the Area 6 boundary (the furthest downgradient monitoring location used to define the plume) in the shallow aquifer. Analytical data will be used to evaluate the potential for off-Base migration of PFAS (if present on-Base), and will inform the off-Base extents of the 1,4-dioxane and VC plumes.

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Area 6, Ault Field Sampling Strategy and Rationale
Area 6, Ault Field, NAS Whidbey Island, Oak Harbor, Washington

Well and Matrix	Well Screen	Analysis and Method	Number of Samples[a]	Rationale
Off-Base Drinking Water[c] and Groundwater[d] (Only if PFAS detected on-Base)	N/A	PFAS USEPA Method 537 rev. 1.1	TBD	Samples will be collected from responding residents within the off-Base sampling area (**Figure 6**) to determine the off-Base extent of PFAS in groundwater that is used as a drinking water supply[e].
Off-Base Drinking[c] and Groundwater[d]	N/A	1-4-dioxane and VC	TBD	Samples will be collected from responding residents within the off-Base sampling area (**Figure 6**) to delineate the extent of the off-Base 1,4-dioxane and VC plumes[e].
Note: A comprehensive well construction summary table for Area 6 monitoring wells is included in **Appendix D**.				

[a] Sample number does not include QC sample count, refer to **Worksheet #12.**

[b] Although the well screen depth is unknown, the well is assumed to be constructed within the Vashon Advance Outwash as the well is listed as a "Shallow Monitoring Well" in Table 2-2 of the Annual 2016-2017 Groundwater Long-Term Monitoring Report (Sealaska, 2017).

[c] Drinking water samples will be collected as described in **Worksheet #14**.

[d] The location and construction of private wells will be evaluated once responses from land parcel owners have been received. If there are additional groundwater monitoring wells appropriately located and constructed that may augment the dataset provided by private wells, these may be included in the sampling program.

[e] Step-out sampling may be conducted over a larger radius if samples collected within the off-Base sampling area have PFAS concentrations exceeding the LHA for PFOS and/or PFOA or the LHA or MCL for 1,4-dioxane and/or VC.

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

Station Identification (ID)	Sample ID	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
Area 6 On-Base Groundwater Monitoring Wells and GETR System						
WI-A06-P-4	WI-A06-P-4-MMYY	GW[a]	TBD	PFAS with TOP Assay	1	**Worksheet #21**
WI-A06-6-S-07	WI-A06-6-S-07-MMYY				3 (MS/MSD)	
	WI-A06-6-S-07-MMYY-MS					
	WI-A06-6-S-07-MMYY-SD					
WI-A06-6-S-26	WI-A06-6-S-26-MMYY				1	
WI-A06-6-S-08	WI-A06-6-S-08-MMYY				1	
WI-A06-6-S-44	WI-A06-6-S-44-MMYY				1	
WI-A06-6-S-31	WI-A06-6-S-31-MMYY				1	
WI-A06-6-S-14	WI-A06-6-S-14-MMYY				1	
WI-A06-6-I-01	WI-A06-6-I-01-MMYY				1	
WI-A06-6-I-03	WI-A06-6-I-03-MMYY				1	
WI-A06-MW-10	WI-A06-MW-10-MMYY				1	
WI-A06-6-S-17	WI-A06-6-S-17-MMYY				1	
WI-A06-6-S-04	WI-A06-6-S-04-MMYY				1	
WI-A06-6-S-19	WI-A06-6-S-19-MMYY				2 (FD)	
	WI-A06-6-S-19P-MMYY					
WI-A06-INF01	WI-A06-INF01-MMYY				1	
WI-A06-EFF01	WI-A06-EFF01-MMYY				2 (FD)	
	WI-A06-EFF01P-MMYY					
Area 6 Off-Base Groundwater Monitoring Wells[c]						
WI-A06-MW-05	WI-A06-MW-05-MMYY	GW[a]	TBD	PFAS, VOCs (VC), SVOCs (1,4-dioxane)	1	**Worksheet #21**
WI-A06-6-S-27	WI-A06-6-S-27-MMYY				1	
WI-A06-6-S-28	WI-A06-6-S-28-MMYY				1	
WI-A06-MW-06	WI-A06-MW-06-MMYY				3 (MS/MSD)	
	WI-A06-MW-06-MMYY-MS					
	WI-A06-MW-06-MMYY-MSD					
WI-A06-MW-01	WI-A06-MW-01-MMYY				1	
WI-A06-MW-02	WI-A06-MW-02-MMYY				1	
WI-A06-MW-03B	WI-A06-MW-03B-MMYY				2 (FD)	
	WI-A06-MW-03BP-MMYY					

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

Station Identification (ID)	Sample ID	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
WI-A06-6-S-42	WI-A06-6-S-42-MMYY				1	
WI-A06-6-S-43	WI-A06-6-S-43-MMYY				1	
WI-A06-6-DW-38A	WI-A06-6-DW-38A-MMYY				1	
WI-A06-MW-XX	WI-A06-MW-XX-MMYY	GW[a]	TBD	PFAS, VOCs (VC), SVOCs (1,4-dioxane)	TBD	
Community and Private Wells (Drinking Water)[a, c]						
WI-A06-RW01	WI-A06-RW01-MMYY	DW	TBD	PFAS, VOCs (VC), SVOCs (1,4-dioxane)	TBD[a]	
WI-A06-RWXX	WI-A06-RWXX-MMYY				TBD[a]	
QC[b]						
WI-A06-FB01	WI-A06-FB01-MMDDYY	QC	N/A	PFAS, VOCs (VC), SVOCs (1,4-dioxane)	1	
WI-A06-FBXX	WI-A06-FBXX-MMDDYY				1	
WI-A06-TBXX	WI-A06-TBXX-MMDDYY			VOCs (VC)	1	

Note:

[a] Drinking water samples will be collected as described in **Worksheets #14** and **#17**.

[b] Field Reagent Blanks will be collected as described in **Worksheet #12.**

[c] The location and construction of private wells will be evaluated once responses from land parcel owners have been received. If there are additional groundwater monitoring wells appropriately located and constructed that may augment the dataset provided by private wells, these may be included in the sampling program.

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time[a] (preparation/ analysis)
Drinking Water	PFAS	USEPA Method 537 / SOP 64	2 x 250 mL polypropylene	250 mL	≤10°C but not frozen, Trizma (5.0 g/L)	14 days/ 28 days
Groundwater	PFAS	USEPA Method 537 Modified / SOP 49	2 x 125 mL polypropylene	125 mL	Cool to ≤6 °C but not frozen	14 days/ 28 days
Drinking Water	VOCs (VC)	SW846 Method 8260C SIM/ TA-MV-0313	3 x 40 mL VOA vials	40 mL	pH < 2 with HCl; Cool to ≤6 °C	14 days
Drinking water	SVOCs (1,4-dioxane)	SW846 Method 8270D SIM / TA-MS-0315	2 x 250 mL Amber Glass Bottles	250 mL	Cool to ≤6 °C	7 days / 40 days
Groundwater	VOCs (VC)	SW846 Method 8260C SIM/ TA-MV-0313	3 x 40 mL VOA vials	40 mL	pH < 2 with HCl; Cool to ≤6 °C	14 days
Groundwater	SVOCs (1,4-dioxane)	SW846 Method 8270D SIM / TA-MS-0315	2 x 250 mL Amber Glass Bottles	250 mL	Cool to ≤6 °C	7 days / 40 days

Notes:

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

g/L = grams per liter

mL = milliliters

VOA = volatile organic analysis

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates[a]	No. of MS/MSDs[a]	No. of Equip. Blanks[a]	No. of Field Reagent Blanks	No. of Trip Blanks[a]	Total No. of Samples to Lab[a]
Area 6								
Groundwater, Influent, Effluent	PFAS	15	2	1/1	7	7	-	34
Residential Wells								
Drinking Water	PFAS	TBD	TBD	TBD	-	TBD (one per property per well)	TBD	TBD
Drinking Water	VOCs (VC)	TBD	TBD	TBD	-	One per site per week	TBD	TBD
Drinking Water	SVOC (1,4-dioxane)	TBD	TBD	TBD	-	One per site per week	TBD	TBD
Off-Base Groundwater Monitoring Wells								
Groundwater	PFAS	Up to 9	Up to 1	Up to 1/1	Up to 5	Up to 9	-	Up to 26
Groundwater	VOCs (VC)	Up to 9	Up to 1	Up to 1/1	Up to 5	Up to 9	Up to 9	Up to 35
Groundwater	SVOC (1,4-dioxane)	Up to 9	Up to 1	Up to 1/1	Up to 5	Up to 9	-	Up to 26

Notes:

[a] Samples will be collected as detailed in **Worksheets #14, #17,** and **#18** of this SAP. Field QA/QC samples will be collected as detailed in **Worksheet #12**.

TBD = to be determined

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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. April 2015	CH2M	Chain-of-custody form	No	
SOP-002[a]	Preparing Field Log Books, rev. April 2015	CH2M	Perfluorinated compound-free logbook and indelible pen	No	Sections III and IV/A/1: Field activities will be recorded on loose paper rather than waterproof log books and will be recorded in pen rather than marker.
SOP-003	Potable Water Supply Sampling rev. September 2016	CH2M	Laboratory-supplied sample bottles	No	
SOP-004[a]	Packaging and Shipping Procedures for Low-Concentration Samples, rev. April 2015	CH2M	Laboratory-supplied coolers	No	Sections III and IV: packing tape will be confirmed to be PFC-free prior to use, chemical (blue) ice will not be used for sample shipping, and samples bottles will be packed in resealable (zip-top) bags to further isolate samples from packing materials/ice.
SOP-005	Field Sampling Protocols to Avoid Cross-Contamination during Water Sampling for Perfluorinated Compounds (PFCs)	NAVFAC	Field sampling equipment (various)	No	

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-006[a]	Low-flow Groundwater Purging and Sampling, rev. March 2015	NAVFAC Northwest	Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump Water quality meter (Horriba U-22 or similar) Air monitoring equipment Water level indicator Laboratory-supplied sample bottles	No	Section 2. Non-dedicated sampling equipment will be PFC-free, Teflon-containing materials will not be used. Field records will be documented on loose paper rather than in waterproof field log books and will be written in pen rather than marker. Non-dedicated equipment will be decontaminated with Alconox or Liquinox soap solutions, Decon 90 will not be used.
SOP-007[a,b]	Equipment Calibration, Operation, and Maintenance, rev April 2015	NAVFAC Northwest	Manufacturer recommended/ supplied calibration standard	No	Section 3. Equipment calibration information will be recorded on loose paper rather than waterproof log books and will be recorded in pen rather than marker.
SOP-008	Field Procedure 3, Water Sample Collection from Treatment Plant, Draft June 2017	Sealaska Environmental Services, LLC	Laboratory-supplied sample bottles	No	

Note:

[a] Where procedures listed in this SOP are in conflict with Navy guidance regarding PFAS field protocols to avoid cross-contamination specified in SOP-005, procedures in SOP-005 will take precedence. The specific items for this SOP are listed under the Comments column.

[b] Additional water quality meter calibration information has been included in **Worksheet #22**.

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

Field Equipment	Activity[a]	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference[b]	Comments
Horiba U-22 pH probe	Calibration	Daily, before use	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-007	**Appendix A**
Horiba U-22 Specific conductance probe	Calibration	Daily, before use	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-007	**Appendix A**
Horiba U-22 Turbidity probe	Calibration	Daily, before use	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-007	**Appendix A**
Horiba U-22 DO and Temperature Probes	Testing	Daily, before use	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-007	**Appendix A**

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

Field Equipment	Activity[a]	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference[b]	Comments
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-007	**Appendix A**
Photoionization Detector	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-007	**Appendix A**

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

[b] Specify the appropriate reference letter or number from the Project Sampling SOP References table (**Worksheet #21**).

SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Reviewed if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work (Y/N)
12	*Sample Receiving and Sample Control Procedures; 11/08/16; rev. 12*		N/A	Drinking Water/ Groundwater/ Influent/ Effluent/ PFAS	N/A	Vista Analytical Laboratory	N	N
14	*Bottle Order Preparation; 09/03/14; rev. 4*		N/A	Drinking Water/ Groundwater/ Influent/Effluent/ PFAS	N/A	Vista Analytical Laboratory	N	N
64	*Preparation and Analysis for the Determination of Per and Polyfluorinated Compounds in Drinking Water; 12/8/16; rev. 1*		Definitive	Drinking Water/ PFAS	UPLC/MS/MS	Vista Analytical Laboratory	N	N
49	*PFAS Preparation and Analysis of Perfluorinated Compounds, 6/14/17, Revision 10*		Definitive	Groundwater/ PFAS	UPLC/MS/MS	Vista Analytical Laboratory	N	N
TA-MS-0315	*Semivolatile Organic Compound (Base/Neutrals and Acids) Analysis by GC/MS [Method 8270D], 4/25/17; rev 3*		Definitive	Drinking water / VOCs	GC/MS	TestAmerica Seattle	N	N
TA-MV-0313	*Determination of Volatile Organic Compounds by GC/MS Selected Ion Monitoring [Methods 8260B and 8260C], 5/4/17; rev 0*		Definitive	Drinking water / SVOCs	GC/MS	TestAmerica Seattle	N	N
TA-QA-0001	*Sample Receipt and Log-in; 4/27/17; rev. 27*		N/A	Drinking water / VOCs/SVOCs	N/A	TestAmerica Seattle	N	N
TA-EHS00036	*Laboratory Waste Management and Disposal; 12/29/15; rev 14*		N/A	Drinking water / VOCs/SVOCs	N/A	TestAmerica Seattle	N	N

Note:

DoD Environmental Laboratory Accreditation Program (ELAP) certification is required for all definitive data. Vista Analytical has DoD ELAP certification that is valid through September 30, 2019. TestAmerica Seattle has DoD ELAP certification that is valid through January 19, 2019.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
UPLC/MS/MS (drinking water)	Tune Check	Prior to ICAL and after any mass calibration or maintenance is performed.	Tuning standard must contain analytes of interest or appropriate substitute. Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone.	Lab Manager/ Analyst	64
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or below the RL	Initial calibration prior to sample analysis	Each calibration point for each analyte (natives and surrogates) must calculate to be within 70-130 percent, except the lowest cal point, which must calculate to within 50 to 150 percent for natives.	Evaluate standards, chromatography, and mass spectrometer response. If problem found with above, correct as appropriate, then repeat initial calibration.		
	Peak Asymmetry Verification	With initial calibration	Calculated factor in the range of 0.8 to 1.5.	Change instrument conditions to correct, then repeat initial calibration.		
	Second-source calibration verification	Once per initial calibration, following initial calibration.	All reported analytes and labeled compounds within ± 30 percent of true value.	Evaluate data. If problem (e.g., concentrated standard, plugged transfer line) found, correct, then repeat second source verification. If it still fails, then repeat initial calibration.		
	Daily calibration verification	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard.	All CV analytes must be within ± 30 percent of true value. For all CCVs, internal standards must be within ± 50 percent of true value and 70 to 140 percent of the most recent prior CCV.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV. OR Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Lab Manager/ Analyst	64

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
LC/MS/MS (PFASs, modified EPA 537)	ICAL for all analytes	At instrument set-up and after ICV or CCV failure, prior to sample analysis.	The available isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) are used for quantitation (except labelled 6:2 FTS) 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 quantitation. 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 non-linear calibrations must have $r^2 \geq 0.99$ for each analyte. Analytes must be within 70-130% of their true value for each calibration standard.	Correct problem, then repeat ICAL.	Analyst/Supervisor	SOP 49 DoD QSM v5.1 Table B-15
	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 30% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard.	Concentration of analytes must range from the LOQ to the mid-level calibration concentration. Analyte concentrations must be within ±30% of their true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVS cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.		
	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 tune check repeated.		
	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.	N/A		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
LC/MS/MS (PFASs, modified EPA 537)	Mass Spectral Acquisition Rate	Each analyte and extracted internal standard analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	N/A	Analyst/Supervisor	SOP 49 DoD QSM v5.1 Table B-15
	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).	N/A		
	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 interferences 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 used due to observed interferences).	N/A		
LC/MS/MS (PFASs, modified EPA 537)	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.	Correct problem, rerun. ISC. If problem persists, repeat ICAL. No samples shall be analyzed until ISC has met acceptance criteria. ISC can serve as the initial daily CCV.	Analyst/Supervisor	SOP 49 DoD QSM v5.1 Table B-15
GC/MS (VOC)	Check of mass spectral ion intensities (tuning procedure) using BFB (8260C)	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	Lab Manager / Analyst	TA-MV-0313
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the RL (ICAL)	Initial calibration prior to sample analysis	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15% Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$; Option 3: non-linear least squares regression (quadratic) for each analyte: r2 ≥ 0.99.	Terminate analysis; correct the problem; recalibrate. Problem must be corrected. No samples may be run until ICAL has passed.		
	Second-source calibration verification	Once after each ICAL	80% of project analytes within ±20% of true value.	Correct problem, and verify second source standard. Rerun verification. If still fails, repeat initial calibration.		
	Retention Time Window Position Establishment	Once per ICAL, for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	N/A		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/MS (SVOC)	Daily calibration verification	Daily, prior to sample analysis and every 12 hours of analysis time.	80% of analytes and surrogates within ± 20% of true value.	Correct problem, then rerun CCV. If that fails, then repeat ICAL. Reanalyze all sample since the last successful CCV.	Lab Manager / Analyst	TA-MS-0315
	Internal Standards	During acquisition of calibration standard.	Retention time within ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		
	Check of mass spectral ion intensities (tuning procedure) using DFTPP (8270D)	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.		
	Performance Check	At the beginning of each 12-hour period, prior to sample analysis	Degradation ≤20% for DDT. Benzidine and Pentachlorophenol present at their normal responses, and tailing factor for each < 2.	Correct problem (inspect/change liner, clip front end of column, or other maintenance as indicated), then repeat the performance check.		
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the RL. (ICAL)	Initial calibration prior to sample analysis	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15% Option 2: linear least squares regression for each analyte: r2 ≥ 0.99; Option 3: non-linear least squares regression (quadratic) for each analyte: r2 ≥ 0.99.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.		
	Second-source calibration verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Acceptance Criteria: All reported analytes within ± 20% of true value.	Correct problem, and verify second source standard. Rerun verification. If still fails, repeat initial calibration.		
	Retention Time Window Position Establishment	Once per ICAL, and at the beginning of the analytical sequence for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	N/A		
	Daily calibration verification (CCV)	Daily, prior to sample analysis and after every 12 hours of analysis time.	All reported analytes and surrogates within ± 20% of true value.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with QAPP approval or written approval from the client.		
	Daily closing calibration verification (CCV)	Daily, at the end of the analytical batch run.	All reported analytes and surrogates within ± 50% for end of analytical batch CCV.	Poor performing compounds will be excluded from this requirement. Also, if the closing CCV fails, TestAmerica will perform reanalysis only for the analytes identified by the clients as critical compounds of concern for the project, and to report qualified results for the other analytes, with QAPP approval or written approval from the client.		
	Internal Standards	During acquisition of calibration standard.	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; EICP area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		

Notes:
± = plus or minus
%RSD = Percent relative standard deviation
amu = atomic mass unit
CCV = continuing calibration verification
ICAL = initial calibration
RL = reporting limit

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
UPLC/MS/MS	Clean sample and gas cones. Change the column. Clean the T-Wave.	USEPA 537/ USEPA 537 Mod	Check the sample and gas cones.	T-Wave cleaning is performed when the instrument response deteriorates. Other instrument maintenance is done as needed to keep the instrument performing at peak performance.	ICAL within acceptance criteria on **Worksheet #24** and IS recovery within acceptance criteria on **Worksheet #28**	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Vista Analyst/ Supervisor	SOP 64/ SOP 49
GC/MS	Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	TestAmerica Chemist	TA-MV-0313/ TA-MS-0315
	Change septum, clean injection port, change or clip column, install new liner, change trap	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	Tune and CCV pass criteria	Reinspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	TestAmerica Chemist	TA-MV-0313/ TA-MS-0315

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Project Field Team, FTL/CH2M. Field SOPs are in Appendix A of this SAP.
Sample Packaging (Personnel/Organization): Project Field Team, FTL/CH2M. Field SOPs are in Appendix A of this SAP.
Coordination of Shipment (Personnel/Organization): FTL/CH2M.
Type of Shipment/Carrier: FedEx Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving – TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California
Sample Custody and Storage (Personnel/Organization): Sample Receiving – TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California
Sample Preparation (Personnel/Organization): TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California
Sample Determinative Analysis (Personnel/Organization): TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization): Sample Disposal – TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California
Number of Days from Analysis: 45 days

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SAP Worksheet #27—Sample Custody Requirements Table

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. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples cooler than 10°C (but not frozen) for PFAS (drinking water) and cooler than 6 °C (but not frozen) for 1,4-dioxane, VC, and PFAS (groundwater) until they are received by the laboratory.

The chain-of-custody form will be placed into the cooler in a resalable zip-top resealable bag. Coolers will be taped and shipped to the laboratories via FedEx overnight, with the air bill number indicated on the chain-of-custody form (to relinquish custody). Upon delivery, the laboratory will log each cooler and report the status of the samples to CH2M.

See **Worksheet #21** for SOPs containing sample custody guidance.

The CH2M field team will ship all environmental samples directly to the laboratory performing the analysis. This will require shipment to TestAmerica Seattle, Seattle, Washington; Vista Analytical, El Dorado Hills, California.

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

Laboratory custody procedures can be found in the laboratory SOPs, which will be provided upon request.

Sample ID Procedures:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler’s initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain-of-custody. The laboratory will send sample log-in forms to the PC to check that sample IDs and parameters are correct.

Chain-of-Custody Procedures:

Chain-of-custody forms 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 chain-of-custody form 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 Laboratory Information Management Systems database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Drinking Water

Analytical Group: PFAS

Analytical Method/SOP Reference: USEPA Method 537/SOP 64

QC Sample	Frequency/Number	Method/ SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria (MPC)
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > 1/2 LOQ or >1/10 sample concentration or >1/10 regulatory limit, whichever is greater. For common laboratory contaminants, no analytes detected >LOQ.	Verify instrument clean (evaluate calibration blank and samples prior to method blank), then reanalyze. Evaluate to determine if systematic issue within laboratory, correct, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements.	Analyst/ Supervisor	Bias/ Contamination	Same as Method/ SOP QC Acceptance Limits
LCS	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Reanalyze LCS once. If acceptable, report. Evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical compounds of concern, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and narrated.		Accuracy/Bias	
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	Method Limits of 70 to 130 percent for spikes > LOQ, and 50 to 150 percent for spikes at or below the LOQ.	Evaluate the data, and re-prepare/reanalyze the native sample and MS/MSD pair if laboratory error is indicated.		Precision/ Accuracy/Bias	
Internal Standards (IS)	Every sample, spiked sample, standard, and method blank	13C-PFOA 50-150% 13C-PFOS 50-150%	For failed QC samples, correct problem and rerun all associated failed field samples. If reanalysis cannot be performed, the data must be qualified and explained in the case narrative.		Accuracy	
Surrogates	Every samples, spiked sample, and method blank	13C2-PFHxA 70-130% 13C2-PFDA 70-130%	Identify and correct the problem. Re-prep and reanalyze all samples with failed surrogates in the associated preparatory batch. If obvious chromatographic interference with surrogate is present, re-analysis may not be necessary. Qualify all applicable data if acceptance criteria are not met, and explain in case narrative.		Accuracy/Bias	

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Groundwater, Influent, Effluent

Analytical Group: PFAS

Analytical Method/SOP Reference: USEPA Method 537 Modified/SOP 49

QC Sample	Frequency/Number	Method/ SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria (MPC)
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > 1/2 LOQ or >1/10 sample concentration or >1/10 regulatory limit, whichever is greater. For common laboratory contaminants, no analytes detected >LOQ.	Correct problem. Reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, the data must be qualified and explained in the case narrative.	Analyst/ Supervisor	Bias/ Contamination	Same as Method/ SOP QC Acceptance Limits
LCS	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Correct problem. Reprep and reanalyze the LCS and all samples in the associated preparatory batch, if sufficient sample material is available. If reanalysis cannot be performed, the data must be qualified and explained in the case narrative.		Accuracy/Bias/ Precision	
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15.** 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. RPD ≤ 30%		Precision/ Accuracy/Bias	
Internal Standards (IS)	Every sample, spiked sample, standard, and method blank	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 reprepared and reanalyzed (greater dilution may be needed).		Accuracy	
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 in samples at which carryover does not occur. If acceptance criteria are not met after sample, additional instrument blanks must be analyzed until acceptance criteria are met. Additional samples shall not be analyzed until acceptance criteria are met.		Bias/ Contamination	

SAP Worksheet #28-3—Laboratory QC Samples Table

Matrix: Groundwater, Influent, Effluent

Analytical Group: VOCs (Vinyl Chloride)

Analytical Method/SOP Reference: SW846 8260C / TA-MV-0312

QC Sample	Frequency/Number	Method/ SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria (MPC)
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > 1/2 LOQ or >1/10 sample concentration or >1/10 regulatory limit, whichever is greater. For common laboratory contaminants, no analytes detected >LOQ.	Re-extract and reanalyze samples. Note exceptions under criteria section. See Section 9.3 of SOP for additional requirements.	Analyst/ Supervisor	Bias/ Contamination	Same as Method/ SOP QC Acceptance Limits
LCS	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Correct problem, then reanalyze the LCS and all associated batch samples in accordance with DoD QSM requirements		Accuracy/Bias	
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Identify problem; if not related to matrix interference, reanalyze MS/MSD and all associated batch samples in accordance with DoD QSM requirements		Precision/ Accuracy/Bias	
Internal Standards (IS)	Every sample, spiked sample, standard, and method blank	Retention time ± 10 seconds from RT of the midpoint standard in ICAL; EICP area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning in accordance with DoD QSM requirements		Accuracy	
Surrogates	Every samples, spiked sample, and method blank	1,2-Dichloroethane-d4: 46-150% 4-Bromofluorobenzene: 81-120% Dibromofluoromethane: 42-132% Toluene-d8: 75-125% Trifluorotoluene: 74-118%	Correct problem, then re-prep and reanalyze all affected samples in accordance with DoD QSM requirements		Accuracy/Bias	

SAP Worksheet #28-4—Laboratory QC Samples Table

Matrix: Groundwater, Influent, Effluent

Analytical Group: SVOCs (1,4-Dioxane)

Analytical Method/SOP Reference: SW846 8260D SIM / TA-MS-0315

QC Sample	Frequency/Number	Method/ SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria (MPC)
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	No analytes detected > 1/2 LOQ or >1/10 sample concentration or >1/10 regulatory limit, whichever is greater. For common laboratory contaminants, no analytes detected >LOQ.	Verify instrument clean (evaluate calibration blank & samples prior to method blank), then reanalyze. Evaluate to determine if systematic issue within laboratory, correct, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements.	Analyst/ Supervisor	Bias/ Contamination	Same as Method/ SOP QC Acceptance Limits
LCS	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Reanalyze LCS once. If acceptable, report. Otherwise, if exceedance is not a critical chemical of concern as identified by the project team, evaluate for sporadic marginal exceedance (SME). If acceptable, report with case narrative comment. If not acceptable for SME, evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment with written approval from the client. If LCS has low bias, or if there are detections for critical chemicals of concern, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first	See **Worksheet #15**	Identify problem; if not related to matrix interference, reanalyze MS/MSD and all associated batch samples in accordance with DoD QSM requirements		Precision/ Accuracy/Bias	
Internal Standards (IS)	Every sample, spiked sample, standard, and method blank	Retention time ± 10 seconds from RT of the midpoint standard in ICAL; EICP area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning in accordance with DoD QSM requirements. If field samples still outside criteria, qualify data and explain in case narrative.		Accuracy	
Surrogates	Every samples, spiked sample, and method blank	Nitrobenzene-d5: 44-125% Terphenyl-d14: 58-132% 2-Fluorobiphenyl: 46-115% 2,4,6-Tribromophenol: 28-143% 2-methylnaphthalene-d10: 40-140% Fluoranthene-d10: 40-140%	Evaluate data, if samples non-detect and surrogate recovery is above upper limits, report with case narrative comment with written approval from the client. If obvious chromatographic interference is present, report with narrative comment. Otherwise, re-extract and reanalyze.		Accuracy/Bias	

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic data deliverables (EDDs) • ID of QC Samples • Meteorological Data from Field • Sampling Instrument Calibration Logs • Sampling Locations and Sampling Plan • Sampling Notes and Drilling Logs • Water Quality Parameter • Sample Receipt, Chain of Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Preparation Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (archived per Navy CLEAN contract) • DV Reports • CA Forms • Laboratory QA Plan • Method Detection Limit Study Information	• Field data deliverables (e.g., logbooks entries, chains-of-custody, air bills, and EDDs) will be kept on CH2M's network server. • Field parameter data will be loaded with the analytical data into the Navy database • Analytical laboratory hard copy deliverables and DV reports will be saved on the network server and archived per the Navy CLEAN contract. • Electronic data from the laboratory will be loaded into Navy database • Following project completion, hard copy deliverables (e.g., logbooks, chains-of-custody) will be archived at Iron Mountain: Iron Mountain Headquarters 745 Atlantic Avenue Boston, MA 02111 (800) 899-IRON • Following project completion, hard copy deliverables including chains-of-custody and raw data will be archived at the Washington National Records Center: Washington National Records Center 4205 Suitland Road Suitland, Maryland 20746-8001 301-778-1550

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization [a]
Drinking Water	PFAS	Refer to **Worksheets #18** and **#20**	USEPA Method 537 with TOP Assay	10 calendar days	Vista Analytical	TBD
Groundwater	PFAS	Refer to **Worksheets #18** and **#20**	USEPA Method 537 Modified with TOP Assay	10 calendar days	Vista Analytical	TBD
Drinking Water	VOCs (VC)	Refer to **Worksheets #18** and **#20**	SW846 8260C SIM	10 calendar days	TestAmerica Seattle	TBD
Drinking Water	SVOCs (1,4-dioxane)	Refer to **Worksheets #18** and **#20**	SW846 8270D SIM	10 calendar days	TestAmerica Seattle	TBD

Notes:

[a] Backup laboratory will be determined if necessary.

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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 CA (title and organizational affiliation)**	**Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)**
Field Performance Audit	One during first quarter sampling event	Internal	CH2M	PM CH2M	FTL CH2M	PM CH2M	PM CH2M
Safe Work Observation	One during each quarterly sampling event	Internal	CH2M	SSC CH2M	Field Team Member observed CH2M	HSM CH2M	SSC CH2M
Field Document Review	Daily during each quarterly sampling event	Internal	CH2M	PM or Task Manager CH2M	FTL CH2M	PM CH2M	PM CH2M

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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, organization)	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	FTL CH2M	Within 1 day of audit	Verbal and Memorandum	FTL CH2M	Within 1 day of receipt of CA Form
Safe Behavior Observation (SBO)	SBO Form	HSM CH2M	Within 1 week of SBO	Memorandum	Field Team Member CH2M	Immediately
Field Document Review	Markup copy of field documentation	FTL CH2M	Within 1 day of review	Verbal and Memorandum	FTL CH2M	Within 1 day of receipt of markup

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SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating CA: ____ Date: _____________

Description of problem and when identified:

____
____
____
____
____

Cause of problem, if known or suspected:

____
____
____
____
____

Sequence of CA: (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:

Anita Dodson, CH2M Navy CLEAN Program Chemist

____
____
____
____

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 ______________________
____

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

Yes No 6) Are QA 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 #32-3—Safe Behavior Observation Form

☐ Federal or ☐ Commercial Sector (check one)		☐ Construction or ☐ Consulting (check one)	
Project Number:		Client/Program:	
Project Name:		Observer:	Date:
Position/Title of Worker Observed:		Background Information/ comments:	
Task/Observation Observed:			

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	**Safe**	**At-Risk**	**Observations/Comments**
Current and accurate Pre-Task Planning/Briefing (for example, Project Safety Plan, Safety Training and Consulting, AHA, Pre-task Safety Plan, tailgate briefing, as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/ experienced			
Tools/Equipment Available and Adequate			
Proper Use of Tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/Work Zone Control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/Attentiveness			**Observer’s CAs/Comments:**
Pace			
Uncomfortable/Unsafe Position			
Inconvenient/Unsafe Location			
Position/Line of Fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker’s CAs/Comments:**
Other			

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, and so forth)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Field Audit Report	One during sampling event	TBD	PM CH2M	Included in project files

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

Data Review Input	Description[a]	Responsible for Verification or Validation	Step I/IIa/IIb[b]	Internal/ External[c]
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	FTL/CH2M	Step I	Internal
Chains of Custody and Shipping Forms	Chain of custody 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 chain of custody forms will be initialed by the reviewer, a copy of the chains of custody forms retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chain of custody forms will also be reviewed for adherence to the SAP by the PC.	FTL/CH2M PC/CH2M	Step I	Internal & External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.	PC/CH2M	Step I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative, which becomes part of the final hard copy data package.	PC/CH2M	Step I	External
EDDs	EDDs will be compared against hard copy laboratory results (10 percent check).	PC/CH2M	Step I	External
Case Narrative	Case narratives will be reviewed by the data validator during the DV process. This is verification that they were generated and applicable to the data packages.	Data Validator	Step I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Laboratory QAO	Step I	Internal
Laboratory Data	The data will be verified for completeness by the PC. To ensure completeness, 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.	PC/CH2M	Step I	External
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 CA 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.	PM/CH2M PC/CH2M	Step I	Internal
CA Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM/CH2M PC/CH2M	Step I	External
Laboratory Methods	During the pre-validation check, ensure that 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.	PC/CH2M	Step IIa	External
Target Compound List and Target Analyte list	During the pre-validation check, ensure that the laboratory reported all analytes from each analysis group as per **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	PC/CH2M	Step IIa	External
Laboratory Limits	During the pre-validation check, the laboratory limits (DL, LOD, LOQ) will be compared to those listed in the project SAP. If limits were not met, the laboratory will be contacted and asked to provide an explanation, which will then be discussed in the associated project report. Often the cause for minor laboratory limit deviation from those presented in the SAP is due to the quarterly update of laboratory LOD.	PC/CH2M	Step IIb	External
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed. Any such discrepancies will be discussed first in the data validation narrative and will be included in the associated project report.	Laboratory QAO	Step IIa	Internal
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered during the DV process.	Data Validator	Step IIa and IIb	External
Raw Data[d]	Ten percent review of raw data to confirm laboratory calculations during Stage 3 data validation. For a recalculated result, the data validator 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 percent difference.	Data Validator	Step IIa	External

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

Data Review Input	Description[a]	Responsible for Verification or Validation	Step I/IIa/IIb[b]	Internal/ External[c]
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	FTL/CH2M	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Data Validator	Step IIa	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run and met limits, and will be discussed in the associated project report.	PC/CH2M	Step IIa	Internal
DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC/CH2M	Step I	External
Analytical data for PFAS SVOCs, and VOCs analyzed for in groundwater and drinking water[d]	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in *National Functional Guidelines for Superfund Organic Data Review* (USEPA, 2017) may be used for DV, and the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Data Validator	Step IIa and IIb	External

Notes:

[a] 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.

[b] 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).

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

[d] Stage 3 data validation will be performed on 10% of all definitive analyses which will include recalculated results from the raw data to verify calculations. The remaining (90%) of the definitive data will have Stage 2B data validation performed.

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 project required quantitation limits 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 or UJ. The qualifiers represent minor QC deficiencies, which 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 are not considered usable for project decisions.
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - J+ = Analyte present. Reported value is estimated and may be biased high.
  - J- = Analyte present. Reported value is estimated and may be biased low.
  - UJ = Analyte not detected. Associated non-detect value may be inaccurate or imprecise.
  - R = Rejected result. Result not reliable.
- The following additional qualifiers may be given by the validator:
  - N = Tentative ID. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
  - NJ = Qualitative ID questionable due to poor resolution. Presumptively present at approximate quantity.
  - U = Not Detected.
- For statistical comparisons, 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.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. The checks include comparison of hard copy data and qualifiers to the EDD. Once the data have 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.

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

- To assess whether a sufficient quantity of acceptable data is available for decision making, the data will be compared to the 95 percent completeness goal and reconciled with MPC following validation and review of DQI.
- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater 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.

SAP Worksheet #37—Usability Assessment (continued)

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:

The following will be prepared by CH2M and presented to and submitted to the Navy and Base for review and decisions on the path forward for the site:

- Data tables will be produced to reflect detected and non-detected site analytes and geochemical parameters. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation, and will be provided in a technical memorandum.

Identify the personnel responsible for performing the usability assessment.

The CH2M Team, including the PM and PC, will review the data and present to the Navy and Base for review and approval of usability.

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Figures

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Legend

- ● City
- Secondary Road
- Local Connecting Road
- Important Local Road
- Site Boundary
- Base Boundary

Figure 1
Base Location Map
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, WA

For Official Use Only

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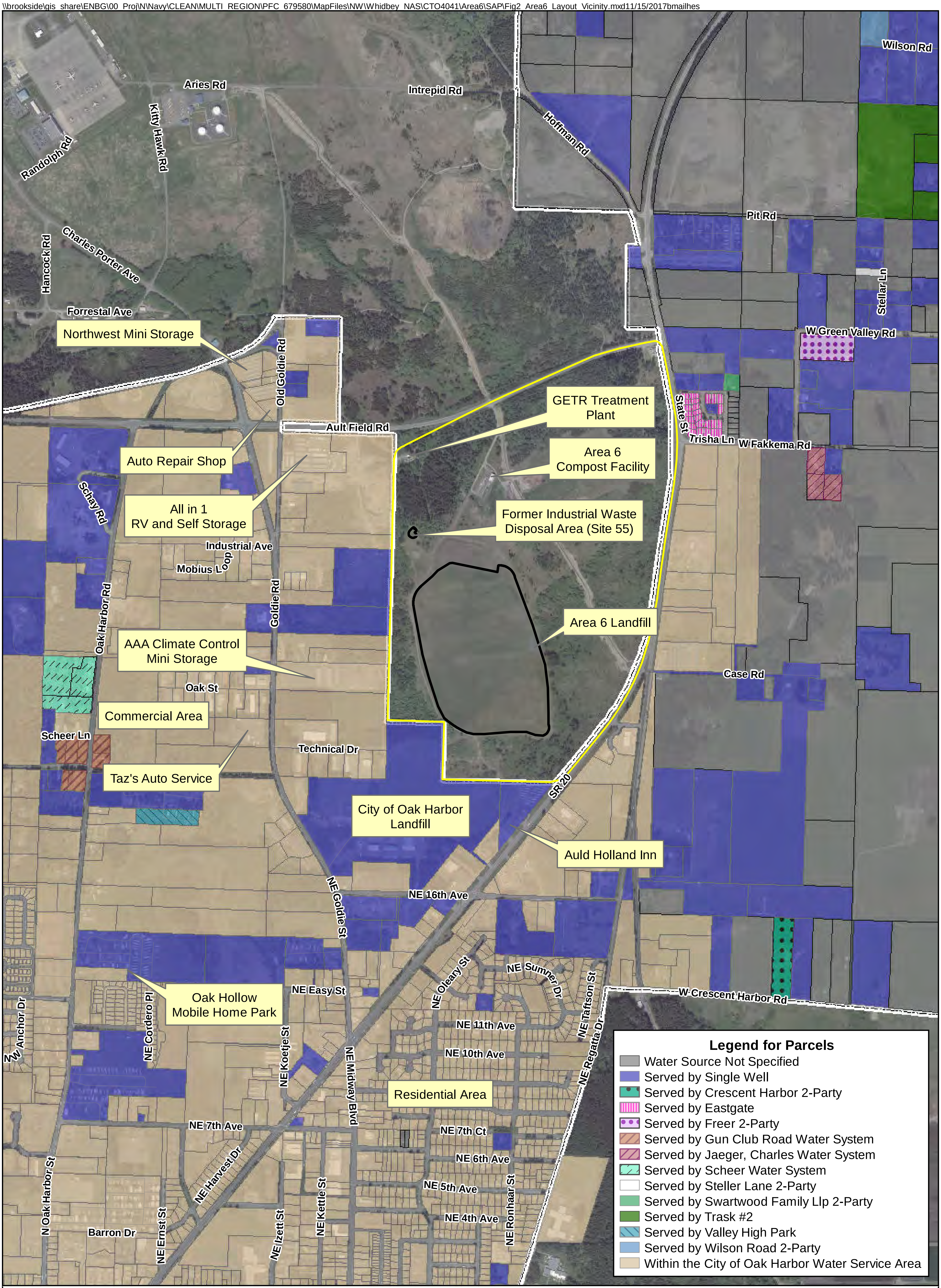


Legend

🟨 Area 6 Boundary (Source: NIRIS)
⬚ Base Boundary (Source: NIRIS)

N
W E
S

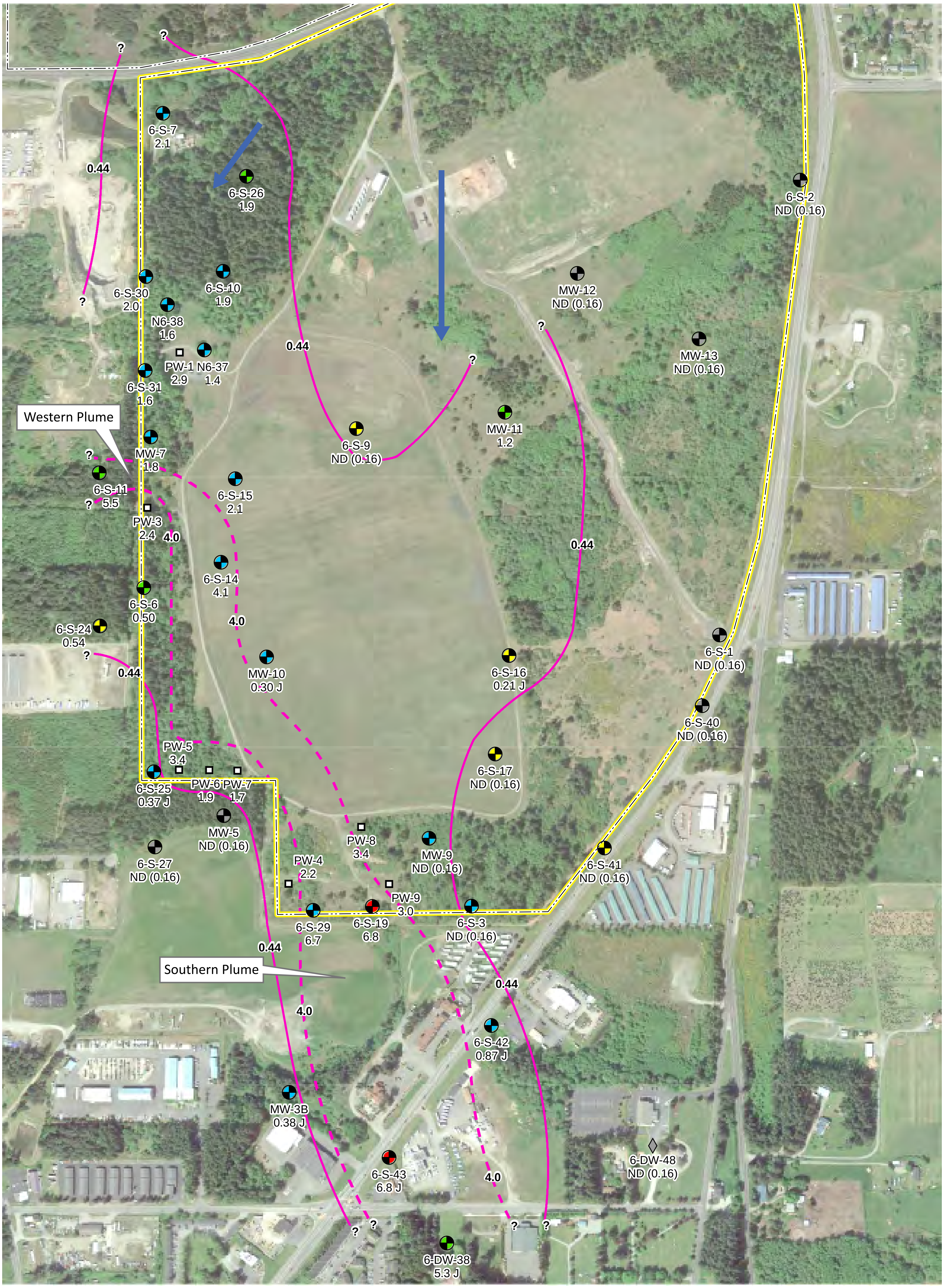
0 0.1 0.2
Miles

1 in = 0.2 mile

Imagery Source: ©2017, Esri

Figure 2
Area 6 Site Layout and Vicinity
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

Note:
Land Parcel and Drinking Water Supply Source: Island County, WA



LEGEND

- 0.44 - Cleanup level contour
- 4.0 - Concentration contour
- — · · — NASWI boundary
- 🟨 Area 6 boundary
- ◆ Domestic well
- ☐ Production well
- ● Monitoring well
- → Approximate groundwater flow direction in the shallow aquifer

Concentration Trends

- ◆ No detections for all sampling events
- ● Concentration is decreasing
- ● Concentration is increasing
- ● No detections for all the last ten sampling events
- ● No statistical analysis
- ● No trend

Notes:

1. Concentrations are shown in micrograms per liter (µg/L).
2. Results are qualified as noted:
   ND = non detection
   J = The result is an estimated concentration that is less than the reporting limit but greater or equal to the method detection limit (MDL).
3. Cleanup level for 1,4-dioxane is 0.44 µg/L.
4. Statistical analysis performed is the Mann-Kendall non-parametric trend test which requires a minimum of four data points, ideally less than 20% non-detect data, and measures if there is a trend to the data set (up to ten events through February 2017). The test determines if there is a trend and, if so, if it is increasing or decreasing with at least 80% confidence.
5. Figure source: Sealaska, 2017.

N

0 250 500
Approximate scale in feet

Figure 3.
Area 6 1,4-Dioxane
Groundwater Concentrations
January/February 2017
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

LEGEND

- 0.1 Cleanup level contour
- 1.0 Concentration contour
- —··—··— NASWI boundary
- 🟨 Area 6 boundary
- ◆ Domestic well
- □ Production well
- ◕ Monitoring well
- → Approximate groundwater flow direction in the shallow aquifer

Concentration Trends

- ◇ No detections for all sampling events
- ● Concentration is decreasing
- ● Concentration is increasing
- ● No detections for all the last ten sampling events
- ● No statistical analysis
- ● No trend

Notes:

1. Concentrations are shown in micrograms per liter (µg/L).
2. Results are qualified as noted:
   ND = non detection
   J = The result is an estimated concentration that is less than the reporting limit but greater or equal to the method detection limit (MDL).
3. Cleanup level for vinyl chloride is 0.1 µg/L.
4. Statistical analysis performed is the Mann-Kendall non-parametric trend test which requires a minimum of four data points, ideally less than 20% non-detect data, and measures if there is a trend to the data set (up to ten events through February 2017). The test determines if there is a trend and, if so, if it is increasing or decreasing with at least 80% confidence.
5. 6-S-11 is screened in the lower portion of the shallow aquifer; therefore, results are not used for plume contouring.
6. Figure source: Sealaska, 2017.

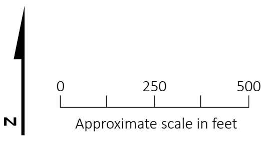


Figure 4.
Area 6 Vinyl Chloride Groundwater Concentrations January/February 2017
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

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Notes
1. Cleanup Level for 1,4-Dioxane is 0.44 µg/L
2. Cleanup Level for Vinyl Chloride is 0.10 µg/L
3. 1,4-Dioxane and Vinyl Chloride isoconcentration contours (Sealaska Environmental Services, LLC, 2017)
4. GETR = groundwater extraction, treatment, and recharge
5. µg/L = micrograms per liter
6. Coordinates for 6-D-05 and 6-S-22 are approximate.

Legend

- Monitoring Well Location - Included in Sampling
- Monitoring Well Location - Not Included in Sampling
- Private Drinking Water Well
- Abandoned Monitoring Well Location
- 1,4-Dioxane Isoconcentration Contour, µg/L
- Approximate 1,4-dioxane Plume Centerline
- Vinyl Chloride Groundwater Plume (>=0.10 µg/L)
- Approximate Vinyl Chloride Plume Centerline
- Approximate Flow Direction in the Shallow Aquifer
- Area 6 Boundary (Source: NIRIS)
- Base Boundary (Source: NIRIS)

N
W E
S

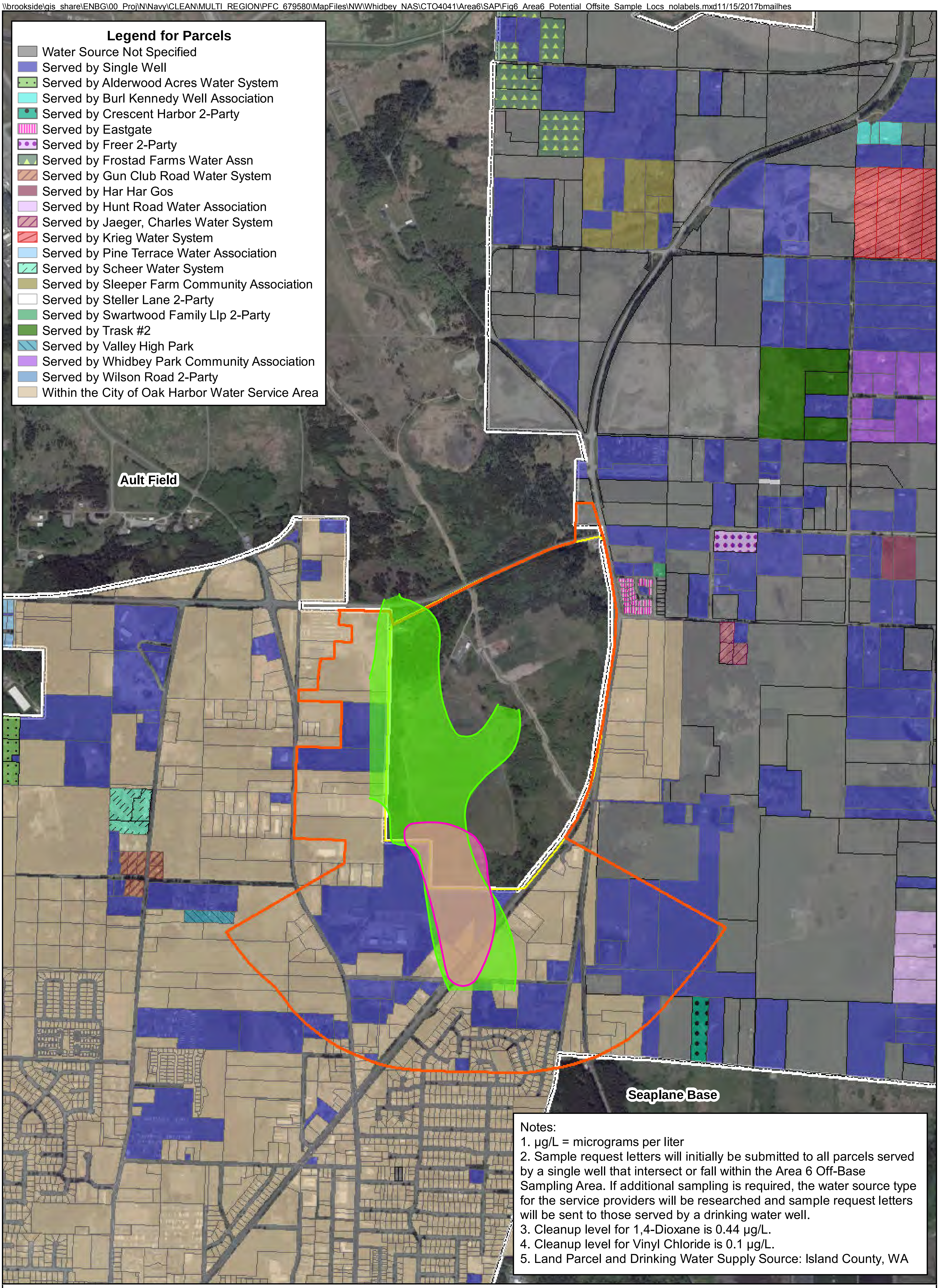
0 0.05 0.1
Miles

1 in = 0.1 mile

Imagery Source: ©2017, Esri

Figure 5
Area 6 Proposed Groundwater Monitoring Well and GETR Sample Locations
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

\\brookside\gis_share\ENBG\00_Proj\N\Navy\CLEAN\MULTI_REGION\PFC_679580\MapFiles\NW\Whidbey_NAS\CTO4041\Area6\SAP\Fig6_Area6_Potential_Offsite_Sample_Locs_nolabels.mxd11/15/2017bmailhes



Notes:
1. µg/L = micrograms per liter
2. Sample request letters will initially be submitted to all parcels served by a single well that intersect or fall within the Area 6 Off-Base Sampling Area. If additional sampling is required, the water source type for the service providers will be researched and sample request letters will be sent to those served by a drinking water well.
3. Cleanup level for 1,4-Dioxane is 0.44 µg/L.
4. Cleanup level for Vinyl Chloride is 0.1 µg/L.
5. Land Parcel and Drinking Water Supply Source: Island County, WA

Legend

1,4-Dioxane Groundwater Plume (>=0.44 µg/L)
Vinyl Chloride Groundwater Plume (>=0.10 µg/L)
Area 6 Boundary (Source: NIRIS)
Area 6 - Off-Base Sampling Area
Base Boundary (Source: NIRIS)

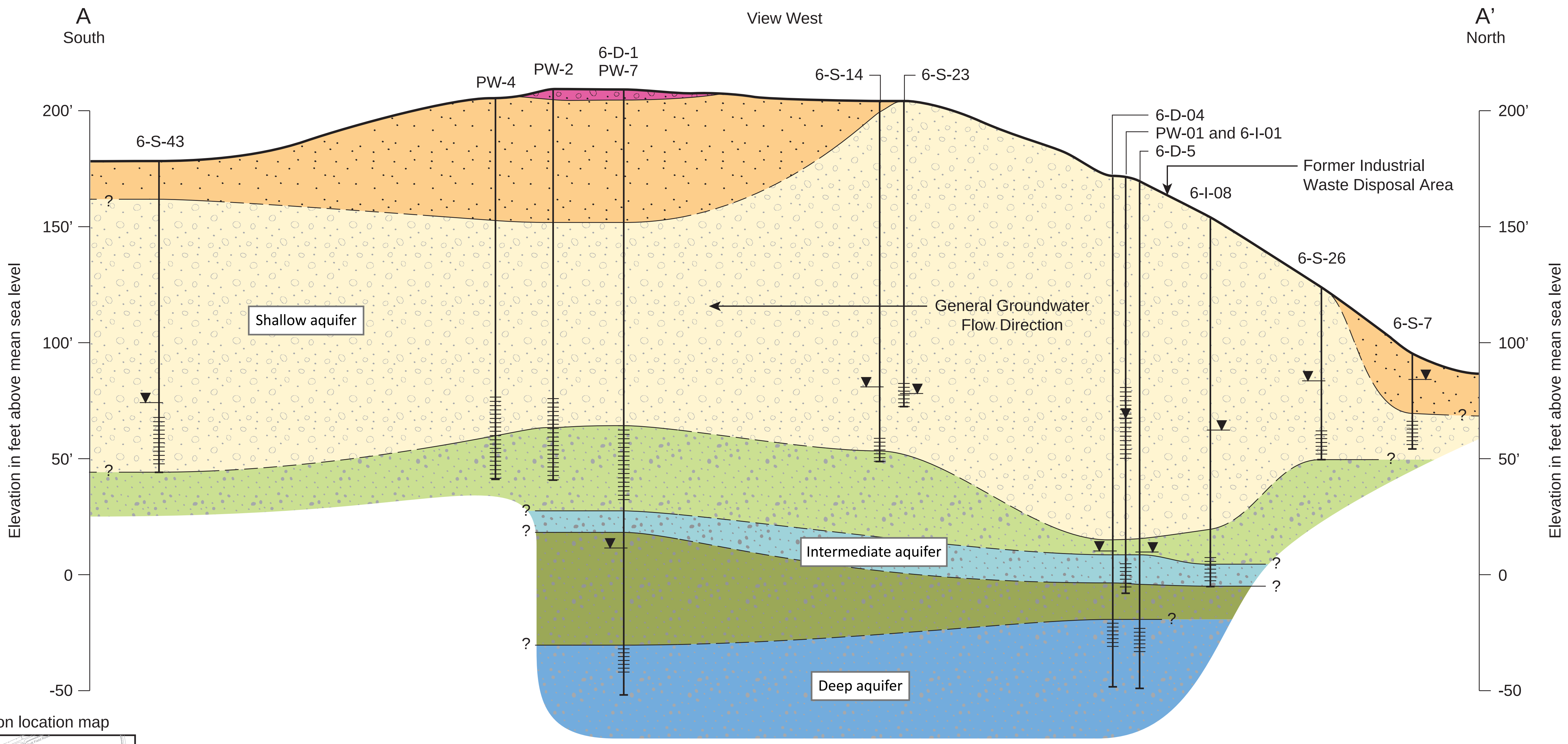
N
W E
S

0 0.125 0.25
Miles

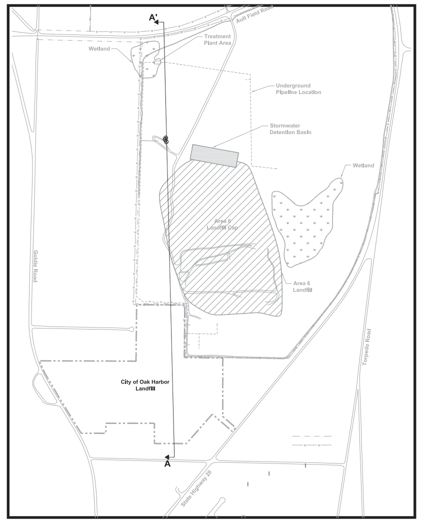
1 in = 0.25 mile

Imagery Source: ©2017, Esri

Figure 6
Area 6, Potential Drinking Water Sample Locations
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

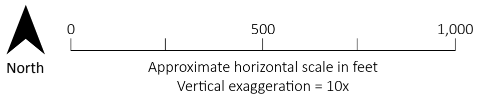


Cross-section location map



LEGEND

🟪	Vashon recessional outwash
🟧	Vashon till
🟨	Vashon advance outwash
🟩	Whidbey #1
🟦	Whidbey #2
🟩	Whidbey #3
🟦	Whidbey #4
▼	Groundwater level during drilling
╫	Screen interval of well



Note: Figure source: URS-AECOM, 2016.

Figure 7.
Area 6 Lithologic Cross-section
January/February 2017
Area 6, Ault Field Sampling and Analysis Plan
Naval Air Station Whidbey Island
Oak Harbor, Washington

Appendix A

Field Standard Operating Procedures – CH2M

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.

A. 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.

B. 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 - CTO Number.

- Station Location - The unique sample number identifying this sample.

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 08/21/12).

- 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 of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

C. 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.

D. 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.)

E. 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 in this space (i.e., Federal Express).

- If a carrier is used, 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

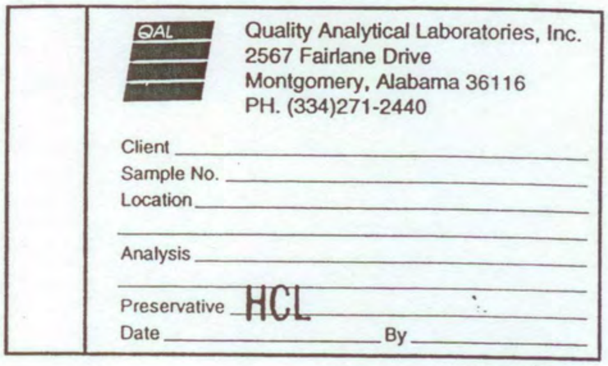
A. Sample Label
B. Chain of Custody Form
C. Custody Seal

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.

Attachment A

Example Sample Label



QAL

Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client ____________________

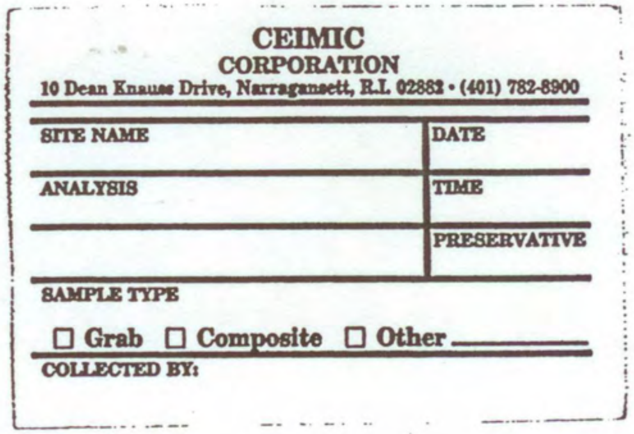
Sample No. ____________________

Location ____________________

Analysis ____________________

Preservative HCL

Date ____________________ By ____________________



CEIMIC
CORPORATION
10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME	**DATE**
ANALYSIS	**TIME**
	PRESERVATIVE

SAMPLE TYPE

☐ **Grab** ☐ **Composite** ☐ **Other** ________

COLLECTED BY:

Attachment B

Example Chain-of-Custody Record

CH2M H

APPLIED S ENCES LABORATORY

CHAIN OF CUSTODY ORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project # ☐☐☐☐☐☐☐☐.☐☐.☐☐

Purchase Order #

Project Name

Company Name CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

OF CONTAINERS

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA– FOR LAB USE ONLY

Lab 1 #	Lab 2 #
Quote #	Kit Request #
Project #	
No. of Samples	Page of
Login	LIMS Ver

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID

Sampled By & Title (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Received By (Please sign and print name) — Date/Time

Work Authorized By (Please sign and print name)

Relinquished By (Please sign and print name) — Date/Time

Relinquished By (Please sign and print name) — Date/Time

Relinquished By (Please sign and print name) — Date/Time

QC Level: 1 2 3 Other: ____

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Shipped Via
UPS BUS Fed-Ex Hand Other ____

Shipping #

Remarks

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REV 3/94 FORM 340

Attachment C

Example Custody Seal

CH2M HILL

CUSTODY SEAL

Date

Signature

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

   - Company name and address

   - Log-holders name if log book was assigned specifically to that person

   - Activity or location

- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."
4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.
5. Daily entries will be made chronologically.
6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.
7. Each page of the log book will have the date of the work and the note takers initials.
8. The final page of each day's notes will include the note-takers signature as well as the date.
9. Only information relevant to the subject project will be added to the log book.
10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.
2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.
3. Scope: Describe the general scope of work to be performed each day.
4. Weather: Record the weather conditions and any significant changes in the weather during the day.
5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

   - Description of the general sampling area – site name, buildings and streets in the area, etc.
   - Station/Location identifier
   - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
   - Sample matrix and type
   - Sample date and time
   - Sample identifier
   - Draw a box around the sample ID so that it stands out in the field notes
   - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
   - Number and type of sample containers collected
   - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
   - Parameters to be analyzed for, if appropriate
   - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M HILL STAFF:
JOHN SMITH: FIELD TEAM LEADER
BOB BUILDER: SITE SAFETY COORD.
WEATHER: OVERCAST + COOL, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • COLLECT GROUNDWATER
SAMPLES FOR LTM work at SITE 14
• SUPERVISE SURVEY CREW
AT SITE 17
0725 BB ~~Con~~ ~~JS~~ JS CALibrates
PID: 101 ppm/100 ppm OK
PID Model #, SERIAL #
0730 BB CAlibrates HORIBA METER
MODEL #, SERIAL #
→ List calibration RESults
0738 Survey crew ARRIVES on Site
→ List NAMES
0745 BB Holds H+S TAlk on Slips, Trips, FAlls, Ticks + AIR Monitoring
JS + Survey CREW ATTEND
NO H+S ISSUES IDENTIFIED AS CONCERNS. All work is in "LEVEL D."
0755 JS Conducts SITE-WIDE AIR Monitoring
All readings = 0.0 ppm in

JS
5-12-03

MAY 12, 2003 EXAMPLE

SITE 14 LTM
BREATHING ZONE (BZ)
0805 Mobilize to well MW-22 to SAMPLE, surveyors setting up AT SITE 17
0815 PM (PAUL PAPER PUSHER) CALLS AND INFORMS JS to collect GW SAMPLE AT well MW-44 today for 24 hour TAT ANALYSIS OF VOC'S
0820 Purging MW-22
→ RECORD WATER QUALITY DATA

JS
5-12-03

0843 Collect SAMPLE AT MW-22 for total TAL Metals AND VOC'S, no Dissolved Metals Needed PER PM
0905 JS + BB Mobilize to SITE 17 to show surveyors wells to survey.
0942 Mobilize to well MW-22 to collect SAMPLE...
0950 CAN not ACCESS well MW-22 due to BASE OPERATIONS; CONTACT PAUL PAPERPUSHER AND HE STATED HE will check on GAINING ACCESS with BASE contact.
0955 Mobilize to well MW-19

JS
5-12-03

STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Drinking Water Sampling when Analyzing for Per- and Polyfluoroalklyl Substances (PFASs)

I. Purpose and Scope

This SOP provides guidelines for drinking water sample collection for samples that will be analyzed for Per- and Polyfluoroalklyl Substances (PFASs), aka perfluorinated compounds (PFCs), including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) via EPA Method 537 (not modified).

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.

II. Equipment and Materials

Equipment and Materials Required

- Drinking water sample containers (polypropylene bottle with polypropylene screw cap and Trizma preservative)
- Laboratory pre-filled polypropylene bottles containing field reagent blank water and Trizma preservative
- Field Reagent Blank sample containers (polypropylene bottle with polypropylene screw cap and no preservative)
- Shipping supplies (labels, coolers, and ice)
- Loose leaf paper without waterproof coating
- Clip board
- Pen (not Sharpie)
- Nitrile or latex gloves

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect drinking water samples should not contain any fluorinated compounds, including polytetrafluoroethylene (PTFE), 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

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

  Sample bottles should be polypropylene in accordance with Method 537. PFASs have a tendency to adhere to glass surfaces. Contact the project manager (PM) if the lab sends glass bottles. Sample vials should not have PTFE/Teflon® lined bottles or caps.

III. Procedures and Guidelines

A. Setup

1. Obtain well construction information from homeowner, if available, in accordance with homeowner questionnaire developed for your project.

2. Record personnel onsite, address, homeowner name, and designated sample ID in the field logbook. Sample IDs should not contain identifying information about the property location due to potential privacy issues, so be sure both address and designated ID are carefully recorded for tracking. Sample IDs and addresses on the sample bottles and in the sample notebook must be checked by both field team members and the address in the field notebook should be confirmed with the homeowner or resident.

3. As feasible, select a sampling collection point prior to any treatment system installed by the homeowner. For example, if the homeowner has a point of use reverse osmosis or granular activated carbon filter in their kitchen sink, collect at the bathroom sink. If there is a point of entry filtration system, ask if there is a sampling port between the well and the system. If there is no way to bypass the existing treatment system without disconnecting pump components or potentially damaging the system, collect a treated sample and note that the sample was collected post-treatment. Avoid collecting samples through hoses. Instead, disconnect the hose and sample from the spigot if an outside collection station is selected.

3. Wash hands before sampling with dish detergent and don nitrile gloves.

4. Open the tap and allow the system to flush for three to five minutes. Do not open bottles until you are ready to sample.

B. Sample Collection

Once flushing is complete, samples can be collected.

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

1. Turn the tap off briefly. Remove the cap from the sample bottle. Position the sample bottle under the tap and turn the tap on.

2. Fill the bottle, taking care not to flush out the sample preservative. Samples do not need to be collected headspace free.

3. After collecting the sample, cap the bottle and agitate by hand until the preservative is dissolved.
4. Pack the sample on ice immediately for shipment to the offsite laboratory.

C. Field Reagent Blank Collection

A field reagent blank is required at each drinking water sampling location and is to be collected immediately following collection of the drinking water sample. The steps to complete collection of the field reagent blank are as follows:

1. A preserved field reagent blank for each sample location will be provided by the laboratory along with empty bottles for the field reagent blanks. While still at the drinking water sample collection point, open the preserved field reagent blank water bottle and an empty unpreserved sample bottle.
2. Pour the preserved reagent blank water from the preserved bottle into the unpreserved blank container.
3. Be sure the field reagent blank bottle is labeled and will be labeled and packed in the same cooler as the associated drinking water sampling for shipment to the offsite laboratory.

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

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 CH2M HILL 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 CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

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 zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite or absorbent pads.

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 protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with 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. Place airbill receipt inside the mailing envelope 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 CH2M HILL 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 CH2M HILL 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 vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

FIELD SAMPLING PROTOCOLS TO AVOID CROSS-CONTAMINATION DURING WATER SAMPLING FOR PERFLUORINATED COMPOUNDS (PFCs)

1.0 PURPOSE

While EPA method 537 provides basic guidance on sampling for PFC's in drinking water, due to the potential for cross contamination this Standard Operating Procedure (SOP) addendum describes additional precautionary procedures/considerations when collecting groundwater or drinking water samples. Sampling specific SOPs should also be reviewed prior to conducting field sampling activities at PFC sites.

2.0 SCOPE

This procedure applies to all qualified personnel and subcontractors who collect or otherwise handle water samples for analysis of PFCs. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 GENERAL

Given the low detection limits associated with PFC analysis and the many potential sources of trace levels of PFCs, field personnel are advised to act on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for background contamination detections of PFCs. Specific items related to field sampling are discussed below.

4.0 PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release sites.

Field Equipment

- **Do not use Teflon®-containing materials** (e.g., Teflon® tubing, bailers, tape, plumbing paste, or other Teflon® materials) since Teflon® contains fluorinated compounds.
- High-density polyethylene (HDPE), low-density polyethylene (LDPE), and silicon materials are acceptable for sampling. Samples should not be stored in containers made of LDPE materials.
- To avoid plastic coating or glue materials, **do not use waterproof field books**. Field reports should be documented on loose paper on masonite or aluminum clipboards (i.e. plastic clipboards, binders, or spiral hard cover notebooks are not acceptable). Sharpies®/markers should be avoided.
- **Post-It Notes are not allowed** on project sites.

- **Do not use markers.** Pens should be used when documenting field activities in the field log and on field forms as well as labeling sample containers and preparing the Chain of Custody.
- **Do not use chemical (blue) ice packs** during the sampling program. This includes the use of ice packs for the storage of food and/or samples.

Field Clothing and Personal Protective Equipment

- **Do not wear water resistant, waterproof, or stain-treated clothing** during the field program. Field clothing made of synthetic and natural fibers (preferably cotton) are acceptable. Field clothing should be laundered avoiding the use of fabric softener. Preferably, field gear should be cotton construction and well laundered (a minimum of 6 times from time of purchase). New clothing may contain PFC related treatments. **Do not use new clothing** while sampling or sample handling.
- **Do not wear clothing or boots containing Gore-Tex™** during the sampling program as it consists of a PFC membrane.
- All safety footwear will consist of steel-toed boots made with polyurethane and polyvinyl chloride (PVC).
- **Do not wear Tyvek® clothing** on-site since it contains fluorinated compounds.
- Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves should be donned prior to the following activities at each sample location:
  - Decontamination of re-usable sampling equipment;
  - Prior to contact with sample bottles or water containers;
  - Insertion of anything into the well (e.g. HDPE tubing, HydraSleeve bailer, etc.);
  - Insertion of silicon tubing into the peristaltic pump;
  - Completion of monitor well purging, prior to sample collection;
  - Handling of any quality assurance/quality control samples including field blanks and equipment blanks; and,
  - After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.

Sample Containers

- Samples should be collected in polypropylene or HDPE bottles fitted with an unlined (no Teflon®), polypropylene HDPE screw cap. This is an especially important point as many laboratories utilize Teflon-lined bottles.
- Container labels will be completed using pen (**NO MARKERS**) after the caps have been placed back on each bottle.

- Glass containers should also be avoided due to potential loss of analyte through adsorption.

Wet Weather

- Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination. Teams should avoid synthetic gear that has been treated with water-repellant finishes containing PFCs. Use rain gear made from polyurethane and wax-coated materials.

Equipment Decontamination

For GW sampling, it is highly recommended that disposable equipment be utilized. However, if equipment re-use is performed, field sampling equipment, including oil/water interface meters and water level indicators, that are utilized at each sample location will require cleaning between uses. Alconox® and Liquinox® soap is acceptable for use since the Material Safety Data Sheets do not list fluoro-surfactants as an ingredient. However, **Decon 90 must not be used** during decontamination activities. Water used for the decontamination of sampling equipment will be laboratory certified "PFC-free" water.

Personnel Hygiene

- Field personnel should not use cosmetics, moisturizers, hand cream, or other related products as part of their personal cleaning/showering routine on the morning of a sampling event, as these products may contain surfactants and represent a potential source of PFCs.
- Many manufactured sunblock and insect repellants contain PFCs and should not be brought or used on-site. Sunblock and insect repellants that are used on-site should consist of 100% natural ingredients.

Food Considerations

- No food or drink shall be brought on-site, with the exception of bottled water and hydration drinks (i.e., Gatorade® and Powerade®).

Blanks

- Utilization of blanks is a good quality check to monitor and control the effects of contamination. Trip blanks and field blanks are recommended.

REFERENCES

- Transport Canada, 2013. *Perfluorochemical (PFC) Field Sampling Protocol*. May.

- Delta Consultants, 2010. *Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota*. February.
- MPCA, 2008. *Closed Landfill Program Sampling Protocol for Monitoring Wells.* October.
- *Oregon State University, 2015. COLLECTION AND HANDLING OF SAMPLES FOR FLUOROCHEMICAL ANALYSIS. July.*
- *EPA, 2009. EPA Document #: EPA/600/R-08/092, METHOD 537. DETERMINATION OF SELECTED PERFLUORINATED ALKYL ACIDS IN DRINKING WATER BY SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY/TANDEM MASS SPECTROMETRY (LC/MS/MS). Version 1.1. September*

LOW-FLOW GROUNDWATER PURGING AND SAMPLING

1.0 PURPOSE

This standard operating procedure (SOP) describes the conventional monitoring well sampling procedures to be used by all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) personnel and contractors.

2.0 PROCEDURE

2.1 PURPOSE

This procedure establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples with as little alteration of water chemistry as possible.

2.2 PREPARATION

2.2.1 Site Background Information

A thorough understanding of the purposes of the sampling event should be established prior to commencing field activities. A review of available data obtained from the site and pertinent to the water sampling should also be conducted. Copies of well logs or summary tables regarding well construction information should be available on-site if possible.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that may be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column.

It is highly recommended that the field sampling team is familiar with the U.S. EPA recommended protocols for low-flow sampling outlined in the April 1996 Ground Water Issue *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures* (U.S. EPA 1996).

2.2.2 Groundwater Analysis Selection

The requisite field and laboratory analyses should be established prior to performing water sampling. The types and numbers of quality assurance/quality control (QA/QC) samples to be collected should be specified in the QA plan developed for the site.

2.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater sampling procedures at a site should include: (1) measurement of depth to groundwater and total depth, (2) assessment of the presence or absence of an immiscible phase (if required by the project plan), (3) assessment of purge parameter stabilization, (4) purging of static water within the well and well bore, and (5) obtaining a groundwater sample. Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events.

2.3.1 Measurement of Static Water Level Elevation

The depth to water and the total depth of the well should be measured to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). Dependent upon individual project requirements, synoptic water level collection may be required prior to groundwater sampling activities. In the event that synoptic water levels **are not** collected prior to sampling activities, total depth measurements should be collected **after** purging and sampling activities to prevent the suspension of fine-grained sediment that may be present at the bottom of the well. Each well should be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed.

An electronic water level meter accurate to 0.01 foot should be used to measure the water level surface and depth of the well. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

2.3.2 Decontamination of Equipment

Each piece of non-dedicated equipment should be decontaminated prior to entering the well. Decontamination should also be conducted prior to the start of sampling at a site, even if the equipment is known to be decontaminated subsequent to its last usage. This precaution is taken to minimize the potential for cross-contamination. In addition, each piece of equipment used at the site should be decontaminated prior to leaving the site. Dedicated sampling equipment need only be decontaminated prior to installation within the well. Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without onsite decontamination.

2.3.3 Detection of Immiscible Phase Layers

Unless specified in the project plans, groundwater samples should not be collected from wells with detectable amounts of LNAPL and DNAPL.

2.3.4 Purging Equipment and Use

To help minimize the potential for cross-contamination, well sampling should proceed from the least contaminated to the most contaminated. This order may be changed in the field if conditions warrant, particularly if dedicated sampling equipment is used. If decontamination of tubing is required by the project, Teflon® tubing is recommended. All groundwater removed from potentially contaminated wells should be handled in accordance with the project investigation-derived waste (IDW) handling procedures.

Purging should be accomplished by removing groundwater from the well at low flow rates using a pump. According to the U.S. EPA (1996), the rate at which groundwater is removed from the well during purging ideally should be between than 0.1 to 0.5 L/min. The pump intake should be placed in the middle of the calculated saturated screened interval. The purge rate should be low enough that substantial drawdown (>0.3 foot) in the well does not occur during purging. If a stabilized drawdown in the well can't be achieved and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. ***Under no circumstances should the well be pumped dry or otherwise over-purged***. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or groundwater sampling log with a recommendation for a different purging and sampling procedure (USEPA, 2012).

Water level measurements should be collected to assess the water level effects of purging. A low purge rate also will reduce the possibility of stripping VOCs from the water, and will reduce the likelihood of mobilizing colloids in the subsurface that are immobile under natural flow conditions.

Water quality parameters should be collected and recorded on a regular basis (every 3-5 minutes) during well evacuation. Field parameters to be collected may include temperature, pH, specific conductance, salinity, dissolved oxygen, Redox potential, and turbidity. At least seven readings should be taken during the purging process unless the field parameters stabilize more quickly. These parameters are measured to demonstrate that the formation water, not stale well casing water, is being evacuated. Purging should be considered complete when the high and low values between three consecutive field parameter measurements stabilize within 10%. Turbidity may be considered stable if values are less than 10 nephelometric turbidity units (NTUs). The criterion for temperature may not be applicable if a submersible pump is used during purging due to the heating of the water by the pump motor. Field personnel should refer to the project-specific Sampling and Analysis Plan (SAP) for specific measurement requirements and well stabilization criteria.

All information obtained during the purging and sampling process should be entered into the field logbook. In addition to the field logbook, the data may be logged on a groundwater sampling log (Figure I-C-5-1 or equivalent). In special situations where LNAPL has been detected in the monitoring well and a groundwater sample is determined to be necessary by the Project Manager, a stilling tube should be inserted into the well prior to well purging. The stilling tube should be composed of a material that meets the performance guidelines for sampling devices. The stilling tube should be inserted into the well to a depth that allows groundwater from the screened interval to be purged and sampled. The bottom of the tube should be set below the upper portion of the screened interval where the LNAPL is entering the well screen. The goal is to sample the aqueous phase (groundwater) while preventing the LNAPL from entering the sampling device. To achieve this goal, the stilling tube must be inserted into the well in a manner that prevents the LNAPL from entering the stilling tube.

One method of doing this is to cover the end of the stilling tube with a membrane or material that will be ruptured by the weight of the pump. A piece of aluminum foil can be placed over the end of the stilling tube. The stilling tube is lowered slowly into the well to the appropriate depth and then attached firmly to the top of the well casing. When the pump is inserted, the weight of the pump breaks the foil covering the end of the tube, and the well can be purged and sampled from below the LNAPL layer. The membrane or material that is used to cover the end of the stilling tube must be fastened firmly so that it remains attached to the stilling tube when ruptured. Moreover, the membrane or material must retain its integrity after it is ruptured. Pieces of the membrane or material must not fall off of the stilling tube into the well. Although aluminum foil is mentioned in this discussion as an example of a material that can be used to cover the end of the tube, a more chemically inert material may be required, based on the site-specific situation. Stilling tubes should be thoroughly decontaminated prior to each use. Groundwater removed during purging should be collected and stored onsite until its disposition is determined based upon laboratory analytical results. Storage should be in secured containers such as DOT-approved drums. Containers of purge water should be labeled with NAVFAC NW approved labels or paint pens.

2.3.5 Groundwater Sampling Methodology

The well should be sampled when groundwater within it is representative of aquifer conditions and after it has recovered sufficiently to provide enough volume for the groundwater sampling parameters. A period of no more than 2 hours should elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. The water level should be measured and recorded prior to sampling to demonstrate the degree of recovery of the well. Sampling equipment should never be dropped into the well, because this could cause aeration of the water upon impact. In addition, the sampling methodology utilized should allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers.

2.3.6 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable; therefore, samples must be preserved. The U.S. Environmental Protection Agency document entitled *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (U.S. EPA 1995), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 specifies the sample containers that should be used for each constituent or common set of parameters. In general, check with specific laboratory requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field team may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Samples should be transferred in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the Quality Assurance Project Plan.

When sampling for VOCs, water samples should be collected in vials or containers specifically designed to prevent loss of VOCs from the sample. An analytical laboratory should provide these vials, preferably by the laboratory that will perform the analysis. Groundwater from the sampling device should be collected in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment should not touch the interior of the vial. The vial should be filled above the top of the vial to form a positive meniscus with no overflow. No headspace should be present in the sample container once the container has been capped. The sample can be checked for headspace by inverting the sample bottle and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that is aerated or naturally carbonated. In these cases, the investigator should note the problem to account for possible error. Field logs and laboratory analysis reports should note any headspace in the sample container(s) at the time of receipt by the laboratory, as well as at the time the sample was first transferred to the sample container at the wellhead.

2.3.6.1 Special Handling Considerations

Samples requiring analysis for organics should not be filtered. Samples should not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container.

Groundwater samples to be analyzed for total and dissolved metals should be obtained sequentially. The sample to be analyzed for total metals, should be obtained directly from the pump and be unfiltered. The second sample should be filtered through a 0.45-micron membrane in-line filter and transferred to a container to be analyzed for dissolved metals. Allow at least 500 ml of effluent to flow through the filter prior to sampling. Any difference in concentration between the total and dissolved fractions may be attributed to the original metallic ion content of the particles and adsorption of ions onto the particles.

2.3.6.2 Field Sampling Preservation

Samples should be preserved immediately upon collection. Ideally, sample jars contain preservatives of known concentration and volume during the initial filling of the jar to a predetermined final sample volume. For example, metals require storage in aqueous media at pH of 2 or less. Typically, 0.5 ml of 1:1 nitric acid added to 500 ml of groundwater will produce a pH less than 2.0. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. It should be noted that introduction of preservatives will dilute samples, and may require normalization of results. Guidance for the preservation of environmental samples can be found in the EPA "Handbook for Sampling and Sample Preservation of Water and Wastewater:" (U.S. EPA 1982).

3.0 DOCUMENTATION

Information collected during groundwater sampling should be documented in the field logbook in accordance with SOP-002, *Preparing Field Log Books*. In addition, groundwater sampling purge logs may be (Figure I-C-5-1 or equivalent) may be filled out in addition to the field logbook. Copies of this information should be sent to the Project Manager and to the project files.

A groundwater sampling log should be documented in the field logbook and contain the following information:

- Identification of well
- Well depth
- Static water level depth
- Presence of immiscible layers
- Purge volume and pumping rate
- Time that the well was purged
- Collection method for immiscible layers
- Sample IDs
- Well evacuation procedure/equipment
- Date and time of collection
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of collector

Figure 1-C-5-1
Groundwater Sampling Log

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 ID(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

4.0 REFERENCES

U.S. EPA. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029. September 1982.

U.S. EPA. 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.

U.S. EPA. 1996. Ground Water Issue, Low-flow (Minimal Drawdown) Groundwater Sampling Procedures. EPA/540/S-95/504. April 1996

U.S. EPA. 1995 and as revised. Test Methods for Evaluating Solid Waste–Physical/Chemical Methods (SW-846). January 1995.

U.S. EPA. 2012. Standard Operating Procedure Low-Stress (Low Flow) / Minimal Drawdown Ground-Water Sample Collection, USEPA, Region 9, Management and Technical Services Division, April 2012.

5.0 ATTACHMENTS

None.

EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

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 pertaining to the operating, calibration, and maintenance of equipment used to collect environmental data. Reliable measurements of data required by the field sampling plan are necessary because the information recorded may be the basis for development of remedial action and responses.

2.0 PROCEDURES

2.1 EQUIPMENT CALIBRATION

All water quality monitoring equipment will be calibrated and adjusted to operate within the manufacturers' specifications. Water quality instruments and equipment that require calibration are to be calibrated to specifications prior to field use. In addition, a one-point calibration check is made at midday and at intervals outlined in the field sampling plan. A final check is conducted at the end of each field day. This is not a recalibration of the meter but a check of the calibration to ensure the continued accuracy of the meter. All calibration information shall be recorded in the project logbook.

Special attention shall be paid to instruments that may be affected by the change in the ambient temperature or humidity. Calibration checks should also be performed when sampling conditions change significantly, a change of sample matrix, and/or readings are unstable or there is a change of parameter measurements that appear unusual.

2.2 EQUIPMENT MAINTENANCE

All field monitoring equipment, field sampling equipment, and accessories are to be maintained in accordance with the manufacturer's recommendations and specifications and/or established field practices. All maintenance will be performed by qualified personnel and documented in the field logbook.

Equipment requiring battery charging shall be charged as recommended by the manufacturer. Backup batteries for meters requiring them shall be included as part of the meters accessories. Care must be taken to protect meters from adverse elements. This may involve placing the meter in a large plastic bag to shield it from the weather.

3.0 DOCUMENTATION

All field equipment calibration, maintenance, and operation information shall be recorded within the field logbook. This is to document that appropriate procedures have been followed and to track the equipment operation. All entries in the field logbook must be written accurately and legibly as outlined in the SOP III-D, *Logbooks*.

Logbook entries shall contain, but are not necessarily limited to, the following:

- Equipment model and serial numbers
- Date and time of calibration or maintenance performed
- Calibration standard used
- Calibration lot number and expiration date if listed on bottle
- Calibration procedure used if there are multiple options
- Calibration and calibration check readings including units used
- Problems and solutions regarding use, calibration or maintenance of the equipment
- And other pertinent information

4.0 REFERENCES

SOP III-D, *Logbooks*

5.0 ATTACHMENTS

None.

FIELD PROCEDURE 3

WATER SAMPLE COLLECTION FROM TREATMENT PLANT

During sampling activities, water samples will be collected from sample ports installed in the influent and effluent lines at the treatment plant. The effluent sample will be taken prior to taking the influent sample. Water quality measurements for pH, conductivity, and temperature will be collected immediately before sample collection in accordance with Field Procedure 1.

Following is the procedure for collecting an extraction well and treatment plant sample:

- Don a clean pair of gloves.
- Flush the sample port and obtain water quality measurements as instructed in Field Procedure 1.
- Open sample port to a slow flow rate (100 to 500 ml/minutes) in order to minimize sample agitation.
- Fill sample containers and close sample port.

Sample Bottle Filling Procedure

Sample container sizes and preservation requirements are listed in SAP Table 2-2. The sample containers will be obtained from the laboratory, containing chemical preservatives as applicable for some of the analytical parameters. The integrity of the sample containers will be checked after receipt from the laboratory.

Sample containers for VOCs will be filled at a slow rate to minimize agitation and aeration of water.

The following procedure will be followed for filling the sample containers:

- Don new, clean gloves.
- Label each sample container and double-check label to make sure the information is correct.
- Open sample containers and fill with water. Avoid contact between the bottle and sampling port. Samples will be collected in the following order (as applicable): VOCs then 1,4-dioxane. Note: For VOCs, which requires chemical preservation, transfer water into appropriate preserved containers. There must be zero headspace (no air bubbles) in the VOC vials.

- Tighten sample container lids hand-tight.
- Dry glassware after they are full and place immediately in cooler.

Appendix B
Department of Defense Environmental Laboratory Accreditation Program Accreditation Letters

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

VISTA ANALYTICAL LABORATORY
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El Dorado Hills, CA 95762
Martha Maier Phone: 916-673-1520
mmaier@vista-analytical.com

ENVIRONMENTAL

Valid To: September 30, 2019 Certificate Number: 3091.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality Systems Manual for Environmental Laboratories), accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

High Resolution Gas Chromatography / Mass Spectrometry
Liquid Chromatography Mass Spectrometry / Mass Spectrometry

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
Dioxins/Furans				
2,3,7,8-Tetrachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
2,3,7,8-Tetrachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,7,8-Pentachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
2,3,4,7,8-Pentachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,7,8-Hexachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290

Parameter/Analyte	Potable Water	Nonpotable Water	Solid Hazardous Waste	Tissue
1,2,3,6,7,8-Hexachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
2,3,4,6,7,8-Hexachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,7,8,9-Hexachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,6,7,8-Heptachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,7,8,9-Heptachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Heptachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Heptachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Hexachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Hexachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Pentachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Pentachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Tetrachlorodibenzofuran	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
Total Tetrachlorodibenzo-p-dioxin	------------------------	EPA 1613B/8290	EPA 1613B/8290	EPA 1613B/8290
PCBs				
2-Chlorobiphenyl (1)	------------------------	EPA 168A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3-Chlorobiphenyl (2)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
4-Chlorobiphenyl (3)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2'-Dichlorobiphenyl (4)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3-Dichlorobiphenyl (5)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3'-Dichlorobiphenyl (6)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4-Dichlorobiphenyl (7)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4'-Dichlorobiphenyl (8)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,5-Dichlorobiphenyl (9)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,6-Dichlorobiphenyl (10)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
3,3'-Dichlorobiphenyl (11)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4-Dichlorobiphenyl (12)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4'-Dichlorobiphenyl (13)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,5-Dichlorobiphenyl (14)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
4,4'-Dichlorobiphenyl (15)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3-Trichlorobiphenyl (16)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4-Trichlorobiphenyl (17)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',5-Trichlorobiphenyl (18)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',6-Trichlorobiphenyl (19)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3'-Trichlorobiphenyl (20)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4-Trichlorobiphenyl (21)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4'-Trichlorobiphenyl (22)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,5-Trichlorobiphenyl (23)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,6-Trichlorobiphenyl (24)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4-Trichlorobiphenyl (25)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',5-Trichlorobiphenyl (26)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',6-Trichlorobiphenyl (27)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4,4'-Trichlorobiphenyl (28)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4,5-Trichlorobiphenyl (29)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4,6-Trichlorobiphenyl (30)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4',5-Trichlorobiphenyl (31)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4',6-Trichlorobiphenyl (32)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,4-Trichlorobiphenyl (33)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,5-Trichlorobiphenyl (34)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
3,3',4-Trichlorobiphenyl (35)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',5-Trichlorobiphenyl (36)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4,4'-Trichlorobiphenyl (37)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4,5-Trichlorobiphenyl (38)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4',5-Trichlorobiphenyl (39)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3'-Tetrachlorobiphenyl (40)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4-Tetrachlorobiphenyl (41)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4'-Tetrachlorobiphenyl (42)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5-Tetrachlorobiphenyl (43)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5'-Tetrachlorobiphenyl (44)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,6-Tetrachlorobiphenyl (45)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,6'-Tetrachlorobiphenyl (46)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,4'-Tetrachlorobiphenyl (47)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,5-Tetrachlorobiphenyl (48)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,5'-Tetrachlorobiphenyl (49)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,6-Tetrachlorobiphenyl (50)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,6'-Tetrachlorobiphenyl (51)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',5,5'-Tetrachlorobiphenyl (52)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',5,6'-Tetrachlorobiphenyl (53)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',6,6'-Tetrachlorobiphenyl (54)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4'-Tetrachlorobiphenyl (55)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4'-Tetrachlorobiphenyl (56)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5-Tetrachlorobiphenyl (57)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5'-Tetrachlorobiphenyl (58)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
2,3,3',6-Tetrachlorobiphenyl (59)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,4'-Tetrachlorobiphenyl (60)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,5-Tetrachlorobiphenyl (61)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,6-Tetrachlorobiphenyl (62)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4',5-Tetrachlorobiphenyl (63)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4',6-Tetrachlorobiphenyl (64)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,5,6-Tetrachlorobiphenyl (65)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,4'-Tetrachlorobiphenyl (66)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,5-Tetrachlorobiphenyl (67)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,5'-Tetrachlorobiphenyl (68)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,6-Tetrachlorobiphenyl (69)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4',5-Tetrachlorobiphenyl (70)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4',6-Tetrachlorobiphenyl (71)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',5,5'-Tetrachlorobiphenyl (72)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',5',6-Tetrachlorobiphenyl (73)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4,4',5-Tetrachlorobiphenyl (74)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,4,4',6-Tetrachlorobiphenyl (75)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,4,5-Tetrachlorobiphenyl (76)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,4'-Tetrachlorobiphenyl (77)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,5-Tetrachlorobiphenyl (78)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,5'-Tetrachlorobiphenyl (79)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',5,5'-Tetrachlorobiphenyl (80)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,4,4',5-Tetrachlorobiphenyl (81)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4-Pentachlorobiphenyl (82)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
2,2',3,3',5-Pentachlorobiphenyl (83)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',6-Pentachlorobiphenyl (84)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4'-Pentachlorobiphenyl (85)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5-Pentachlorobiphenyl (86)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5'-Pentachlorobiphenyl (87)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,6-Pentachlorobiphenyl (88)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,6'-Pentachlorobiphenyl (89)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5-Pentachlorobiphenyl (90)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',6-Pentachlorobiphenyl (91)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5,5'-Pentachlorobiphenyl (92)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5,6-Pentachlorobiphenyl (93)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5,6'-Pentachlorobiphenyl (94)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5',6-Pentachlorobiphenyl (95)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,6,6'-Pentachlorobiphenyl (96)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3',4,5-Pentachlorobiphenyl (97)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3',4,6-Pentachlorobiphenyl (98)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,4',5-Pentachlorobiphenyl (99)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,4',6-Pentachlorobiphenyl (100)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,5,5'-Pentachlorobiphenyl (101)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,5,6'-Pentachlorobiphenyl (102)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,5,'6-Pentachlorobiphenyl (103)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,6,6'-Pentachlorobiphenyl (104)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4'-Pentachlorobiphenyl (105)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5-Pentachlorobiphenyl (106)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
2,3,3',4',5-Pentachlorobiphenyl (107)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5'-Pentachlorobiphenyl (108)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,6-Pentachlorobiphenyl (109)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4',6-Pentachlorobiphenyl (110)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5,5'-Pentachlorobiphenyl (111)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5,6-Pentachlorobiphenyl (112)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5',6-Pentachlorobiphenyl (113)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,4',5-Pentachlorobiphenyl (114)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,4',6-Pentachlorobiphenyl (115)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,5,6-Pentachlorobiphenyl (116)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4',5,6-Pentachlorobiphenyl (117)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,4',5-Pentachlorobiphenyl (118)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,4',6-Pentachlorobiphenyl (119)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,5,5'-Pentachlorobiphenyl (120)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,5,'6-Pentachlorobiphenyl (121)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,3',4,5-Pentachlorobiphenyl (122)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,4,4',5-Pentachlorobiphenyl (123)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,4,5,5'-Pentachlorobiphenyl (124)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2',3,4,5,6'-Pentachlorobiphenyl (125)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,4',5-Pentachlorobiphenyl (126)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,5,5'-Pentachlorobiphenyl (127)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4'-Hexachlorobiphenyl (128)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5-Hexachlorobiphenyl (129)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5'-Hexachlorobiphenyl (130)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	Potable Water	Nonpotable Water	Solid Hazardous Waste	Tissue
2,2',3,3',4,6-Hexachlorobiphenyl (131)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,6'-Hexachlorobiphenyl (132)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',5,5'-Hexachlorobiphenyl (133)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',5,6-Hexachlorobiphenyl (134)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',5,6'-Hexachlorobiphenyl (135)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',6,6'-Hexachlorobiphenyl (136)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5-Hexachlorobiphenyl (137)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5'-Hexachlorobiphenyl (138)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',6-Hexachlorobiphenyl (139)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',6'-Hexachlorobiphenyl (140)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5,5'-Hexachlorobiphenyl (141)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5,6-Hexachlorobiphenyl (142)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5,6'-Hexachlorobiphenyl (143)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5',6-Hexachlorobiphenyl (144)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,6,6'-Hexachlorobiphenyl (145)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5,5'-Hexachlorobiphenyl (146)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5,6-Hexachlorobiphenyl (147)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5,6'-Hexachlorobiphenyl (148)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5',6-Hexachlorobiphenyl (149)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',6,6'-Hexachlorobiphenyl (150)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5,5',6-Hexachlorobiphenyl (151)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,5,6,6'-Hexachlorobiphenyl (152)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,4',5,5'-Hexachlorobiphenyl (153)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',4,4',5',6-Hexachlorobiphenyl (154)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	Potable Water	Nonpotable Water	Solid Hazardous Waste	Tissue
2,2',4,4',6,6'-Hexachlorobiphenyl (155)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5-Hexachlorobiphenyl (156)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',6-Hexachlorobiphenyl (158)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5,5'-Hexachlorobiphenyl (159)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5,6-Hexachlorobiphenyl (160)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5',6-Hexachlorobiphenyl (161)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4',5,5'-Hexachlorobiphenyl (162)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4',5,6-Hexachlorobiphenyl (163)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4',5',6-Hexachlorobiphenyl (164)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',5,5',6-Hexachlorobiphenyl (165)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,4,4',5,6-Hexachlorobiphenyl (166)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3',4,4',5',6-Hexachlorobiphenyl (168)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2'3,3',4,4',6-Heptachlorobiphenyl (171)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,6-Heptachlorobiphenyl (173)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4',5,6-Heptachlorobiphenyl (177)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
2,2',3,3',5,6,6'-Heptachlorobiphenyl (179)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5,6-Heptachlorobiphenyl (181)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,5,6,6'-Heptachlorobiphenyl (186)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4',5,6,6'-Heptachlorobiphenyl (188)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,5,5',6-Heptachlorobiphenyl (192)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4',5,5',6-Heptachlorobiphenyl (193)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,5',6'-Octachlorobiphenyl (199)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',5,5',6,6'-Octachlorobiphenyl (202)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,4,4',5,6,6'-Octachlorobiphenyl (204)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (207)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (208)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Decachlorobiphenyl (209)	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Decachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Dichlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Heptachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Hexachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Monochlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Nonachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Octachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Pentachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Tetrachlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Trichlorobiphenyl, Total	------------------------	EPA 1668A/1668C	EPA 1668A/1668C	EPA 1668A/1668C
Per- and Poly-fluorinated compounds				
6:2 Fluorotelomer sulfanate (6:2 FTS)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
8:2 Fluorotelomer sulfanate (8:2 FTS)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
N-ethylperfluoro-1-octanesulfonamide (N-EtFOSA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
N-ethylperfluoro-1-octanesulfonamido ethanol (N-EtFOSE)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
N-methylperfluoro-1-octanesulfonamide (N-MeFOSA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
N-methylperfluoro-1-octanesulfonamido ethanol (N-MeFOSE)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorobutanesulfonic acid (PFBS)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorobutanoic acid (PFBA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorodecanesulfonate (PFDS)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorodecanoic acid (PFDA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorododecanoic acid (PFDoA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluoroundecanoic acid (PFUnA)	EPA 537	-----------------	------------------	-----------------
Perfluoroheptanesulfonate (PFHpS)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluoroheptanonic acid (PFHpA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorohexadecanoic acid (PFHxDA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorohexanesulfononic acid (PFHxS)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorohexanoic acid (PFHxA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorononaoic acid (PFNA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorooctane sulfonamide (PFOSA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
Perfluorooctanesulfonic acid (PFOS)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorooctanoic acid (PFOA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluoropentanoic acid (PFPeA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorotetradecanoic acid (PFTeDA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluorotridecanoic acid (PFTrDA)	EPA 537 EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)
Perfluoroundecanoic acid (PFUdA)	EPA 537 (Mod.)	EPA 537 (Mod.)	EPA 537 (Mod.) (VAL-PFAS)	EPA 537 (Mod.) (VAL-PFAS)

Accredited Laboratory

A2LA has accredited

VISTA ANALYTICAL LABORATORY

El Dorado Hills, CA

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 5th day of July 2017.

President and CEO
For the Accreditation Council
Certificate Number 3091.01
Valid to September 30, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

TestAmerica Laboratories, Inc.
5755 8th Street East
Tacoma WA 98424

has been assessed by ANAB
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of tests to which this accreditation applies.

L2236
Certificate Number

ANAB Approval

Certificate Valid: 06/14/2017 - 01/19/2019
Issued: 06/14/2017

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).

Scope of Accreditation
For
TestAmerica Laboratories, Inc

5755 8th Street East
Tacoma, WA 98424
Terri Torres
253-922-2310

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM V5) based on the TNI Standard - Environmental Laboratory Sector, Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis, Sept 2009 (EL-V1-2009); accreditation is granted to **TestAmerica Laboratories, Inc.** to perform the following tests

Accreditation granted through: **January 19, 2019**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/200.7	Silver
ICP-AES	EPA 6010B/6010C/200.7	Aluminum
ICP-AES	EPA 6010B/6010C/200.7	Arsenic
ICP-AES	EPA 6010B/6010C/200.7	Boron
ICP-AES	EPA 6010B/6010C/200.7	Barium
ICP-AES	EPA 6010B/6010C/200.7	Beryllium
ICP-AES	EPA 6010B/6010C/200.7	Calcium
ICP-AES	EPA 6010B/6010C/200.7	Cadmium
ICP-AES	EPA 6010B/6010C/200.7	Cobalt
ICP-AES	EPA 6010B/6010C/200.7	Chromium
ICP-AES	EPA 6010B/6010C/200.7	Copper
ICP-AES	EPA 6010B/6010C/200.7	Iron
ICP-AES	EPA 6010B/6010C/200.7	Potassium
ICP-AES	EPA 6010B/6010C/200.7	Magnesium
ICP-AES	EPA 6010B/6010C/200.7	Manganese
ICP-AES	EPA 6010B/6010C/200.7	Molybdenum
ICP-AES	EPA 6010B/6010C/200.7	Sodium
ICP-AES	EPA 6010B/6010C/200.7	Nickel

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/200.7	Lead
ICP-AES	EPA 6010B/6010C/200.7	Antimony
ICP-AES	EPA 6010B/6010C/200.7	Selenium
ICP-AES	EPA 6010B/6010C/200.7	Silicon
ICP-AES	EPA 6010B/6010C/200.7	Tin
ICP-AES	EPA 6010B/6010C/200.7	Titanium
ICP-AES	EPA 6010B/6010C/200.7	Strontium
ICP-AES	EPA 6010B/6010C/200.7	Thallium
ICP-AES	EPA 6010B/6010C/200.7	Vanadium
ICP-AES	EPA 6010B/6010C/200.7	Zinc
ICP-MS	EPA 6020/6020A/200.8	Silver
ICP-MS	EPA 6020/6020A/200.8	Arsenic
ICP-MS	EPA 6020/6020A/200.8	Barium
ICP-MS	EPA 6020/6020A/200.8	Beryllium
ICP-MS	EPA 6020/6020A/200.8	Cadmium
ICP-MS	EPA 6020/6020A/200.8	Cobalt
ICP-MS	EPA 6020/6020A/200.8	Chromium
ICP-MS	EPA 6020/6020A/200.8	Copper
ICP-MS	EPA 6020/6020A/200.8	Manganese
ICP-MS	EPA 6020/6020A/200.8	Molybdenum
ICP-MS	EPA 6020/6020A/200.8	Nickel
ICP-MS	EPA 6020/6020A/200.8	Lead
ICP-MS	EPA 6020/6020A/200.8	Antimony
ICP-MS	EPA 6020/6020A/200.8	Selenium
ICP-MS	EPA 6020/6020A/200.8	Thallium
ICP-MS	EPA 6020/6020A/200.8	Uranium
ICP-MS	EPA 6020/6020A/200.8	Vanadium
ICP-MS	EPA 6020/6020A/200.8	Zinc
CVAAS	EPA 7470A/245.1	Mercury
GC/MS	EPA 8260B/8260C/624	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C/624	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C/624	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C/624	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C/624	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C/624	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C/624	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C/624	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C/624	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C/624	1,2,4-Trichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C/624	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C/624	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B/8260C/624	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C/624	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C/624	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C/624	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C/624	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C/624	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C/624	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C/624	2-Chloroethylvinylether
GC/MS	EPA 8260B/8260C/624	2-Chlorotoluene
GC/MS	EPA 8260B/8260C/624	2-Hexanone
GC/MS	EPA 8260B/8260C/624	4-Chlorotoluene
GC/MS	EPA 8260B/8260C/624	4-Isopropyltoluene
GC/MS	EPA 8260B/8260C/624	Acetone
GC/MS	EPA 8260B/8260C/624	Acetonitrile
GC/MS	EPA 8260B/8260C/624	Acrolein
GC/MS	EPA 8260B/8260C/624	Acrylonitrile
GC/MS	EPA 8260B/8260C/624	Benzene
GC/MS	EPA 8260B/8260C/624	Bromobenzene
GC/MS	EPA 8260B/8260C/624	Bromodichloromethane
GC/MS	EPA 8260B/8260C/624	Bromoform
GC/MS	EPA 8260B/8260C/624	Bromomethane
GC/MS	EPA 8260B/8260C/624	Carbon disulfide
GC/MS	EPA 8260B/8260C/624	Carbon tetrachloride
GC/MS	EPA 8260B/8260C/624	Chlorobenzene
GC/MS	EPA 8260B/8260C/624	Chlorobromomethane
GC/MS	EPA 8260B/8260C/624	Chlorodibromomethane
GC/MS	EPA 8260B/8260C/624	Chloroethane
GC/MS	EPA 8260B/8260C/624	Chloroform
GC/MS	EPA 8260B/8260C/624	Chloromethane
GC/MS	EPA 8260B/8260C/624	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C/624	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C/624	Dibromomethane
GC/MS	EPA 8260B/8260C/624	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C/624	Ethylbenzene
GC/MS	EPA 8260B/8260C/624	Ethylene Dibromide
GC/MS	EPA 8260B/8260C/624	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C/624	Isopropylbenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/8260C/624	Methyl Ethyl Ketone
GC/MS	EPA 8260B/8260C/624	Methyl Isobutyl Ketone
GC/MS	EPA 8260B/8260C/624	Methyl tert-butyl ether
GC/MS	EPA 8260B/8260C/624	Methylene Chloride
GC/MS	EPA 8260B/8260C/624	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C/624	Naphthalene
GC/MS	EPA 8260B/8260C/624	n-Butylbenzene
GC/MS	EPA 8260B/8260C/624	N-Propylbenzene
GC/MS	EPA 8260B/8260C/624	o-Xylene
GC/MS	EPA 8260B/8260C/624	sec-Butylbenzene
GC/MS	EPA 8260B/8260C/624	Styrene
GC/MS	EPA 8260B/8260C/624	tert-Butylbenzene
GC/MS	EPA 8260B/8260C/624	Tetrachloroethene
GC/MS	EPA 8260B/8260C/624	Toluene
GC/MS	EPA 8260B/8260C/624	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C/624	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C/624	Trichloroethene
GC/MS	EPA 8260B/8260C/624	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C/624	Vinyl Acetate
GC/MS	EPA 8260B/8260C/624	Vinyl chloride
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,1,2-Tetrachloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,2,2-Tetrachloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,2-Trichloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1-Dichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,2-Dichloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,4-Dichlorobenzene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	2-Hexanone
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Benzene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromoform
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Butadiene

Non-Potable Water

Technology	Method	Analyte
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Chlorodibromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Chloroform
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	cis-1,2-Dichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	cis-1,3-Dichloropropene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Dibromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromodichloromethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Ethylene Dibromide
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Hexachlorobutadiene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Isopropyl alcohol
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Naphthalene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Tetrachloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	trans-1,3-Dichloropropene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Trichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Vinyl chloride
GC/MS	EPA 8270C/8270D/625	1-Methylnaphthalene
GC/MS	EPA 8270C/8270D/625	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/8270D/625	1,2-Dichlorobenzene
GC/MS	EPA 8270C/8270D/625	1,3-Dichlorobenzene
GC/MS	EPA 8270C/8270D/625	1,4-Dichlorobenzene
GC/MS	EPA 8270C/8270D/625	bis(2-chloroisopropyl)ether
GC/MS	EPA 8270C/8270D/625	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/8270D/625	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/8270D/625	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/8270D/625	2,4-Dichlorophenol
GC/MS	EPA 8270C/8270D/625	2,4-Dimethylphenol
GC/MS	EPA 8270C/8270D/625	2,4-Dinitrophenol
GC/MS	EPA 8270C/8270D/625	2,4-Dinitrotoluene
GC/MS	EPA 8270C/8270D/625	2,6-Dinitrotoluene
GC/MS	EPA 8270C/8270D/625	2-Chloronaphthalene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/8270D/625	2-Chlorophenol
GC/MS	EPA 8270C/8270D/625	2-Methylnaphthalene
GC/MS	EPA 8270C/8270D/625	2-Methylphenol
GC/MS	EPA 8270C/8270D/625	2-Nitroaniline
GC/MS	EPA 8270C/8270D/625	2-Nitrophenol
GC/MS	EPA 8270C/8270D/625	3 & 4 Methylphenol
GC/MS	EPA 8270C/8270D/625	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/8270D/625	3-Nitroaniline
GC/MS	EPA 8270C/8270D/625	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/8270D/625	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/8270D/625	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/8270D/625	4-Chloroaniline
GC/MS	EPA 8270C/8270D/625	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/8270D/625	4-Nitroaniline
GC/MS	EPA 8270C/8270D/625	4-Nitrophenol
GC/MS	EPA 8270C/8270D/625	Acenaphthene
GC/MS	EPA 8270C/8270D/625	Acenaphthylene
GC/MS	EPA 8270C/8270D/625	Aniline
GC/MS	EPA 8270C/8270D/625	Anthracene
GC/MS	EPA 8270C/8270D/625	1,2-Diphenylhydrazine as Azobenzene
GC/MS	EPA 8270C/8270D/625	Benzo[a]anthracene
GC/MS	EPA 8270C/8270D/625	Benzo[a]pyrene
GC/MS	EPA 8270C/8270D/625	Benzo[b]fluoranthene
GC/MS	EPA 8270C/8270D/625	Benzo[g,h,i]perylene
GC/MS	EPA 8270C/8270D/625	Benzo[k]fluoranthene
GC/MS	EPA 8270C/8270D/625	Benzoic acid
GC/MS	EPA 8270C/8270D/625	Benzyl alcohol
GC/MS	EPA 8270C/8270D/625	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/8270D/625	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/8270D/625	Bis(2-ethylhexyl) phthalate
GC/MS	EPA 8270C/8270D/625	Butyl benzyl phthalate
GC/MS	EPA 8270C/8270D/625	Carbazole
GC/MS	EPA 8270C/8270D/625	Chrysene
GC/MS	EPA 8270C/8270D/625	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/8270D/625	Dibenzofuran
GC/MS	EPA 8270C/8270D/625	Diethyl phthalate
GC/MS	EPA 8270C/8270D/625	Dimethyl phthalate
GC/MS	EPA 8270C/8270D/625	Di-n-butyl phthalate
GC/MS	EPA 8270C/8270D/625	Di-n-octyl phthalate

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/8270D/625	Fluoranthene
GC/MS	EPA 8270C/8270D/625	Fluorene
GC/MS	EPA 8270C/8270D/625	Hexachlorobenzene
GC/MS	EPA 8270C/8270D/625	Hexachlorobutadiene
GC/MS	EPA 8270C/8270D/625	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/8270D/625	Hexachloroethane
GC/MS	EPA 8270C/8270D/625	Indeno[1,2,3-cd]pyrene
GC/MS	EPA 8270C/8270D/625	Isophorone
GC/MS	EPA 8270C/8270D/625	Naphthalene
GC/MS	EPA 8270C/8270D/625	Nitrobenzene
GC/MS	EPA 8270C/8270D/625	N-Nitrosodimethylamine
GC/MS	EPA 8270C/8270D/625	N-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/8270D/625	N-Nitrosodiphenylamine
GC/MS	EPA 8270C/8270D/625	Pentachlorophenol
GC/MS	EPA 8270C/8270D/625	Phenanthrene
GC/MS	EPA 8270C/8270D/625	Phenol
GC/MS	EPA 8270C/8270D/625	Pyrene
GC/MS	EPA 8270C/8270D/625	Pyridine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1,3-Dinitrobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1,4-Dioxane
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4,6-Trichlorophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4-Dinitrophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4-Dinitrotoluene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,6-Dinitrotoluene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]anthracene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[b]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[g,h,i]perylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[k]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Bis(2-chloroethyl)ether
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorobutadiene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorocyclopentadiene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachloroethane
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Indeno[1,2,3-cd]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Nitrobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	N-Nitrosodimethylamine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	N-Nitrosodi-n-propylamine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pentachlorophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pyrene
GC-ECD	EPA 8011/504.1	1,2-Dibromoethane
GC-ECD	EPA 8011/504.1	1,2-Dibromo-3-Chloropropane
GC-ECD	EPA 8011/504.1	1,2,3-Trichloropropane

Non-Potable Water

Technology	Method	Analyte
GC-ECD	EPA 8081A/8081B/608	4,4'-DDD
GC-ECD	EPA 8081A/8081B/608	4,4'-DDE
GC-ECD	EPA 8081A/8081B/608	4,4'-DDT
GC-ECD	EPA 8081A/8081B/608	Aldrin
GC-ECD	EPA 8081A/8081B/608	alpha-BHC
GC-ECD	EPA 8081A/8081B/608	alpha-Chlordane
GC-ECD	EPA 8081A/8081B/608	beta-BHC
GC-ECD	EPA 8081A/8081B/608	delta-BHC
GC-ECD	EPA 8081A/8081B/608	Dieldrin
GC-ECD	EPA 8081A/8081B/608	Endosulfan I
GC-ECD	EPA 8081A/8081B/608	Endosulfan II
GC-ECD	EPA 8081A/8081B/608	Endosulfan sulfate
GC-ECD	EPA 8081A/8081B/608	Endrin
GC-ECD	EPA 8081A/8081B/608	Endrin aldehyde
GC-ECD	EPA 8081A/8081B/608	Endrin ketone
GC-ECD	EPA 8081A/8081B/608	gamma-BHC (Lindane)
GC-ECD	EPA 8081A/8081B/608	gamma-Chlordane
GC-ECD	EPA 8081A/8081B/608	Heptachlor
GC-ECD	EPA 8081A/8081B/608	Heptachlor epoxide
GC-ECD	EPA 8081A/8081B/608	Methoxychlor
GC-ECD	EPA 8081A/8081B/608	Technical Chlordane
GC-ECD	EPA 8081A/8081B/608	Toxaphene
GC-ECD	EPA 8082/8082A/608	PCB-1016
GC-ECD	EPA 8082/8082A/608	PCB-1221
GC-ECD	EPA 8082/8082A/608	PCB-1232
GC-ECD	EPA 8082/8082A/608	PCB-1242
GC-ECD	EPA 8082/8082A/608	PCB-1248
GC-ECD	EPA 8082/8082A/608	PCB-1254
GC-ECD	EPA 8082/8082A/608	PCB-1260
GC-ECD	EPA 8082/8082A/608	PCB-1262
GC-ECD	EPA 8082/8082A/608	PCB-1268
GC-IT/MS	EPA 8151A MOD	2,4,5-T
GC-IT/MS	EPA 8151A MOD	2,4-D
GC-IT/MS	EPA 8151A MOD	2,4-DB
GC-IT/MS	EPA 8151A MOD	4-Nitrophenol
GC-IT/MS	EPA 8151A MOD	Dalapon
GC-IT/MS	EPA 8151A MOD	Dicamba
GC-IT/MS	EPA 8151A MOD	Dichlorprop
GC-IT/MS	EPA 8151A MOD	Dinoseb

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-IT/MS	EPA 8151A MOD	MCPA
GC-IT/MS	EPA 8151A MOD	Mecoprop
GC-IT/MS	EPA 8151A MOD	Pentachlorophenol
GC-IT/MS	EPA 8151A MOD	Silvex (2,4,5-TP)
GC-FID	EPA 8015B	Gasoline
GC-FID	AK101	Gasoline
GC-FID	NWTPH-Gx	Gasoline
GC-FID	NWVPH	Volatile Petroleum Hydrocarbons
GC-FID	EPA 8015B	Diesel
GC-FID	AK102	Diesel
GC-FID	NWTPH-Dx	Diesel
GC-FID	NWEPH	Extractable Petroleum Hydrocarbons
GC-FID	EPA 8015B	Motor Oil
GC-FID	AK103	Motor Oil
GC-FID	NWTPH-Dx	Motor Oil
Titration	EPA 310.1 / SM 2320B	Alkalinity
Colorimetric / RFA	EPA 353.2	Nitrate
Colorimetric / RFA	EPA 353.2	Nitrite
Colorimetric / RFA	EPA 353.2	Nitrate + Nitrite
Probe	EPA 405.1 / SM 5210B	BOD
Titration	EPA 410.2 SM 5220C	COD
Colorimetric / RFA	SM 5220D 21st Ed	COD
Gravimetric	EPA 1664A	Oil & Grease
Colorimetric/RFA	EPA 9012A	Total Cyanides
Colorimetric	EPA 7196A	Hexavalent Chromium
Ion Chromatography	EPA 300.0/9056A	Bromide
Ion Chromatography	EPA 300.0/9056A	Chloride
Ion Chromatography	EPA 300.0/9056A	Fluoride
Ion Chromatography	EPA 300.0/9056A	Sulfate
Ion Chromatography	EPA 300.0/9056A	Nitrate
Ion Chromatography	EPA 300.0/9056A	Nitrite
TOC Analyzer (IR)	EPA 415.1/9060	TOC
Probe	EPA 9040/9045/150.1	pH
Conductivity meter	EPA 9050A/120.1 SM 2510B	Specific Conductance
Setaflash	EPA 1020A	Flashpoint

Non-Potable Water

Preparation	Method	Type
Separatory Funnel Liquid-Liquid Extraction	EPA 3510C	Semivolatile and Nonvolatile Organics
Continuous Liquid-Liquid Extraction	EPA 3520C	Semivolatile and Nonvolatile Organics
Purge and Trap	EPA 5030B	Volatile Organic Compounds
Acid Digestion (Aqueous)	EPA 3005A/3010A	Inorganics
TCLP Extraction	EPA 1311	Toxicity Characteristic Leaching Procedure
Florisil Cleanup	EPA 3620B	Cleanup of pesticide residues and other chlorinated hydrocarbons
Silica Gel Cleanup	EPA 3630C	Column Cleanup
Sulfur Cleanup	EPA 3660B	Sulfur Cleanup Reagent
Sulfuric Acid Cleanup	EPA 3665A	Cleanup for Quantization of PCBs

Solid and Chemical Materials

Technology	Method	Analyte
ICP-AES	EPA 6010B/6010C	Silver
ICP-AES	EPA 6010B/6010C	Aluminum
ICP-AES	EPA 6010B/6010C	Arsenic
ICP-AES	EPA 6010B/6010C	Boron
ICP-AES	EPA 6010B/6010C	Barium
ICP-AES	EPA 6010B/6010C	Beryllium
ICP-AES	EPA 6010B/6010C	Calcium
ICP-AES	EPA 6010B/6010C	Cadmium
ICP-AES	EPA 6010B/6010C	Cobalt
ICP-AES	EPA 6010B/6010C	Chromium
ICP-AES	EPA 6010B/6010C	Copper
ICP-AES	EPA 6010B/6010C	Iron
ICP-AES	EPA 6010B/6010C	Potassium
ICP-AES	EPA 6010B/6010C	Magnesium
ICP-AES	EPA 6010B/6010C	Manganese
ICP-AES	EPA 6010B/6010C	Molybdenum
ICP-AES	EPA 6010B/6010C	Sodium
ICP-AES	EPA 6010B/6010C	Nickel
ICP-AES	EPA 6010B/6010C	Lead
ICP-AES	EPA 6010B/6010C	Antimony
ICP-AES	EPA 6010B/6010C	Selenium
ICP-AES	EPA 6010B/6010C	Silicon
ICP-AES	EPA 6010B/6010C	Tin

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C	Titanium
ICP-AES	EPA 6010B/6010C	Strontium
ICP-AES	EPA 6010B/6010C	Thallium
ICP-AES	EPA 6010B/6010C	Vanadium
ICP-AES	EPA 6010B/6010C	Zinc
ICP-MS	EPA 6020/6020A	Silver
ICP-MS	EPA 6020/6020A	Arsenic
ICP-MS	EPA 6020/6020A	Barium
ICP-MS	EPA 6020/6020A	Beryllium
ICP-MS	EPA 6020/6020A	Cadmium
ICP-MS	EPA 6020/6020A	Cobalt
ICP-MS	EPA 6020/6020A	Chromium
ICP-MS	EPA 6020/6020A	Copper
ICP-MS	EPA 6020/6020A	Manganese
ICP-MS	EPA 6020/6020A	Molybdenum
ICP-MS	EPA 6020/6020A	Nickel
ICP-MS	EPA 6020/6020A	Lead
ICP-MS	EPA 6020/6020A	Antimony
ICP-MS	EPA 6020/6020A	Selenium
ICP-MS	EPA 6020/6020A	Thallium
ICP-MS	EPA 6020/6020A	Uranium
ICP-MS	EPA 6020/6020A	Vanadium
ICP-MS	EPA 6020/6020A	Zinc
CVAAS	EPA 7471A	Mercury
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	2-Chloroethylvinylether
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Acetone
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	Chlorobromomethane
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethylene Dibromide
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	Methyl Ethyl Ketone
GC/MS	EPA 8260B/8260C	Methyl Isobutyl Ketone
GC/MS	EPA 8260B/8260C	Methyl tert-butyl ether
GC/MS	EPA 8260B/8260C	Methylene Chloride

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	N-Propylbenzene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	Vinyl Acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,1,2-Tetrachloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,2,2-Tetrachloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1,2-Trichloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,1-Dichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,2-Dichloroethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	1,4-Dichlorobenzene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	2-Hexanone
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Benzene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromoform
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Butadiene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Chlorodibromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Chloroform

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	cis-1,2-Dichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	cis-1,3-Dichloropropene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Dibromomethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Bromodichloromethane
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Ethylene Dibromide
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Hexachlorobutadiene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Isopropyl alcohol
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Naphthalene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Tetrachlroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	trans-1,3-Dichloropropene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Trichloroethene
GC/MS SIM	EPA 8260B SIM EPA 8260C SIM	Vinyl chloride
GC/MS	EPA 8270C/8270D	1-Methylnaphthalene
GC/MS	EPA 8270C/8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/8270D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/8270D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/8270D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/8270D	bis(2-chloroisopropyl)ether
GC/MS	EPA 8270C/8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/8270D	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/8270D	2,4-Dichlorophenol
GC/MS	EPA 8270C/8270D	2,4-Dimethylphenol
GC/MS	EPA 8270C/8270D	2,4-Dinitrophenol
GC/MS	EPA 8270C/8270D	2,4-Dinitrotoluene
GC/MS	EPA 8270C/8270D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/8270D	2-Chloronaphthalene
GC/MS	EPA 8270C/8270D	2-Chlorophenol
GC/MS	EPA 8270C/8270D	2-Methylnaphthalene
GC/MS	EPA 8270C/8270D	2-Methylphenol
GC/MS	EPA 8270C/8270D	2-Nitroaniline

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270C/8270D	2-Nitrophenol
GC/MS	EPA 8270C/8270D	3 & 4 Methylphenol
GC/MS	EPA 8270C/8270D	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/8270D	3-Nitroaniline
GC/MS	EPA 8270C/8270D	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/8270D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/8270D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/8270D	4-Chloroaniline
GC/MS	EPA 8270C/8270D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/8270D	4-Nitroaniline
GC/MS	EPA 8270C/8270D	4-Nitrophenol
GC/MS	EPA 8270C/8270D	Acenaphthene
GC/MS	EPA 8270C/8270D	Acenaphthylene
GC/MS	EPA 8270C/8270D	Aniline
GC/MS	EPA 8270C/8270D	Anthracene
GC/MS	EPA 8270C/8270D	1,2-Diphenylhydrazine as Azobenzene
GC/MS	EPA 8270C/8270D	Benzo[a]anthracene
GC/MS	EPA 8270C/8270D	Benzo[a]pyrene
GC/MS	EPA 8270C/8270D	Benzo[b]fluoranthene
GC/MS	EPA 8270C/8270D	Benzo[g,h,i]perylene
GC/MS	EPA 8270C/8270D	Benzo[k]fluoranthene
GC/MS	EPA 8270C/8270D	Benzoic acid
GC/MS	EPA 8270C/8270D	Benzyl alcohol
GC/MS	EPA 8270C/8270D	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/8270D	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/8270D	Bis(2-ethylhexyl) phthalate
GC/MS	EPA 8270C/8270D	Butyl benzyl phthalate
GC/MS	EPA 8270C/8270D	Carbazole
GC/MS	EPA 8270C/8270D	Chrysene
GC/MS	EPA 8270C/8270D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/8270D	Dibenzofuran
GC/MS	EPA 8270C/8270D	Diethyl phthalate
GC/MS	EPA 8270C/8270D	Dimethyl phthalate
GC/MS	EPA 8270C/8270D	Di-n-butyl phthalate
GC/MS	EPA 8270C/8270D	Di-n-octyl phthalate
GC/MS	EPA 8270C/8270D	Fluoranthene
GC/MS	EPA 8270C/8270D	Fluorene
GC/MS	EPA 8270C/8270D	Hexachlorobenzene
GC/MS	EPA 8270C/8270D	Hexachlorobutadiene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/8270D	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/8270D	Hexachloroethane
GC/MS	EPA 8270C/8270D	Indeno[1,2,3-cd]pyrene
GC/MS	EPA 8270C/8270D	Isophorone
GC/MS	EPA 8270C/8270D	Naphthalene
GC/MS	EPA 8270C/8270D	Nitrobenzene
GC/MS	EPA 8270C/8270D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/8270D	N-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/8270D	N-Nitrosodiphenylamine
GC/MS	EPA 8270C/8270D	Pentachlorophenol
GC/MS	EPA 8270C/8270D	Phenanthrene
GC/MS	EPA 8270C/8270D	Phenol
GC/MS	EPA 8270C/8270D	Pyrene
GC/MS	EPA 8270C/8270D	Pyridine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1,3-Dinitrobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1,4-Dioxane
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4,6-Trichlorophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4-Dinitrophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,4-Dinitrotoluene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2,6-Dinitrotoluene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	3,3’-Dichlorobenzidine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	4-Chloroaniline
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]anthracene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[b]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[g,h,i]perylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[k]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Bis(2-chloroethyl)ether
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorobutadiene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachlorocyclopentadiene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Hexachloroethane
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Indeno[1,2,3-cd]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Nitrobenzene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	N-Nitrosodimethylamine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	N-Nitrosodi-n-propylamine
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pentachlorophenol
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pyrene
GC-ECD	EPA 8011	1,2-Dibromoethane
GC-ECD	EPA 8011	1,2-Dibromo-3-Chloropropane
GC-ECD	EPA 8011	1,2,3-Trichloropropane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-ECD	EPA 8081A/8081B	4,4'-DDD
GC-ECD	EPA 8081A/8081B	4,4'-DDE
GC-ECD	EPA 8081A/8081B	4,4'-DDT
GC-ECD	EPA 8081A/8081B	Aldrin
GC-ECD	EPA 8081A/8081B	alpha-BHC
GC-ECD	EPA 8081A/8081B	alpha-Chlordane
GC-ECD	EPA 8081A/8081B	beta-BHC
GC-ECD	EPA 8081A/8081B	delta-BHC
GC-ECD	EPA 8081A/8081B	Dieldrin
GC-ECD	EPA 8081A/8081B	Endosulfan I
GC-ECD	EPA 8081A/8081B	Endosulfan II
GC-ECD	EPA 8081A/8081B	Endosulfan sulfate
GC-ECD	EPA 8081A/8081B	Endrin
GC-ECD	EPA 8081A/8081B	Endrin aldehyde
GC-ECD	EPA 8081A/8081B	Endrin ketone
GC-ECD	EPA 8081A/8081B	gamma-BHC (Lindane)
GC-ECD	EPA 8081A/8081B	gamma-Chlordane
GC-ECD	EPA 8081A/8081B	Heptachlor
GC-ECD	EPA 8081A/8081B	Heptachlor epoxide
GC-ECD	EPA 8081A/8081B	Methoxychlor
GC-ECD	EPA 8081A/8081B	Technical Chlordane
GC-ECD	EPA 8081A/8081B	Toxaphene
GC-ECD	EPA 8082/8082A	PCB-1016
GC-ECD	EPA 8082/8082A	PCB-1221
GC-ECD	EPA 8082/8082A	PCB-1232
GC-ECD	EPA 8082/8082A	PCB-1242
GC-ECD	EPA 8082/8082A	PCB-1248
GC-ECD	EPA 8082/8082A	PCB-1254
GC-ECD	EPA 8082/8082A	PCB-1260
GC-ECD	EPA 8082/8082A	PCB-1262
GC-ECD	EPA 8082/8082A	PCB-1268
GC-IT/MS	EPA 8151A MOD	2,4,5-T
GC-IT/MS	EPA 8151A MOD	2,4-D
GC-IT/MS	EPA 8151A MOD	2,4-DB
GC-IT/MS	EPA 8151A MOD	4-Nitrophenol
GC-IT/MS	EPA 8151A MOD	Dalapon
GC-IT/MS	EPA 8151A MOD	Dicamba
GC-IT/MS	EPA 8151A MOD	Dichlorprop
GC-IT/MS	EPA 8151A MOD	Dinoseb

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-IT/MS	EPA 8151A MOD	MCPA
GC-IT/MS	EPA 8151A MOD	Mecoprop MCPP
GC-IT/MS	EPA 8151A MOD	Pentachlorophenol
GC-IT/MS	EPA 8151A MOD	Silvex (2,4,5-TP)
GC-FID	EPA 8015B	Gasoline
GC-FID	AK101	Gasoline
GC-FID	NWTPH-Gx	Gasoline
GC-FID	NWVPH	Volatile Petroleum Hydrocarbons
GC-FID	EPA 8015B	Diesel
GC-FID	AK102	Diesel
GC-FID	NWTPH-Dx	Diesel
GC-FID	NWEPH	Extractable Petroleum Hydrocarbons
GC-FID	EPA 8015B	Motor Oil
GC-FID	AK103	Motor Oil
GC-FID	NWTPH-Dx	Motor Oil
Colorimetric/RFA	EPA 9012A	Total Cyanides
Ion Chromatography	EPA 300.0/9056A	Bromide
Ion Chromatography	EPA 300.0/9056A	Chloride
Ion Chromatography	EPA 300.0/9056A	Fluoride
Ion Chromatography	EPA 300.0/9056A	Sulfate
Ion Chromatography	EPA 300.0/9056A	Nitrate
Ion Chromatography	EPA 300.0/9056A	Nitrite
TOC Analyzer (IR)	EPA 9060	TOC
Probe	EPA 9040/9045	pH/Corrosivity
Conductivity meter	EPA 9050A	Specific Conductance
Setaflash	EPA 1020A	Flashpoint
Separatory Funnel Liquid-Liquid Extraction	EPA 3510C	Semivolatile and Nonvolatile Organics
Continuous Liquid-Liquid Extraction	EPA 3520C	Semivolatile and Nonvolatile Organics
Microwave Extraction	EPA 3546	Semivolatile and Nonvolatile Organics
Ultrasonic Extraction	EPA 3550B	Semivolatile and Nonvolatile Organics
Solvent Dilution	EPA 3580A	Semivolatile and Nonvolatile Organics
Waste Dilution	EPA 3585	Volatile Organic Compounds
Purge and Trap	EPA 5030B	Volatile Organic Compounds
Purge and Trap	EPA 5035A	Volatile Organic Compounds

Solid and Chemical Materials

Technology	Method	Analyte
Acid Digestion (Aqueous)	EPA 3005A/3010A	Inorganics
Acid Digestion (Sediments, Sludges, Soils)	EPA 3050B	Inorganics
TCLP Extraction	EPA 1311	Toxicity Characteristic Leaching Procedure
Florisil Cleanup	EPA 3620B	Cleanup of pesticide residues and other chlorinated hydrocarbons
Silica Gel Cleanup	EPA 3630C	Column Cleanup
Sulfur Cleanup	EPA 3660B	Sulfur Cleanup Reagent
Sulfuric Acid Cleanup	EPA 3665A	Cleanup for Quantitation of PCBs

This accreditation covers testing performed at the main laboratory listed above, and a mobile laboratory (VIN# 1GDJP32K0L3500707, State of Alaska License # GLF522) for the tests indicated below.

Solid and Chemical Materials

Technology	Method	Type
GC-MS	AK101	Gasoline
GC-FID	AK102	Diesel
GC-FID	AK103	Motor Oil
GC-ECD	EPA 8082/8082A	PCB-1016
GC-ECD	EPA 8082/8082A	PCB-1221
GC-ECD	EPA 8082/8082A	PCB-1232
GC-ECD	EPA 8082/8082A	PCB-1242
GC-ECD	EPA 8082/8082A	PCB-1248
GC-ECD	EPA 8082/8082A	PCB-1254
GC-ECD	EPA 8082/8082A	PCB-1260
GC-ECD	EPA 8082/8082A	PCB-1262
GC-ECD	EPA 8082/8082A	PCB-1268
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene

Solid and Chemical Materials

Technology	Method	Type
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	2-Chloroethylvinylether
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Acetone
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	Chlorobromomethane
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethylene Dibromide
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene

Solid and Chemical Materials

Technology	Method	Type
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	Methyl Ethyl Ketone
GC/MS	EPA 8260B/8260C	Methyl Isobutyl Ketone
GC/MS	EPA 8260B/8260C	Methyl tert-butyl ether
GC/MS	EPA 8260B/8260C	Methylene Chloride
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	N-Propylbenzene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	Vinyl Acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[b]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[g,h,i]perylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[k]fluoranthene

Solid and Chemical Materials

Technology	Method	Type
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Indeno[1,2,3-cd]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pyrene
Preparation	**Method**	**Type**
Ultrasonic Extraction	EPA 3550B	Semivolatile and Nonvolatile Organics
Sulfuric Acid Cleanup	EPA 3665A	Cleanup for Quantitation of PCBs
Purge and Trap	EPA 5035A	Volatile Organic Compounds
Microwave Extraction	EPA 3546	Semivolatile and Nonvolatile Organics
Silica Gel Cleanup	EPA 3630C	Column Cleanup

This accreditation covers testing performed at the main laboratory listed above, and a mobile laboratory (VIN# 4AG3U30D0RC019385, State of Alaska License # 9643SR) for the tests indicated below.

Solid and Chemical Materials

Technology	Method	Type
GC-MS	AK101	Gasoline
GC-FID	AK102	Diesel
GC-FID	AK103	Motor
GC-ECD	EPA 8082/8082A	PCB-1016
GC-ECD	EPA 8082/8082A	PCB-1221
GC-ECD	EPA 8082/8082A	PCB-1232
GC-ECD	EPA 8082/8082A	PCB-1242
GC-ECD	EPA 8082/8082A	PCB-1248
GC-ECD	EPA 8082/8082A	PCB-1254
GC-ECD	EPA 8082/8082A	PCB-1260
GC-ECD	EPA 8082/8082A	PCB-1262

Solid and Chemical Materials

Technology	Method	Type
GC-ECD	EPA 8082/8082A	PCB-1268
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	2-Chloroethylvinylether
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Acetone
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	Chlorobromomethane

Solid and Chemical Materials

Technology	Method	Type
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethylene Dibromide
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	Methyl Ethyl Ketone
GC/MS	EPA 8260B/8260C	Methyl Isobutyl Ketone
GC/MS	EPA 8260B/8260C	Methyl tert-butyl ether
GC/MS	EPA 8260B/8260C	Methylene Chloride
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	N-Propylbenzene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	Vinyl Acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthylene

Solid and Chemical Materials

Technology	Method	Type
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[b]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[g,h,i]perylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[k]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Indeno[1,2,3-cd]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pyrene
Preparation	**Method**	**Type**
Ultrasonic Extraction	EPA 3550B	Semivolatile and Nonvolatile Organics
Sulfuric Acid Cleanup	EPA 3665A	Cleanup for Quantitation of PCBs
Purge and Trap	EPA 5035A	Volatile Organic Compounds
Microwave Extraction	EPA 3546	Semivolatile and Nonvolatile Organics
Silica Gel Cleanup	EPA 3630C	Column Cleanup

This accreditation covers testing performed at the main laboratory listed above, and a mobile laboratory (VIN# 4AG3U30D9RC019532, State of Alaska License # 9644SR) for the tests indicated below.

Solid and Chemical Materials

Technology	Method	Type
GC-MS	AK101	Gasoline
GC-FID	AK102	Diesel
GC-FID	AK103	Motor Oil
GC-ECD	EPA 8082/8082A	PCB-1016
GC-ECD	EPA 8082/8082A	PCB-1221
GC-ECD	EPA 8082/8082A	PCB-1232
GC-ECD	EPA 8082/8082A	PCB-1242
GC-ECD	EPA 8082/8082A	PCB-1248
GC-ECD	EPA 8082/8082A	PCB-1254
GC-ECD	EPA 8082/8082A	PCB-1260
GC-ECD	EPA 8082/8082A	PCB-1262
GC-ECD	EPA 8082/8082A	PCB-1268
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-Chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	2-Chloroethylvinylether
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Acetone

Solid and Chemical Materials

Technology	Method	Type
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	Chlorobromomethane
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethylene Dibromide
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	Methyl Ethyl Ketone
GC/MS	EPA 8260B/8260C	Methyl Isobutyl Ketone
GC/MS	EPA 8260B/8260C	Methyl tert-butyl ether
GC/MS	EPA 8260B/8260C	Methylene Chloride
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	N-Propylbenzene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene

Solid and Chemical Materials

Technology	Method	Type
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	Vinyl Acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	1-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	2-Methylnaphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Acenaphthylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[a]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[b]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[g,h,i]perylene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Benzo[k]fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Indeno[1,2,3-cd]pyrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270C SIM EPA 8270D SIM	Pyrene
Preparation	**Method**	**Type**
Ultrasonic Extraction	EPA 3550B	Semivolatile and Nonvolatile Organics
Sulfuric Acid Cleanup	EPA 3665A	Cleanup for Quantitation of PCBs

Solid and Chemical Materials

Technology	Method	Type
Purge and Trap	EPA 5035A	Volatile Organic Compounds
Microwave Extraction	EPA 3546	Semivolatile and Nonvolatile Organics
Silica Gel Cleanup	EPA 3630C	Column Cleanup

Notes:

1) This laboratory offers commercial testing service.
2) This scope is formatted as part of a single document including Certificate of Accreditation No. L2236.

R.D.

Vice President

Appendix C
Laboratory Standard Operating Procedures

SOP 49	**Revision: 10**	**Supersedes: 9**
PREPARATION AND ANALYSIS FOR THE DETERMINATION OF PER and POLY-FLUORINATED COMPOUNDS		
Analyst Review:		
Management: Martha Maier		
Quality Assurance:		
Effective Date: June 14, 2017		

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Revision No.	Revision Date	Description of Revision
6	08/14/2015	Added Section 4.9: Two PFOS transitions are monitored for. Added Section 4.14: Using EDL to check sensitivity. Added Section 14.5.7: Estimated Detection Limits.
7	03/07/2016	Updated 11.2.2: Changed the allowable limits for the method blank, 11.7.2: Second Source Standards must be within 25% of true value, 14.2.1: changed at least 5 points to at least 6 points in ICAL. Updated section 11.3.4 with internal standard requirements. Section 13.3: Updated wash solvent
8	07/27/2016	Removed sections 13.3.2, 14.5.7 Modified sections 13.3 Updated sections 2.2, 8.20-8.22, 12.1.3, 13.3.1.2, 13.4.1, 13.5.2, 14.1, 14.2.1, 12, 13.5.1, 13.5.2, 14.1. All tables have been updated with the most recent information. Added curve requirement to section 14.2.1.
9	06/08/2017	General revisions of all sections including tables and values.
10	06/14/2017	Updated sections: 4; 12.1.1; 13.1.2; 13.1.3; 13.1.4; 13.2.3.2; 13.5.4; Table 3. New sections: 4.12; 19; 20; 21.

1. PURPOSE

1.1. This SOP outlines and describes the preparative and analytical techniques used for the determination of per and poly-fluorinated compounds (PFAS).

2. SCOPE

2.1. All differences between EPA 537, ISO 25101 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.

2.2. Data determined to be out-of-control from criteria stated within this SOP, is handled according to procedures addressed within the applicable section.

Compound	**CAS Registry No.***
Perfluorobutanesulfonic acid (PFBS)	375-73-5
Perfluoroheptanoic acid (PFHpA)	375-85-9
Perfluorohexanesulfonoic acid (PFHxS)	355-46-4
Perfluorohexanoic acid (PFHxA)	307-24-4
Perfluorooctanesulfonic acid (PFOS)	1763-23-1
Perfluorooctanoic acid (PFOA)	355-67-1
Perfluorobutanoic acid (PFBA)	375-22-4
Perfluoroheptanesulfonate (PFHpS)	60270-55-5
Perfluorodecanesulfonate (PFDS)	13419-61-9
Perfluoropentanoic acid (PFPeA)	2706-90-
Perfluorononaoic acid (PFNA)	375-95-1
Perfluoroundecanoic acid (PFUnA)	2058-94-8
Perfluorodecanoic acid (PFDA)	335-76-2
Perfluorododecanoic acid (PFDoA)	307-55-1
Perfluorotridecanoic acid (PFTrDA)	72629-94-8
Perfluorotetradecanoic acid (PFTeDA)	376-06-7
Perfluorohexadecanoic acid (PFHxDA)	67905-19-5
Perfluorooctadecanoic acid (PFODA)	16517-11-6
6:2 Fluorotelomer sulfanate (6:2 FTS)	27619-97-2
8:2 Fluorotelomer sulfanate (8:2 FTS)	39108-34-4
N-methylperfluoro-1-octanesulfonamide (N-MeFOSA)	31506-32-8
N-ethylperfluoro-1-octanesulfonamide (N-EtFOSA)	4151-50-2
Perfluorooctane sulfonamide (PFOSA)	754-91-6
N-methylperfluoro-1-octanesulfonamido ethanol (N-MeFOSE)	24448-09-7
N-ethylperfluoro-1-octanesulfonamido ethanol (N-EtFOSE)	1691-99-2
N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	2991-50-6
N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	2355-31-9

*Chemical Abstract Service

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3. SUMMARY OF METHOD

3.1. This procedure uses ultra-performance liquid chromatography/tandem mass spectrometry (UPLC/MS/MS) for detection and quantitation of per and poly-fluorinated compounds, commonly referred to as PFAS.

3.2. All differences between the method and actual laboratory techniques have been developed to reduce interferences and increase sensitivity.

3.3. Detection limits are sample-specific and congener-specific.

4. MODIFICATIONS

4.1. Calibration standards made using methanol and water.

4.2. The extraction volume for aqueous samples is 125mLs, but can be up to 1 L.

4.3. The internal standard (IS) is not spiked directly into the sample bottle. The IS is spiked into a test tube containing methanol. Then the test tube is poured into the sample bottle.

4.4. Isotope dilution technique is utilized.

4.5. Surrogates are not used.

4.6. Samples follow the IS recovery limits listed in Table 3.

4.7. SPE extracts are concentrated to near dryness and reconstituted in MeOH and 2mM NH_4OAc in H2O.

4.8. Symmetry of peaks not calculated due to the greatly improved chromatography of UPLC versus HPLC.

4.9. MS/MSD and duplicate samples are performed upon client request.

4.10. The SPE cartridge used is a polymeric weak anion cartridge and therefore requires the reagents used in the SPE procedure.

4.11. The calculation of the detection limit, SOP Section 15.2, differs from Section 9.2.7 in EPA Method 537, version 1.1, September 2009.

4.12. The OPR is spiked at a static, mid-level concentration.

4.13. Continuing calibration standards are not rotated between a mid and a high concentration.

4.14. Spiked samples are equilibrated for at least 30 minutes before extraction.

5. CONTAMINATION AND INTERFERENCES

5.1. Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts or elevated baselines that may cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interfering substances under the conditions of analysis by performing laboratory method blanks. Analysts should avoid using materials containing PTFE, where possible.

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5.2. All differences between EPA 537, ISO 25101 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.

5.3. The use of high purity reagents and solvents helps to minimize interference problems.

5.4. Interferants co-extracted from the sample will vary considerably from matrix to matrix.

6. DEFINITIONS

6.1. Definitions are presented in the Glossary.

7. SAFETY

7.1. Procedures shall be carried out in a manner that protects the health and safety of all Vista employees.

7.2. Each chemical compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. All compounds or reagents should be handled only by highly trained personnel thoroughly familiar with handling and cautionary procedures and the associated risks.

7.3. Additional health and safety information can be obtained from safety data sheets (SDS) available to all personnel involved in these analyses.

7.4. In the event of a known or potential compromise to the health and safety of a Vista associate, all work must stop and the incident reported immediately to management.

7.5. Contamination of the laboratory will be minimized by conducting most of the manipulations in a hood

7.6. The toxicity or carcinogenicity of each chemical used in this method has not been precisely determined; however, each compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of MSDS should also be made available to all personnel involved in these analyses.

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8. APPARATUS AND MATERIALS

Note: All materials used should be suitable for LC work, and comparable brand materials can be substituted where specific brands are mentioned.

8.1. Analytical Balances, capable of reading to 0.01g and 0.0001g

8.2. Solid Phase Extraction Manifold (Waters)

8.3. [redacted]

8.4. Silicone tubing, 1/16” diameter, various lengths (Nalgene)

8.5. Screw top polypropylene LC vials, 12x32mm (Waters)

8.6. Screw top high recovery glass LC vials, 12x32mm (Phenomenex)

8.7. HDPE Bottle various sizes (Nalgene)

8.8. Screw caps with pre-slit polypropylene septa, for 12x32mm vials (Waters)

8.9. Disposable polypropylene Pasteur pipets, various sizes

8.10. Chlorine test strips (Hach Aquacheck, or equivalent)

8.11. Organomation 24-Station N-Evaporator with water bath [redacted]

8.12. Polypropylene centrifuge tubes, 13 mm x 100 mm

8.13. Wiretrol II Precision Disposable Micropipettes

8.14. Sonicator, VWR, Model 150T

8.15. Eppendorf Centrifuge, Model 5804

8.16. [redacted]

8.17. Acquity PFC Isolator Column (Waters)

8.18. Acquity Ultra Performance LC (Waters)

8.19. Lenovo computer work station with MassLynx Software

8.20. Quattro Premier XE with Micromass Technology (Waters)

8.21. Shimadzu Nexera X2 UHPLC LC System (Shimadzu USA)

8.22. Dell Optiplex XE2 computer work station with Analyst and MultiQuant Software

8.23. 4000 Q Trap (Sciex)

8.24. AB SCIEX API 4000 Triple Quadrupole Mass Spectrometer
8.25. Waters Mass Spectrometer (TQTMS) MS/MS

9. REAGENTS, SOLVENTS AND STANDARDS

9.1. Reagents (HPLC grade or above)

9.1.1. Trizma pre-set crystals (Supelco cat #T-7193)
9.1.2. Sodium Acetate, HPLC grade
9.1.3. Ammonium Acetate, HPLC grade
9.1.4. Ammonium Hydroxide, Concentrated
9.1.5. Formic Acid, Concentrated
9.1.6. Ultra-pure nitrogen gas
9.1.7. Ultra-pure argon gas
9.1.8. [redacted]

9.2. Solvents (HPLC Grade or above)

9.2.1. Reagent Water
9.2.2. Acetonitrile (ACN)
9.2.3. Hexane (for cleaning)
9.2.4. Methanol (MeOH)

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9.2.5. Methylene chloride (DCM)

9.2.6. Acetone

9.2.7. Isopropyl Alcohol (IPA)

9.3. Standards

9.3.1. All analytical standards are obtained from a certified vendor.

9.3.2. See SOP 15 and the current spike sheet for more information.

10. COLLECTION, PRESERVATION, AND HANDLING

10.1. HDPE or polypropylene bottles and jars must be used for collection.

10.2. Trizma is added to the sample bottles prior to the collection of drinking water samples in the amount of 5.0g/L.

10.3. Aqueous samples must be extracted within 14 days of collection and analyzed within 28 days of extraction.

10.4. Solid and Tissue samples must be extracted within 60 days from collection and analyzed within 30 days of extraction. No hold times have been established for tissue samples.

10.5. Store at < 6°C.

11. QUALITY CONTROL

11.1. Each time a modification is made to this method and the detection limit will be affected by the change, the laboratory is required to demonstrate that the MDL is lower than one-third the regulatory compliance level or one-third the method reporting limit (MRL) in the method, whichever is higher.

11.2. Instrument Blank: Instrument blank is analyzed immediately following the highest standard analyzed and daily prior to sample analysis.

11.2.1. Concentration of each analyte must be < ½ the LOQ.

11.2.2. 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.

11.3. Method Blank (MB): Method blank is a matrix preparation that is free of native analyte that has been prepared and analyzed using the same procedures followed for the rest of the analytical batch. Simulate as close as possible the matrix to be extracted.

11.3.1. Daily or with each extraction batch of up to 20 samples, (whichever is more frequent).

11.3.2. For the determination of native PFAS, the levels measured in the method blank of all method analytes must be below 1/2 the LOQ or less than 1/10th the amount measured in any sample or 1/10th the regulatory limit whichever is greater.

11.3.3. If amount found is greater than the minimum level or one-third the regulatory compliance limit, whichever is greater; or if any potentially interfering compound is found in the blank at or above the minimum level for each congener, the data must be evaluated to determine whether the batch shall be re-extracted or the data are qualified appropriately.

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11.3.4. If there is evidence of contamination within the MB, then the source of the contamination must be located. The data must be evaluated to determine whether the batch shall be re-extracted or the data is qualified appropriately.

11.4. Ongoing Precision and Recovery Samples (OPR): An ongoing precision and recovery sample is prepared by adding a known quantity of native standards to an interferant free matrix and used to assess method performance (precision and recovery).

11.4.1. Add the appropriate amount of native spike. The native spikes contain the compounds listed in Table 1.

11.4.2. Native spike includes quantitative standards for PFOS and PFHxS containing both the linear and branched isomers.

11.4.3. An OPR is analyzed with every analytical batch.

11.4.4. The OPR % recoveries for native and internal standards must be within the limits shown in Table 3.

11.4.5. If the percent recovery of the native or, two or more of the internal standards of an isomer in the OPR is out of method limits, it is recommended that the sample(s) be re-extracted and/or re-analyzed.

11.5. Matrix Spike (MS/MSD): A matrix spike sample is prepared by adding the appropriate quantity of native standards to a sample matrix prior to extraction. MS/MSD's are performed by client request. For DoD projects, MS and MSD samples are required per preparatory batch.

11.5.1. The relative percent difference (RPD) between MS/MSD samples should be 30%.

11.5.2. If RPD does not meet the acceptance criteria, the data is evaluated and qualified appropriately.

11.6. Duplicate Samples: Duplicate samples are two separate aliquots taken from the same source.

11.6.1. Duplicate samples are analyzed independently to assess laboratory precision. Duplicate samples are performed by client request and on all samples prepared by serial dilution.

11.6.2. The relative percent difference between duplicate samples should be ≤30%.

11.6.3. If the concentration is within a factor of 2 of the MRL, the relative percentage difference (RPD) must be ≤ 50%.

11.6.4. If the RPD does not meet the acceptance criteria, the data are evaluated and qualified appropriately.

11.7. Field Reagent Blank (FRB): A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples. FRB's are performed upon client request.

11.7.1. Analysis of the FRB is only necessary if a Field Sample contains a method analyte at or above the MRL.

11.8. Second source standard: Analytes from a different source than that of the calibration standards. This is prepared and analyzed in the same way as a CCC.

11.8.1. This is analyzed with every calibration curve.

11.8.2. The calculated value for the second source standard must be within ±30% of the expected true value.

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12. SAMPLE PREPARATION

12.1. pH Determination

12.1.1. Obtain a pH strip and pour sample directly onto it.

12.1.2. Check the color on the strip against the color chart on the pH container.

12.1.3. [redacted]

13. EXTRACTION PROCEDURES

13.1. Aqueous Samples

13.1.1. Record the combined weight of the bottle, cap and sample for each sample to be extracted. After the sample has been removed from the bottle, allow it to drain overnight and reweigh it and the cap to determine the amount of sample extracted.

13.1.2. For the method blank (MB) and OPR(s), transfer [redacted] reagent water into a bottle for each.

13.1.3. [redacted]

13.1.4. Add the appropriate volume of Internal Standard (IS) solution and the appropriate volume of Native Standard (NS) solution to OPR, MS or MSD. Allow the spiked samples to equilibrate for at least 30 minutes before extraction.

13.2. Solid/Tissue Samples

13.2.1. Digestion

13.2.1.1. Weigh out [redacted] solid or well ground fish/tissue into a polypropylene test tube

13.2.1.2. Add the appropriate volume of Internal Standard (IS) solution and the appropriate volume of Native Standard (NS) solution to OPR, MS, or MSD.

13.2.1.3. Add [redacted] then vortex.

13.2.1.4. Sonicate [redacted]

13.2.1.5. [redacted]

13.2.2. Neutralization

13.2.2.1. Add [redacted] Hydrochloric Acid, vortex briefly.

13.2.3. Extraction

13.2.3.1. [redacted]

13.2.3.2. [redacted]

13.2.3.3. Decant [redacted]

13.2.3.4. Repeat the extraction process (13.2.3)

13.3. SPE Cleanup

13.3.1. Assemble the SPE apparatus and attach the SPE cartridges as shown in the appendix A, Figure 1.

13.3.2. Condition the cartridges by eluting with [redacted] methanol. Discard eluant.

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13.3.3. Condition the cartridge with [redacted] reagent water. Discard eluant.

13.3.4. Load sample onto cartridge by way of siphon, [redacted]

13.3.5. Once sample has passed through, rinse bottle with reagent water and re-siphon.

13.3.6. Upon completion of siphon wash cartridge [redacted]

13.3.7. Dry the cartridge under vacuum [redacted]

13.4. Cartridge Elution

13.4.1. Rinse bottle [redacted] Use these rinses to elute cartridge. Collect extracts eluted from the column into clean test tube containing the appropriate amount of RS.

13.5. Envi-Carb Clean-up (optional)

13.5.1. Condition cartridge [redacted]

13.5.2. Load Sample

13.5.3. Collect immediately.

13.5.4. Elute with [redacted] into a test tube with RS.

13.6. Adjustment to Final Volume

13.6.1. Concentrate extract [redacted]

13.6.2. [redacted]

13.6.3. [redacted]

13.6.4. If cloudy, [redacted]

14. LC/MS ANALYSIS

14.1. Full mass calibration is performed initially prior to use and after performing major maintenance, or at least annually.

14.1.1. The mass scale of the MS is calibrated with the compounds and procedures described by the manufacturer.

14.2. All compounds are tuned during the set-up of the method. When masses fall outside of the ±0.5 amu of the true value, the compound must be retuned.

14.3. A minimum of 10 spectra scans are acquired across each chromatographic peak for all analytes, internal standards and recovery standards.

14.4. Establish the necessary conditions. The LC conditions may be optimized for compound separation and sensitivity. Once optimized, the same LC conditions must be used for the analysis of all standards, blanks, OPR aliquots, and samples. The following LC operating conditions are guidance and adjustments may be required.

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14.5. Instrument: Aquity UPLC/ Waters Quattro Premier XE

Column: [redacted]
Ionization: Negative Ion Electrospray
Acquisition: MRM mode, unit resolution
Injection Volume: 5-15µL

[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
MS Conditions	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

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14.6. Instrument: Shimadzu DGU-20Asr/Sciex 4000 Q trap

Column: [redacted]
Ionization: Negative Ion Electrospray
Acquisition: MRM mode, unit resolution
Injection Volume: 1-5 µL

General LC Conditions	
Column [redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
MS Conditions	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
MS Conditions	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

LC Gradient Program			***LC Gradient Program***	**Parameter**	
Time (min)	**Flow Mixture***				Events
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

14.7. Instrument: Aquity UPLC/ Waters TQS-Micro

Column: [redacted]

Ionization: Negative Ion Electrospray

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Acquisition: MRM mode, unit resolution
Injection Volume: 1-5µL

General LC Conditions	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
MS Conditions	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

LC Gradient Program			*LC Gradient Program*	Gradient
Time (min)	Flow Mixture*			
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

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14.8. Initial Calibration (ICAL)

14.8.1. An initial calibration curve is created using either a linear or quadratic regression over the calibration range and consisting of at least 5 points for linear and 6 points for quadratic. This curve must be forced through zero. An initial calibration is repeated at least annually, whenever a new set of spiking calibration standards is created or whenever the continuing calibration falls outside the acceptance criteria. [redacted]

14.8.1.1. Establish the operating conditions suggested in Section 14.4

14.8.2. The following retention time criterion must be met:

14.8.2.1. The absolute retention time of the last-eluted compound, must be ±0.5% of its targeted value.

14.8.3. The Coefficient of determination for all native compounds must be ≥ to 0.99.

14.8.4. RSD requirements are ≤20% for all internal standards

14.8.5. The following analyte recovery criteria must be met: Each calibration point for each analyte must calculate to be with 70-130%

14.8.6. The S/N Ratio must be > 10:1 for all ions used for quantification. For all analytes with a qualitative transition ion, the S/N ratio must be ≥ 3:1.

14.9. Continuing Calibration

14.9.1. A continuing calibration check (CCC) must be analyzed at the beginning, after every 10 samples and at the end of each analytical run. The beginning CCC must be at the LOQ level, and all subsequent CCCs should be at a midlevel concentration. Additionally, a CCC at the LOQ level must be run every 12 hours.

14.9.2. The continuing calibration verification is acceptable if the following criteria are met:

14.9.2.1. The LC peak representing each native ion used for quantification and labeled compound must be present with a S/N ≥10, for all qualitative ions, the S/N ratio must be ≥ 3:1.

14.9.2.2. The percent recovery for native standards and the internal standards must be within the limits shown in Table 3.

14.9.2.3. The retention times for internal compounds must be within ± 15 seconds of the respective retention times in the most recent CCC.

14.9.2.4. If the CCC fails because the calculated concentration is greater than 130% for a particular method analyte, and Field Sample extracts show no detection for that method analyte, non-detects may be reported without re-analysis.

14.10. Qualitative Determination

14.10.1. The signal to noise ratio (S/N) at the LC peak maximum for each native compound must be greater than or equal to 3:1 for each compound detected in a sample extract.

14.10.2. The retention time of the peak for a native compound must be within ±15 seconds of its RT in the most recent CCC standard.

14.11. Quantitative Determination

14.11.1. Calibration by Isotope Dilution: Isotope dilution calibration is used for the native PFAS for which labeled compounds are available. If an isotope is available and not used, the reason must be technically justified.

14.11.2. Native compounds should have a retention time within 0.1 mins. of its equivalent internal standard.

14.11.3. Recovery of each internal standard versus the recovery standard must be within the limits shown in Table 3.

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14.11.4. Recovery standard peak areas must be within -50% to +50% of the area measured in the ICAL midpoint standard. On days when ICAL is not performed, the peak areas must be within -50% to +50% of the peak area measured in daily beginning CCC.

14.11.5. If recovery standard recoveries are acceptable for QC samples, but not field samples, the field samples must be re-prepared and re-analyzed (greater dilution may be needed). If recoveries are unacceptable for QC samples, correct problem and reanalyze all associated failed field samples.

14.11.6. Recoveries below the limits may be accepted if the signal to noise is >10:1. If the signal to noise is not >10:1, samples must be re-extracted and re-analyzed or the data must be qualified.

14.11.7. If the concentration of any of the analytes exceeds the concentration of the highest calibration point, a dilution of the extract must be analyzed.

14.11.8. PFHxS, PFOA, PFOS, N-MeFOSAA and N-EtFOSAA have both linear and branched isomers. All chromatographic peaks for these compounds are integrated and the areas totaled. Technical mixtures are referenced when commercially available.

15. CALCULATIONS

15.1. The concentrations of native compounds are determined by quadratic regression:

$$NRR = \frac{A_x}{A_y} Q_y$$

Where:

NRR = Normalized relative response

Ax = Area of the quantitation ion for the native compound in sample

Ay = Area of the quantitation ion for the labeled compound in sample

Qy = Quantity of Internal Standard in sample

15.1.1. Determine the calibration equation for each compound by regressing the NRR against the native compound concentration (See Appendix B).

15.1.2. The curve may be concentration weighted based on the analysts discretion.

15.2. The concentration of each internal standard is calculated as follows:

$$C_{Samp} = \frac{A_x Q_y}{A_y RRF S_W}$$

Where:

CSamp = Concentration of compound in sample

Ax = Area of the quantitation ion for the native compound in sample

Ay = Area of the quantitation ion for the labeled compound in sample

Qy = Quantity, in pg, of Internal Standard in sample

SW = Sample weight
RRF = Relative response factor, a sum of the response factors (RF):

$$\sum RF = \frac{A_n C_l}{A_l C_n}$$

Where:
Cl = Internal Standard Concentration at the curve point
Ax = Area of daughter m/z for native compound
Al = Area of daughter m/z for labeled compound
Cn = Concentration of Native Standard at the curve point

15.3. Internal standard recoveries are calculated by using the formula:

$$\%Rec = \frac{(A_{IS})(Q_{RS}) \times 100}{(A_{RS})(Q_{IS})(RRF_{IS})}$$

Where:
AIS = Area of the quantitation ion for the internal standard.
ARS = Area of the quantitation ion for the recovery standard.
QIS = Quantity of the internal standard.
QRS = Quantity of the recovery standard.
RRFIS = Calculated relative response factor for the internal std. analyte.

15.4. RRF for labeled analytes (RRFIS):

$$RRF_{IS} = \frac{(A_{IS})(Q_{RS})}{(Q_{IS})(A_{RS})}$$

Where:
AIS = Sum of the integrated ion abundances of the quantitation ions for the labeled standards
ARS = Sum of the integrated ion abundances of the quantitation ions for the labeled recovery standards
QIS = Quantity of internal standard injected (pg)
QRS = Quantity of recovery standard injected (pg)

15.5. The RPD is calculated as follows:

$$RPD = \frac{(H - L)}{(H + L)/2} * 100$$

Where:
RPD = Relative Percentage Difference
H = Highest area

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L = Lowest area

16. POLLUTION PREVENTION

16.1. The solvent evaporation techniques used in this method are amenable to solvent recovery, and the laboratory shall recover solvents wherever feasible.

16.2. Standards should be prepared in volumes consistent with laboratory use to minimize disposal of standard.

17. WASTE MANAGEMENT

17.1. Waste generated in the procedure must be segregated and disposed according to the facility hazardous waste procedures. Safety officer should be contacted if additional information is required.

17.2. The laboratory waste management is in compliance with all federal, state, and local regulations to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations

18. METHOD PERFORMANCE

18.1. This SOP is based on methods noted as references (Section 19).

19. EQUIPMENT/INSTRUMENT MAINTENANCE

19.1. Equipment/Instrument maintenance is performed in accordance with SOP 10 “Instrument Maintenance Logbooks and Schedule”.

19.2. Records of maintenance are kept in instrument logbooks.

20. COMPUTER HARDWARE AND SOFTWARE

20.1. MassLynx

20.2. Analyst 1.6.2

21. TROUBLESHOOTING

21.1. Troubleshooting is performed in accordance with Instrument Manuals:

- 21.1.1. ACQUITY UPLC system maintenance (Waters)
- 21.1.2. Waters Micromass Quattro Premier XE Mass Spectrometer Operator’s guide
- 21.1.3. MassLynx 4.1 Manual and Documents
- 21.1.4. SHIMADZU LC-30AD Instruction Manual
- 21.1.5. SHIMADZU System Guide
- 21.1.6. SHIMADZU CTO-20A, 20AC Instruction Manual
- 21.1.7. SHIMADZU DGU-20A3R, 20A5R Instruction Manual
- 21.1.8. Line adjustment Transformer Instruction Manual

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21.1.9. Eppendorf operating manual for Multipipet M4, Repeater M4

21.1.10. AB SCIEX API 4000 Triple Quadrupole Mass Spectrometer (Q-3) 2017

21.1.11. Waters Acquity Mass Spectrometer (TQTMS) MS/MS Q-4 2017

21.1.12. Eppendorf operating manual for Multipipet M4, Repeater M4

22. REFERENCES

22.1. ISO 25101:2009 – Water Quality – Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanonate (PFOA) – Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry, 1st edition, Dated March 2009.

22.2. EPA 821-R-11-007- Draft Procedure for Analysis of Perfluorinated Carboxylic Acids and Sulfonic Acids in Sewage Sludge and Biosolids by HPLC/MS/MS, Draft, December 2011.

22.3. Method 537, Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), Version 1.1, September 2009.

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Table 1
Calibration Curve Concentration (pg/μL)

Compound	CS(-2)	CS(-1)	CS0	CS1	CS2	CS3	CS4	CS5
PFBS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFHpA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFHxS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFHxA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFOS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFOA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFBA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFHpS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFDS (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFPeA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFDA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFNA (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFUdA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFDoA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFTrDA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFTeDA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFHxDA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
PFODA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
6:2 FTS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
8:2 FTS (A)	0.25	0.5	1.0	2.0	5.0	10	50	100
N-MeFOSA(B)	1.25	2.5	5.0	10	25	50	250	500
N-EtFOSA(B)	1.25	2.5	5.0	10	25	50	250	500
PFOSA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
N-MeFOSE(B)	1.25	2.5	5.0	10	25	50	250	500
N-EtFOSE (B)	1.25	2.5	5.0	25	25	50	250	500
N-EtFOSAA (B)	0.25	0.5	1.0	2.0	5.0	10	50	100
N-MeFOSAA(B)	0.25	0.5	1.0	2.0	5.0	10	50	100

** A and B reflects associated FV composition and injection

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Table 1 Continued
Calibration Curve Concentration (pg/μL)

Internal Standard	CS-1	CS0	CS1	CS2	CS3	CS4	CS5	CS6
13C3-PFBA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C3-PFPeA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C3-PFBS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-PFHxA	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
13C2-PFDA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C4-PFHpA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
18O2-PFHxS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-6:2 FTS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-PFOA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C8-PFOS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C5-PFNA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-8:2 FTS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C8-PFOSA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-PFUdA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-PFDoA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
d3-N-MeFOSA	150	150	150	150	150	150	150	150
d7-N-MeFOSE	150	150	150	150	150	150	150	150
d9-N-EtFOSE	150	150	150	150	150	150	150	150
d5-N-EtFOSA	150	150	150	150	150	150	150	150
13C2-PFTeDA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-PFHxDA	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
d5-N-EtFOSAA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
d3-N-MeFOSAA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5

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Table 1 Continued
Calibration Curve Concentration (pg/μL)

Recovery Standard	CS-1	CS0	CS1	CS2	CS3	CS4	CS5	CS6
13C6-PFDA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C4-PFBA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-4:2FTS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C5-PFHxA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C3-PFHxS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C8-PFOA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C4-PFOS	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C9-PFNA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C7-PFUdA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
13C2-FOUEA	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5

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Table 2

Exact Masses Monitored Waters Quattro Premier XE

Compound	Native Parent-Daughter	Internal Standard	Native Parent-Daughter
PFBS	299 - 80	$^{13}C_3$-PFBS	302 - 99
	299 - 99		
PFHpA	363 - 319	$^{13}C_4$-PFHpA	367 - 322
	363 - 169		
PFHxS	399 - 80	$^{18}O_2$-PFHxS	403 - 103
	399 - 99		
PFHxA	313 - 269	$^{13}C_2$-PFHxA	315 - 269
	313 - 119		
PFOS	499 - 80	$^{13}C_8$-PFOS	507 - 80
	499 - 99		
PFOA	413 - 369	$^{13}C_2$-PFOA	415 - 370
	413 - 169		
PFBA	213 - 169	$^{13}C_3$-PFBA	216 - 179
PFHpS	449 - 99	$^{13}C_2$-PFOA	415 - 370
	449 - 80		
PFDS	599 - 99	$^{13}C_2$-PFUdA	565 - 520
	599 - 80		
PFPeA	263 - 219	$^{13}C_3$-PFPeA	266 - 229
PFDA	513 - 469	$^{13}C_2$-PFDA	515 - 470
	513 - 219		
PFNA	463 - 419	$^{13}C_5$-PFNA	468 - 423
	463 - 219		
PFUdA	563 - 519	$^{13}C_2$-PFUdA	565 - 520
	563 - 269		
PFDoA	613 - 319	$^{13}C_2$-PFDoA	615 - 570
	613 - 569		
PFTrDA	663 - 619	$^{13}C_2$-PFDoA	615 - 570
	663 - 319	$^{13}C_2$-PFTeDA	715 - 670
PFTeDA	713 - 669	$^{13}C_2$-PFTeDA	715 - 670
	713 - 369		
PFHxDA	813 - 769	$^{13}C_2$-PFHxDA	815 - 770
	813 - 219		
PFODA	913 - 869	$^{13}C_2$-PFHxDA	815 - 770
6:2 FTS	427 - 407	$^{13}C_2$-6:2 FTS	429 - 409
	427 - 80		
8:2 FTS	527 - 507	$^{13}C_2$-8:2 FTS	529 - 509
	527 - 80		
N-MeFOSA	512 - 169	d_3-N-MeFOSA	515 - 169
	512 - 219		

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Compound	Native Parent-Daughter	Internal Standard	Native Parent-Daughter
N-EtFOSA	526 - 169	d_5-N-EtFOSA	531 - 169
	526 - 219		
PFOSA	498 - 79	$^{13}C_8$-PFOSA	506 - 78
	498 - 478		
N-MeFOSE	616 - 59	d_7-N-MeFOSE	623 - 59
N-EtFOSE	630 - 59	d_9-N-EtFOSE	639 - 59
N-EtFOSAA	584 - 419	d_5-N-EtFOSAA	589 - 419
	584 - 483		
N-MeFOSAA	570 - 419	d_3-N-MeFOSAA	573 - 419
	570 - 483		
Recovery Standard			
$^{13}C_6$-PFDA	519 - 474	NA	NA
$^{13}C_2$-FOUEA	459 - 394	NA	NA
$^{13}C_4$-PFBA	217 - 179	NA	NA
$^{13}C_2$-4:2 FTS	329 - 309	NA	NA
$^{13}C_8$-PFOA	421 - 376	NA	NA
$^{13}C_5$-PFHxA	318 - 273	NA	NA
$^{13}C_3$-PFHxS	402 - 80	NA	NA
$^{13}C_4$-PFOS	503 - 80	NA	NA
$^{13}C_9$-PFNA	472 - 427	NA	NA
$^{13}C_7$-PFUdA	570 - 525	NA	NA

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Table 3
Acceptance Criteria for Performance Tests

Compound	CCC	IPR		OPR %	Labeled compound recovery in samples %
		RSD %	Ave %		
PFBA	70-130	20	70-130	70-130	NA
PFPeA	70-130	20	70-130	70-130	NA
PFBS	70-130	20	70-130	70-130	NA
PFHxA	70-130	20	70-130	70-130	NA
PFHpA	70-130	20	70-130	70-130	NA
PFHxS	70-130	20	70-130	70-130	NA
6:2 FTS	70-130	20	60-130	60-130	NA
PFOA	70-130	20	70-130	70-130	NA
PFHpS	70-130	20	60-130	60-130	NA
PFOS	70-130	20	70-130	70-130	NA
PFNA	70-130	20	70-130	70-130	NA
PFDA	70-130	20	70-130	70-130	NA
8:2 FTS	70-130	20	60-130	60-130	NA
PFOSA	70-130	20	70-130	70-130	NA
PFDS	70-130	20	60-130	60-130	NA
PFUdA	70-130	20	70-130	70-130	NA
PFDoA	70-130	20	70-130	70-130	NA
N-MeFOSA	70-130	20	70-130	70-130	NA
N-MeFOSE	70-130	20	70-130	70-130	NA
PFTrDA	70-130	20	60-130	60-130	NA
N-EtFOSA	70-130	20	70-130	70-130	NA

Compound	CCC	IPR		OPR %	Labeled compound recovery in samples %
		RSD %	Ave %		
N-EtFOSE	70-130	20	70-130	70-130	NA
PFTeDA	70-130	20	70-130	70-130	NA
PFHxDA	70-130	20	70-130	70-130	NA
PFODA	70-130	20	40-130	40-130	NA
N-EtFOSAA	70-130	20	70-130	70-130	NA
N-MeFOSAA	70-130	20	70-130	70-130	NA
Internal Standards					
$^{13}C_3$-PFBA	50-150	20	50-150	50-150	50-150
$^{13}C_3$-PFPeA	50-150	20	50-150	50-150	50-150
$^{13}C_3$-PFBS	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFHxA	50-150	20	50-150	50-150	50-150
$^{13}C_4$-PFHpA	50-150	20	50-150	50-150	50-150
$^{18}O_2$-PFHxS	50-150	20	50-150	50-150	50-150
$^{13}C_2$-6:2 FTS	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFOA	50-150	20	50-150	50-150	50-150
$^{13}C_8$-PFOS	50-150	20	50-150	50-150	50-150
$^{13}C_5$-PFNA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFDA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-8:2 FTS	50-150	20	50-150	50-150	50-150
$^{13}C_8$-PFOSA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFUnA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFDoA	50-150	20	50-150	50-150	50-150
d_3-N-MeFOSA	50-150	20	50-150	50-150	50-150

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Compound	CCC	IPR		OPR %	Labeled compound recovery in samples %
		RSD %	Ave %		
d_7-N-MeFOSE	50-150	20	50-150	50-150	50-150
d_9-N-EtFOSE	50-150	20	50-150	50-150	50-150
d_5-N-EtFOSA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFTeDA	50-150	20	50-150	50-150	50-150
$^{13}C_2$-PFHxDA	50-150	20	50-150	50-150	50-150
d_5-N-EtFOSAA	50-150	20	50-150	50-150	50-150
d_3-N-MeFOSAA	50-150	20	50-150	50-150	50-150

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Table 4
Reporting Limits

Compound	RL Aqueous (ng/L)	RL Solid (ng/g)	RL Tissue (ng/g)
PFBS	8.0	2.0	2.0
PFHpA	8.0	2.0	2.0
PFHxS	8.0	2.0	2.0
PFHxA	8.0	2.0	2.0
PFOS	8.0	2.0	2.0
PFOA	8.0	2.0	2.0
PFBA	8.0	2.0	2.0
PFHpS	8.0	2.0	2.0
PFDS	8.0	2.0	2.0
PFPeA	8.0	2.0	2.0
PFDA	8.0	2.0	2.0
PFNA	8.0	2.0	2.0
PFUdA	8.0	2.0	2.0
PFDoA	8.0	2.0	2.0
PFTrDA	8.0	2.0	2.0
PFTeDA	8.0	2.0	2.0
PFHxDA	8.0	2.0	2.0
PFODA	8.0	2.0	2.0
6:2 FTS	8.0	2.0	2.0
8:2 FTS	8.0	2.0	2.0
N-MeFOSA	40	10	10
N-EtFOSA	40	10	10
PFOSA	8.0	2.0	2.0
N-MeFOSE	40	10	10
N-EtFOSE	40	10	10
N-MeFOSAA	8.0	2.0	2.0
N-EtFOSAA	8.0	2.0	2.0

*RL's based on 125mLs for aqueous samples and 1g for solids and tissues.

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Glossary

Analyte – Compound of interest. The analytes are listed in Table 1.

Calibration Standard – A solution prepared from a stock solution and used to calibrate the response of the HPLC/MSMS.

Calibration Verification Standard (CCC) – Calibration Standard containing a known concentration of native analytes, internal standard and recovery standards. This is analyzed to verify the accuracy of the existing calibration for those analytes.

Field Reagent Blank – A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples

Internal Standard – A labeled compound used as a reference for quantitation of other labeled and native compounds.

IPR – Initial precision and recovery; four aliquots of a reference material spiked with analytes of interest are analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed anytime the method or instrumentation is modified.

Isotope dilution quantitation – Determination of a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. This method employs ^{2}H or ^{13}C labeled analogs which are spiked into each sample

LC – Liquid chromatography

Labeled Compound – A molecule in which one or more of the atoms is isotopically enriched, thereby increasing the mass of the molecule

Laboratory Blank – See method blank.

May – This action, activity, or procedural step is neither required nor prohibited.

May Not – This action, activity, or procedural step is prohibited.

Method Blank – An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with samples. The method blank is used to determine if analytes or interferences are present in the laboratory environment, the reagents, or the apparatus.

Method Detection Limit (MDL) – The lowest concentration at which an analyte can be detected under routine operating conditions (see 40 CFR 136, Appendix B).

MS – Mass spectrometer or mass spectrometry.

Must – This action, activity, or procedural step is required.

Native Compound – A molecule in which all atoms have naturally occurring isotopic abundances

OPR – Ongoing precision and recovery sample (OPR); a laboratory blank spiked with known quantities of analytes. The OPR is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery.

Reagent Water – Water demonstrated to be free from the analytes of interest and potentially interfering substances at the method detection limit for the analyte.

Relative Standard Deviation (RSD) – The standard deviation times 100 divided by the mean. Also termed "coefficient of variation."

RPD – Relative Percent Difference shown

RF – Response factor.

RRF – Relative response factor.

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Should – Although this action, activity, or procedural step is suggested, it is not required.
SICP – Selected ion current profile; the line described by the signal at an exact m/z.
Signal-to-noise ratio (S/N) – The height of the signal as measured from the mean of the noise to the peak maximum divided by the width of the noise.
SPE – Solid-phase extraction; an extraction technique in which an analyte is extracted from an aqueous sample by passage over or through a material capable of reversibly adsorbing the analyte.
Stock Solution – A solution containing an analyte that is prepared using a reference material traceable to EPA, the National Institute of Science and Technology (NIST), or a source that will attest to the purity and authenticity of the reference material.
UPLC – Ultra performance liquid chromatography

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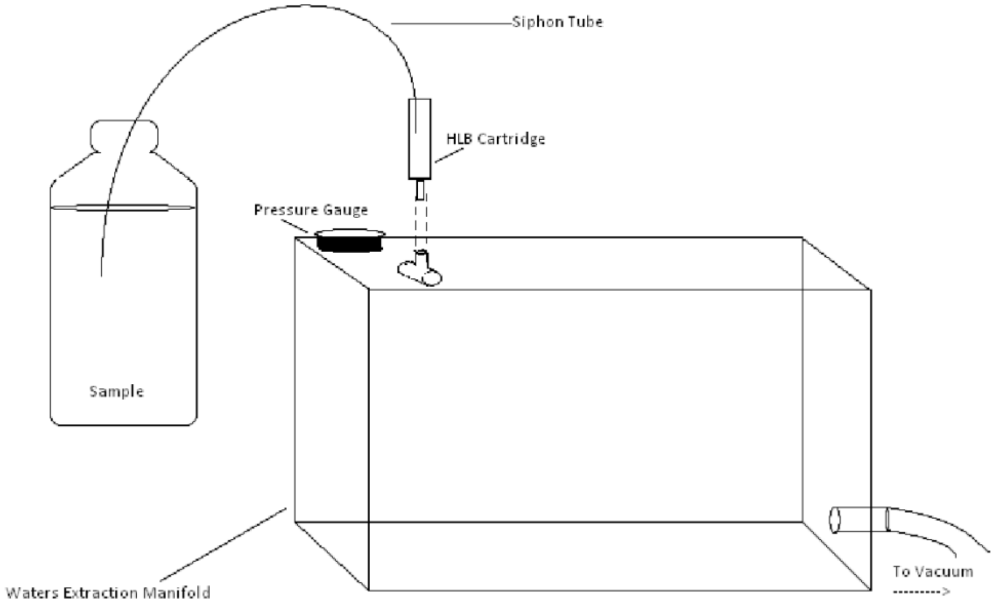
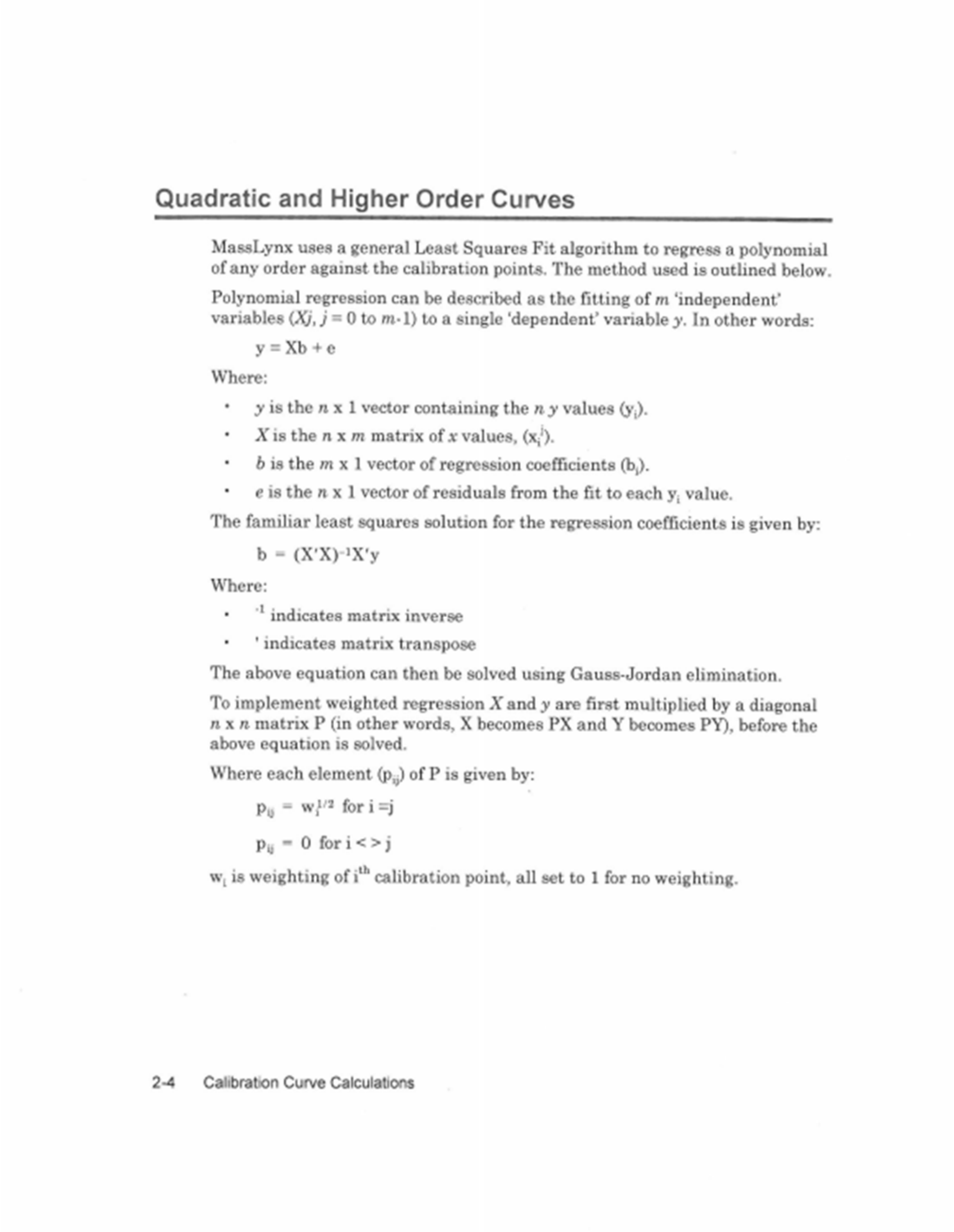
Appendix A

Figure 1. Extraction Manifold Set-up



Appendix B



Quadratic and Higher Order Curves

MassLynx uses a general Least Squares Fit algorithm to regress a polynomial of any order against the calibration points. The method used is outlined below.

Polynomial regression can be described as the fitting of m 'independent' variables (Xj, $j = 0$ to m-1) to a single 'dependent' variable y. In other words:

$$y = Xb + e$$

Where:

- y is the n x 1 vector containing the n y values (y_i).
- X is the n x m matrix of x values, (x_i^j).
- b is the m x 1 vector of regression coefficients (b_j).
- e is the n x 1 vector of residuals from the fit to each y_i value.

The familiar least squares solution for the regression coefficients is given by:

$$b = (X'X)^{-1}X'y$$

Where:

- $^{-1}$ indicates matrix inverse
- ' indicates matrix transpose

The above equation can then be solved using Gauss-Jordan elimination.

To implement weighted regression X and y are first multiplied by a diagonal n x n matrix P (in other words, X becomes PX and Y becomes PY), before the above equation is solved.

Where each element (p_{ij}) of P is given by:

$$p_{ij} = w_i^{1/2} \text{ for } i = j$$

$$p_{ij} = 0 \text{ for } i <> j$$

w_i is weighting of i^{th} calibration point, all set to 1 for no weighting.

SOP 64	**Revision: 3**	**Supersedes: 2**
PREPARATION AND ANALYSIS FOR THE DETERMINATION OF PER and POLY-FLUORINATED COMPOUNDS IN DRINKING WATER		
Analyst Review:		
Management: Martha Maier		
Quality Assurance:		
Effective Date: June 14, 2017		

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Revision No.	Revision Date	Description of Revision
0	10/14/2016	NEW SOP
1	12/08/2016	Replaced any reference to Table 5 to correctly indicate Table 3. Added section 2.2. Added section 4, Modifications.
2	06/06/2017	General revisions of all sections to expand the compound's list.
3	06/14/2017	New sections: 18; 19; 20.

1. PURPOSE

1.1 This SOP outlines and describes the preparative and analytical techniques used for the determination of per and poly-fluorinated compounds (PFAS).

2. SCOPE

2.1 All differences between EPA 537 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.

2.2 Any modifications made are per section 1.6 of EPA Method 537.

2.3 Data determined to be out-of-control from criteria stated within this SOP, is handled according to procedures addressed within the applicable section.

Compound	**CAS Registry No.***
Perfluorobutanesulfonic acid (PFBS)	375-73-5
Perfluoroheptanoic acid (PFHpA)	375-85-9
Perfluorohexanesulfonoic acid (PFHxS)	355-46-4
Perfluorohexanoic acid (PFHxA)	307-24-4
Perfluorooctanesulfonic acid (PFOS)	1763-23-1
Perfluorooctanoic acid (PFOA)	355-67-1
Perfluorononaoic acid (PFNA)	375-95-1
Perfluoroundecanoic acid (PFUnA)	2058-94-8
Perfluorodecanoic acid (PFDA)	335-76-2
Perfluorododecanoic acid (PFDoA)	307-55-1
Perfluorotridecanoic acid (PFTrDA)	72629-94-8
Perfluorotetradecanoic acid (PFTeDA)	376-06-7
N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	2991-50-6
N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	2355-31-9

*Chemical Abstract Service

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3. SUMMARY OF METHOD

3.1 This procedure uses ultra performance liquid chromatography/tandem mass spectrometry (UPLC/MS/MS) for detection and quantitation of per and poly-fluorinated compounds, commonly referred to as PFAS.

3.2 All differences between the method and actual laboratory techniques have been developed to reduce interferences and increase sensitivity.

4. MODIFICATIONS

4.1 All LC conditions and mobile phases were optimized for peak shape, resolution and to increase sensitivity.

5. CONTAMINATION AND INTERFERENCES

5.1 Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts or elevated baselines that may cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interfering substances under the conditions of analysis by performing laboratory method blanks. Analysts should avoid using materials containing PTFE, where possible.

5.2 All differences between EPA 537 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.

5.3 The use of high purity reagents and solvents helps to minimize interference problems.

5.4 Interferants co-extracted from the sample will vary considerably from matrix to matrix.

6. DEFINITIONS

6.1 Definitions are presented in the Glossary.

7. SAFETY

7.1 Procedures shall be carried out in a manner that protects the health and safety of all Vista employees.

7.2 Each chemical compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. All compounds or reagents should be handled only by highly trained personnel thoroughly familiar with handling and cautionary procedures and the associated risks.

7.3 Additional health and safety information can be obtained from safety data sheets (SDSs) available to all personnel involved in these analyses.

7.4 In the event of a known or potential compromise to the health and safety of a Vista associate, all work must stop and the incident reported immediately to management.

7.5 Contamination of the laboratory will be minimized by conducting most of the manipulations in a hood

7.6 The toxicity or carcinogenicity of each chemical used in this method has not been precisely determined; however, each compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of MSDS should also be made available to all personnel involved in these analyses.

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8. APPARATUS AND MATERIALS

Note: All materials used should be suitable for LC work, and comparable brand materials can be substituted where specific brands are mentioned.

8.1 Analytical balances capable of reading to 0.01g and 0.0001g;

8.2 Solid Phase Extraction Manifold [redacted]

8.3 [redacted]

8.4 Silicone tubing 1/16” diameter, various lengths [redacted]

8.5 Screw top polypropylene LC vials [redacted]

8.6 HDPE Bottle various sizes [redacted]

8.7 Screw caps with pre-slit polypropylene septa, for [redacted]

8.8 Disposable polypropylene Pasteur pipets, various sizes;

8.9 Chlorine test strips [redacted], or equivalent);

8.10 Organomation 24-Station N-Evaporator with water bath capable of heating to 65°C;

8.11 Polypropylene centrifuge tubes, 13 mm x 100 mm;

8.12 Wiretrol II Precision Disposable Micropipettes;

8.13 Sonicator VWR Model 150T;

8.14 Eppendorf Centrifuge Model 5804;

8.15 [redacted]

8.16 [redacted]

8.17 Acquity Ultra Performance LC (Waters);

8.18 Lenovo computer work station with MassLynx Software;

8.19 Shimadzu Nexera X2 UHPLC LC System (Shimadzu USA);

8.20 Dell Optiplex XE2 computer work station with Analyst and MultiQuant Software;

8.21 4000 Q Trap (Sciex);

8.22 Waters Quattro Premier XE Tandem Quadrupole Mass Spectrometer (QT™Q) MS/MS

8.23 AB SCIEX API 4000 Triple Quadrupole Mass Spectrometer;

8.24 Waters Mass Spectrometer (TQ™S micro) MS/MS

9. REAGENTS, SOLVENTS AND STANDARDS

9.1 Reagents (HPLC grade or above)

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- 9.1.1 Trizma pre-set crystals [redacted]
- 9.1.2 Ammonium Acetate, HPLC grade
- 9.1.3 Ultra-pure nitrogen gas
- 9.1.4 Ultra-pure argon gas
- 9.1.5 [redacted]

9.2 Solvents (HPLC Grade or above)

- 9.2.1 Reagent Water
- 9.2.2 Acetonitrile (ACN)
- 9.2.3 Hexane (for cleaning)
- 9.2.4 Methanol (MeOH)
- 9.2.5 Isopropyl Alcohol (IPA)

9.3 Standards

- 9.3.1 All analytical standards are obtained from a certified vendor.
- 9.3.2 See SOP 15 and the current spike sheet for more information.

10. COLLECTION, PRESERVATION, AND HANDLING

10.1 HDPE or polypropylene bottles and jars must be used for collection.

10.2 Trizma is added to the sample bottles prior to the collection of drinking water samples in the amount of 5.0g/L.

10.3 Aqueous samples must be extracted within 14 days of collection and analyzed within 28 days of extraction.

10.4 Store at < 6^{o}C.

11. QUALITY CONTROL

11.1 Each time a modification is made to this method and the detection limit will be affected by the change, the laboratory is required to demonstrate that the MDL is lower than one-third the regulatory compliance level or one-third the method reporting limit (MRL) in the method, whichever is higher.

11.2 Method Blank (MB): Method blank is a matrix preparation that is free of native analyte that has been prepared and analyzed using the same procedures followed for the rest of the analytical batch. Simulate as close as possible the matrix to be extracted.

- 11.2.1 Daily or with each extraction batch of up to 20 samples, (whichever is more frequent).
- 11.2.2 For the determination of native PFAS, the levels measured in the method blank of all method analytes must be below 1/3 the MRL.

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11.2.3 If amount found is greater than the minimum level or one-third the regulatory compliance limit, whichever is greater; or if any potentially interfering compound is found in the blank at or above the minimum level for each congener, the data must be evaluated to determine whether the batch shall be re-extracted or the data are qualified appropriately.

11.2.4 If there is evidence of contamination within the MB, then the source of the contamination must be located. The data must be evaluated to determine whether the batch shall be re-extracted or the data is qualified appropriately.

11.3 Ongoing Precision and Recovery Samples (OPR): An ongoing precision and recovery sample is prepared by adding a known quantity of native standards to an interferant free matrix and used to assess method performance (precision and recovery).

11.3.1 Add the appropriate amount of native spike. The native spikes contain the compounds listed in Table 1.

11.3.2 The native spike is rotated between a low, medium and high concentration per batch.

11.3.3 An OPR is analyzed with every analytical batch of 20 samples or less.

11.3.4 The OPR % recoveries for native and surrogates must be within the limits shown in Table 3.

11.4 Matrix Spike (MS/MSD): A matrix spike sample is prepared by adding the appropriate quantity of native standards to a sample matrix prior to extraction. MS/MSD's are performed in every batch.

11.4.1 The native spike for MS/MSDs should be rotated between a low, medium and high concentration per batch.

11.4.2 Analyte recoveries for MS/MSDs fortified at a medium or high concentration should be between 70-130%. For those fortified at a concentration of 2x the MDL or lower, recoveries of 50-150% are acceptable.

11.4.3 If the recovery of the MDL does not meet criteria, but the CCC recoveries are acceptable, the data is evaluated and qualified appropriately.

11.4.4 The relative percent difference (RPD) between MS/MSD samples should be $\leq$ 30%.

11.4.5 If the concentration is within a factor of 2 of the MRL, the relative percentage difference (RPD) must be ≤ 50%

11.4.6 If RPD does not meet the acceptance criteria, the data is evaluated and qualified appropriately.

11.5 Duplicate Samples: Duplicate samples are two separate aliquots taken from the same source. Duplicate samples are analyzed independently to assess laboratory precision. Duplicate samples are performed by client request.

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11.5.1 The relative percent difference between duplicate samples should be ≤ 30%

11.5.2 If the concentration is within a factor of 2 of the MRL, the relative percentage difference (RPD) must be ≤ 50%

11.5.3 If the RPD does not meet the acceptance criteria, the data are evaluated and qualified appropriately.

11.6 Field Reagent Blank (FRB): A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples.

11.6.1 Analysis of the FRB is only necessary if a Field Sample contains a method analyte at or above the MRL.

11.7 Second source standard: Analytes from a different source than that of the calibration standards. This is prepared and analyzed in the same way as a CCC.

11.7.1 This is analyzed at least quarterly, or whenever a new set of standards are made.

11.7.2 The calculated value for the second source standard must be within ±30% of the true value.

12. EXTRACTION PROCEDURES

12.1 Aqueous Samples

12.1.1 All samples are preserved, collected, and stored as presented in Section 10. All field and QC samples, including the LRB, LFB, and FRB, must contain Trizma, as listed in Section 10.2.

12.1.2 Record the combined weight of the bottle, cap and sample for each sample to be extracted. After the sample has been removed from the bottle, allow it to drain overnight and reweigh it and the cap to determine the amount of sample extracted.

12.1.3 For the method blank (MB) and OPR(s), transfer ~250mL of reagent water into a bottle for each.

12.1.4 Add the appropriate volume of Surrogate standard (SUR) solution to all samples and QCs and the appropriate volume of Native Standard (NS) solution to OPR, MS and/or MSD. Allow the spiked samples to equilibrate for at least 1 hour before extraction.

12.2 SPE Cleanup

12.2.1 Assemble the SPE apparatus and attach the SPE cartridges as shown in the appendix A, Figure 1.

12.2.1.1 Rinse the cartridge with [redacted] Discard eluant.

12.2.1.2 Condition the cartridge with 18mL reagent water. Discard eluant.

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12.2.1.3 Load sample onto cartridge by way of siphon, maintaining a flow rate of ~10mL/min at 5” Hg.

12.2.1.4 Once sample has passed through, rinse bottle with 15mL reagent water and re-siphon.

12.2.2 [redacted]

12.3 Cartridge Elution

12.3.1 Rinse the bottle with 4mLs of methanol and re-siphon, followed by another [redacted]. Collect extracts eluted from the column into a clean test tube.

12.4 Adjustment to Final Volume

12.4.1 Concentrate extract to dryness under a gentle stream of nitrogen and a water bath [redacted]

12.4.2 Reconstitute with 96:4 MeOH to H_2O and the appropriate amount of Internal Standard (IS).

13. LC/MS ANALYSIS

13.1 Establish the necessary conditions. The LC conditions may be optimized for compound separation and sensitivity. Once optimized, the same LC conditions must be used for the analysis of all standards, blanks, OPR aliquots, and samples. The following LC operating conditions are guidance and adjustments may be required.

13.1.1 **Instrument:** Aquity UPLC/ Waters Quattro Premier XE

Column: Waters BEH C18, 100mm x 2.1 mm i.d., 1.7 µm particle size
Ionization: [redacted]
Acquisition: MRM mode, unit resolution
Injection Volume: 5-15µL

General LC Conditions	
Column Temp	60°C
Max Pressure	15,000 psi
Autosampler Tray Temp.	18°C
MS Conditions	
Source Temp.	150°C
Desolvation Temp.	[redacted]
Cone/Desolvation Gas Rate	25 L/hr 850 L/hr

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LC Gradient Program			***LC Gradient Program***	**Gradient**
Time (min)	**Flow Mixture***			
0.00	90%A	10%B	0.400	
5.00	10%A	90%B	0.400	6
8.00	6%A	94%B	0.400	6
8.10	1%A	99%B	0.400	6
10.00	1%A	99%B	0.400	6
10.10	90%A	10%B	0.400	1
11.40	90%A	10%B	0.400	6

- Solvent A = 2mM NH$_4$Oac 5mM 1-MP in 95:5 HPLC water:MEOH
- Solvent B = 2mM NH$_4$Oac 5mM 1-MP in 70:20:5 MEOH:ACN:H2O

13.1.2 **Instrument:** Shimadzu DGU-20Asr/Sciex 4000 Q trap

Column: [redacted]

Ionization: Negative Ion Electrospray
Acquisition: MRM mode, unit resolution
Injection Volume: 1-5 µL

General LC Conditions	
Column Temp	60°C
Max Pressure	15,000 psi
Autosampler Tray Temp.	18°C
MS Conditions	
Cur.	20.00
CAD	High
IS	-4000.00
MS Conditions	
TEM	[redacted]
GS1	40.00
GS2	60.00
ihe	ON
EP	-10.00

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LC Gradient Program			*LC Gradient Program*	**Parameter**	
Time (min)	**Flow Mixture***				Events
0.00	90%A	10%B	0.400	NA	NA
5.00	10%A	90%B	0.400	90	Pump B Conc.
8.00	6%A	94%B	0.400	94	Pump B Conc.
8.10	1%A	99%B	0.400	99	Pump B Conc.
9.8	1%A	99%B	0.400	99	Pump B Conc.
9.9	90%A	10%B	0.400	10	Pump B Conc.
9.9	90%A	10%B	0.400	-10	Pump B Curv.
11.40	90%A	10%B	0.400	NA	Stop

- Solvent A = 2mM NH$_4$Oac 5mM 1-MP in 95:5 HPLC water:MeOH
- Solvent B=2mM NH4Oac 5mM 1-MP in 70:20:5 MeOH:ACN:H2O

13.1.3 **Instrument:** Aquity UPLC/ Waters TQS-Micro

Column: Waters BEH C18, 100mm x 2.1 mm i.d., 1.7 µm particle size
Ionization: Negative Ion Electrospray
Acquisition: MRM mode, unit resolution
Injection Volume: 1-5µL

General LC Conditions	
Column Temp	80°C
Max Pressure	15,000 psi
Autosampler Tray Temp.	15°C
MS Conditions	
Source Temp.	150°C
Desolvation Temp.	320°C
Cone/Desolvation Gas Rate	25 L/hr 850 L/hr

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LC Gradient Program			***LC Gradient Program***	**Gradient**
Time (min)	**Flow Mixture***			
0.00	95%A	5%B	0.250	
5.00	50%A	50%B	0.250	6
8.00	20%A	80%B	0.250	6
8.10	2%A	98%B	0.250	6
10.00	2%A	98%B	0.250	6
10.10	95%A	5%B	0.250	1
11.40	95%A	5%B	0.250	6

- Solvent A = 2mM NH_4OAc 5mM 1-MP in 95:5 HPLC water:IPA
- Solvent B = 2mM NH_4OAc 5mM 1-MP in 70:20:5 IPA:ACN:H2O

13.2 Initial Calibration (ICAL)

13.2.1 An initial calibration curve is created using the internal standard technique. Either a linear or quadratic regression is used, consisting of at least 5 or 6 points, respectively.

13.2.2 This curve must be forced through zero.

13.2.3 Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed and repeated at the beginning, whenever a new set of spiking calibration standards is created or whenever the continuing calibration falls outside the acceptance criteria.

13.2.4 The peak asymmetry factor for the first two eluting compounds must be calculated each time a new calibration curve is generated, using a mid-level calibration point. The factor must fall into the range of 0.8 – 1.5.

13.2.5 Each calibration point for each analyte must be within 70-130% of its true value, except for the lowest calibration point, which must be within 50-150% of its true value.

13.2.6 To evaluate whether there is any suppression during calibration, an RPD must be calculated between the high and the low IS areas. The RPD must be <20% for each IS, or recalibrate with lower concentrations.

13.2.7 Establish the operating conditions suggested in Section 13.1

13.2.8 The curve may be concentration weighted at the analysts discretion.

13.2.9 The coefficient of determination for all native compounds must be greater than or equal to 0.99.

13.2.10 RSD requirements are ≤20% for all internal standards.

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13.3 Continuing Calibration

13.3.1 A continuing calibration check (CCC) must be analyzed at the beginning, after every 10 field samples and at the end of each analytical run.

13.3.2 The continuing calibration verification is acceptable if the following criteria are met:

13.3.2.1 The LC peak representing each native and labeled compound must be present with a S/N ≥10.

13.3.2.2 The percent recovery for native standards and the internal standards must be within the limits shown in Table 3.

13.3.2.3 The absolute areas of the ISs must be within 70-140% of the most recent CCAL and within 50-150% of the current ICAL.

13.3.2.4 If one or more analytes exceed the limits for the CCC, but those method analytes are not found in the samples above the MRL, reanalysis is not required.

13.4 Qualitative Determination

13.4.1 The signal to noise ratio (S/N) at the LC peak maximum for each native compound must be greater than or equal to 3 for each compound detected in a sample extract.

13.4.2 The retention time of the peak for a native compound must be within ±15 seconds of its RT in the most recent CCC standard.

13.5 Quantitative Determination

13.5.1 Native compounds should have a retention time within 0.1 mins. of its equivalent internal standard.

13.5.2 Recovery of each surrogate standard must be within the limits shown in Table 3.

13.5.3 Recoveries below the limits may be accepted if the signal to noise is >10:1. If the signal to noise is not >10:1, samples must be re-extracted and re-analyzed or the data must be qualified.

13.5.4 If the concentration of one or more analytes is above the highest calibration point, a dilution must be analyzed.

13.5.5 PFHxS, PFOA and PFOS have both linear and branched isomers. All chromatographic peaks for these compounds are integrated and the areas totaled. Technical mixtures are referenced when available.

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14. CALCULATIONS

14.1 The concentration of each internal standard is calculated as follows:

$$C_{Samp} = \frac{A_x Q_y}{A_y RRF\, S_v}$$

Where:

C_{Samp} = *Concentration of compound in sample*
A_x = *Area of the quantitation ion for the IS compound in sample*
A_y = *Area of the quantitation ion for the RS compound in sample*
Q_y = *Quantity, in pg, of Internal Standard in sample*
S_v = *Sample volume in liters*
RRF = *Relative response factor, a sum of the response factors* (RF):

$$\sum RF = \frac{A_n C_l}{A_l C_n}$$

Where:

C_l = *Internal Standard Concentration at the curve point*
A_x = *Area of daughter m/z for IS compound*
A_l = *Area of daughter m/z for RS compound*
C_n = *Concentration of IS at the curve point*

14.2 Internal standard recoveries are calculated by using the formula:

$$\%Rec = \frac{(A_{IS})(Q_{RS}) \times 100}{(A_{RS})(Q_{IS})(RRF_{IS})}$$

Where:

A_{IS} = *Area of the quantitation ion for the internal standard.*
A_{RS} = *Area of the quantitation ion for the recovery standard.*
Q_{IS} = *Quantity of the internal standard.*
Q_{RS} = *Quantity of the recovery standard.*
RRF_{IS} = *Calculated relative response factor for the internal std. analyte.*

14.3 RRF for labeled analytes (RRFIS):

$$RRF_{IS} = \frac{(A_{IS})(Q_{RS})}{(Q_{IS})(A_{RS})}$$

Where:

A_{IS} = *Sum of the integrated ion abundances of the quantitation ions for the labeled standards*
A_{RS} = *Sum of the integrated ion abundances of the quantitation ions for the labeled recovery standards*
Q_{IS} = *Quantity of internal standard injected (pg)*
Q_{RS} = *Quantity of recovery standard injected (pg)*
Q_X = *Quantity of unlabeled analyte injected (pg)*

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14.4 The RPD is calculated as follows:

$$RPD = \frac{(H - L)}{(H + L)/2} * 100$$

Where:
RPD = *Relative Percentage Difference*
H = *Highest area*
L = *Lowest area*

14.5 The Peak Asymmetry factor is calculated as follows:

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

Where:
A_S = *peak asymmetry factor*
b = *width of the back half of the peak, measured at 10% peak height*
a = *width of the front half of the peak, measured at 10% peak height*

14.6 The LC/MS/MS workstation uses Micromass TargetLynx software to process raw data used to calculate the calibration curves and sample analyte concentrations. If the regression is linear and forced through zero, use the following formula:

$$C_{Samp} = \frac{(A_x)(C_{is})}{(A_{is})(a)(V_s)}$$

Where:
C_{Samp} = *Concentration of compound in sample*
A_x = *Area of the quantitation ion for the native compound in sample*
A_{is} = *Area of the quantitation ion for the internal standard in sample*
C_{is} = *Quantity, in ng, of Internal Standard in sample*
V_s = *Sample volume in liters*
a = *Slope of the calibration line*

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15. POLLUTION PREVENTION

15.1 The solvent evaporation techniques used in this method are amenable to solvent recovery, and the laboratory shall recover solvents wherever feasible.

15.2 Standards should be prepared in volumes consistent with laboratory use to minimize disposal of standard.

16. WASTE MANAGEMENT

16.1 Waste generated in the procedure must be segregated and disposed according to the facility hazardous waste procedures. Safety officer should be contacted if additional information is required.

16.2 The laboratory waste management is in compliance with all federal, state, and local regulations to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations

17. METHOD PERFORMANCE

17.1 This SOP is based on methods noted as references (Section 18).

18. EQUIPMENT/INSTRUMENT MAINTENANCE

18.1 Equipment/Instrument maintenance is performed in accordance with SOP 10 “Instrument Maintenance Logbooks and Schedule”.

18.2 Records of maintenance are kept in instrument logbooks.

19. COMPUTER HARDWARE AND SOFTWARE

19.1 MassLynx

19.2 Analyst 1.6.2

20. TROUBLESHOOTING

20.1 Troubleshooting is performed in accordance with Instrument Manuals:

20.1.1 ACQUITY UPLC system maintenance (Waters)

20.1.2 Waters Micromass Quattro Premier XE Mass Spectrometer Operator’s guide

20.1.3 MassLynx 4.1 Manual and Documents

20.1.4 SHIMADZU LC-30AD Instruction Manual

20.1.5 SHIMADZU System Guide

20.1.6 SHIMADZU CTO-20A, 20AC Instruction Manual

20.1.7 SHIMADZU DGU-20A3R, 20A5R Instruction Manual

20.1.8 Line adjustment Transformer Instruction Manual

20.1.9 Eppendorf operating manual for Multipipet M4, Repeater M4

20.1.10 AB SCIEX API 4000 Triple Quadrupole Mass Spectrometer (Q-3) 2017

20.1.11 Waters Acquity Mass Spectrometer (TQTMS) MS/MS Q-4 2017

20.1.12 Eppendorf operating manual for Multipipet M4, Repeater M4

21. REFERENCES

21.1 Method 537, Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), Version 1.1, September 2009.

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Table 1
Calibration Curve Concentration (pg/µL)

Compound	**CS(-2)**	**CS(-1)**	**CS0**	**CS1**	**CS2**	**CS3**	**CS4**	**CS5**
PFBS	0.885	1.77	4.42	8.85	22.1	44.2	66.3	88.4
PFHpA	1.0	2.0	5.0	10	25	50	75	100
PFHxS	0.91	1.82	4.56	9.12	22.8	45.6	68.4	91.2
PFOS	0.924	1.85	4.62	9.24	23.1	46.2	69.3	92.4
PFOA	1.0	2.0	5.0	10	25	50	75	100
PFHxA	1.0	2.0	5.0	10	25	50	75	100
PFDA	1.0	2.0	5.0	10	25	50	75	100
PFNA	1.0	2.0	5.0	10	25	50	75	100
PFUnA	1.0	2.0	5.0	10	25	50	75	100
PFDoA	1.0	2.0	5.0	10	25	50	75	100
PFTrDA	1.0	2.0	5.0	10	25	50	75	100
PFTeDA	1.0	2.0	5.0	10	25	50	75	100
N-EtFOSAA	1.0	2.0	5.0	10	25	50	75	100
N-MeFOSAA	1.0	2.0	5.0	10	25	50	75	100
Internal Standard	**CS(-2)**	**CS(-1)**	**CS0**	**CS1**	**CS2**	**CS3**	**CS4**	**CS5**
13C2-PFHxA	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
13C2-PFDA	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
13C2-PFOA	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
13C4-PFOS	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7
d5-N-EtFOSAA	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
d3-N-MeFOSAA	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

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Table 2
Exact Masses Monitored

Compound	Native Parent-Daughter
PFBS	299-80
PFHxA	313-269
PFHpA	363-319
PFHxS	399-80
PFOS	499-80
PFOA	413-369
PFNA	463-419
PFDA	513-468
PFUnA	563-519
PFDoA	613-319
PFTrDA	663-619
PFTeDA	713-669
N-EtFOSAA	584-419
N-MeFOSAA	570-419
Surrogate Standards	
$^{13}C_2$-PFHxA	315-270
$^{13}C_2$-PFDA	515-470
d5-N-EtFOSAA	589-419
Internal Standards	
$^{13}C_2$-PFOA	415 -370
$^{13}C_4$-PFOS	503- 80
d3-N-MeFOSAA	573-419

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Table 3
Acceptance Criteria for Performance Tests

Compound	CCC	IPR		OPR %	Labeled compound recovery in samples %
		RSD %	Ave %		
PFBS	70-130	20	70-130	70-130	NA
PFHpA	70-130	20	70-130	70-130	NA
PFHxS	70-130	20	70-130	70-130	NA
PFOA	70-130	20	70-130	70-130	NA
PFOS	70-130	20	70-130	70-130	NA
PFHxA	70-130	20	70-130	70-130	NA
PFDA	70-130	20	70-130	70-130	NA
PFNA	70-130	20	70-130	70-130	NA
PFUnA	70-130	20	70-130	70-130	NA
PFDoA	70-130	20	70-130	70-130	NA
PFTrDA	70-130	20	70-130	70-130	NA
PFTeDA	70-130	20	70-130	70-130	NA
N-EtFOSAA	70-130	20	70-130	70-130	NA
N-MeFOSAA	70-130	20	70-130	70-130	NA
$^{13}C_2$-PFHxA	70-130	20	70-130	70-130	70-130
$^{13}C_2$-PFDA	70-130	20	70-130	70-130	70-130
d5-N-EtFOSAA	70-130	20	70-130	70-130	70-130

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Table 4
Reporting Limits

Compound	RL Aqueous (ng/L)
PFBS	20.0
PFHpA	20.0
PFHxS	20.0
PFOS	20.0
PFOA	20.0
PFHxA	20.0
PFDA	20.0
PFNA	20.0
PFUnA	20.0
PFDoA	20.0
PFTrDA	20.0
PFTeDA	20.0
N-EtFOSAA	20.0
N-MeFOSAA	20.0

*RLs based on 250 mLs and 1mL final volume.

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Glossary

Analyte — Compound of interest. The analytes are listed in Table 1.

Calibration Standard — A solution prepared from a stock solution and used to calibrate the response of the HPLC/MSMS.

Calibration Verification Standard (CCC) — Calibration Standard containing a known concentration of native analytes, internal standard and recovery standards. This is analyzed to verify the accuracy of the existing calibration for those analytes.

Field Reagent Blank — A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples

Internal Standard – A labeled compound used as a reference for quantitation of other labeled and native compounds.

IPR — Initial precision and recovery; four aliquots of a reference material spiked with analytes of interest are analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed anytime the method or instrumentation is modified.

Isotope dilution quantitation – Determination of a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. This method employs ^{2}H or ^{13}C labeled analogs which are spiked into each sample

LC – Liquid chromatography

Labeled Compound – A molecule in which one or more of the atoms is isotopically enriched, thereby increasing the mass of the molecule

Laboratory Blank — See method blank.

May — This action, activity, or procedural step is neither required nor prohibited.

May Not — This action, activity, or procedural step is prohibited.

Method Blank — An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with samples. The method blank is used to determine if analytes or interferences are present in the laboratory environment, the reagents, or the apparatus.

Method Detection Limit (MDL) — The lowest concentration at which an analyte can be detected under routine operating conditions (see 40 CFR 136, Appendix B).

MS — Mass spectrometer or mass spectrometry.

Must — This action, activity, or procedural step is required.

Native Compound – A molecule in which all atoms have naturally occurring isotopic abundances

OPR — Ongoing precision and recovery sample (OPR); a laboratory blank spiked with known quantities of analytes. The OPR is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery.

Reagent Water — Water demonstrated to be free from the analytes of interest and potentially interfering substances at the method detection limit for the analyte.

Relative Standard Deviation (RSD) — The standard deviation times 100 divided by the mean. Also termed "coefficient of variation."

RPD – Relative Percent Difference shown

RF — Response factor.

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RRF — Relative response factor.

Should — Although this action, activity, or procedural step is suggested, it is not required.

SICP — Selected ion current profile; the line described by the signal at an exact m/z.

Signal-to-noise ratio (S/N) – The height of the signal as measured from the mean of the noise to the peak maximum divided by the width of the noise.

SPE — Solid-phase extraction; an extraction technique in which an analyte is extracted from an aqueous sample by passage over or through a material capable of reversibly adsorbing the analyte.

Stock Solution — A solution containing an analyte that is prepared using a reference material traceable to EPA, the National Institute of Science and Technology (NIST), or a source that will attest to the purity and authenticity of the reference material.

UPLC — Ultra performance liquid chromatography

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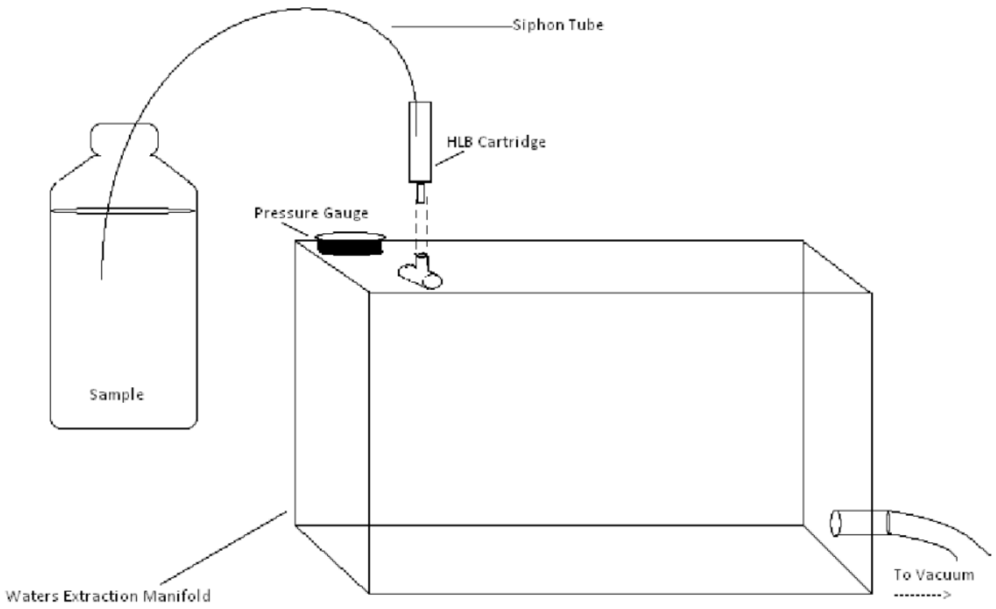
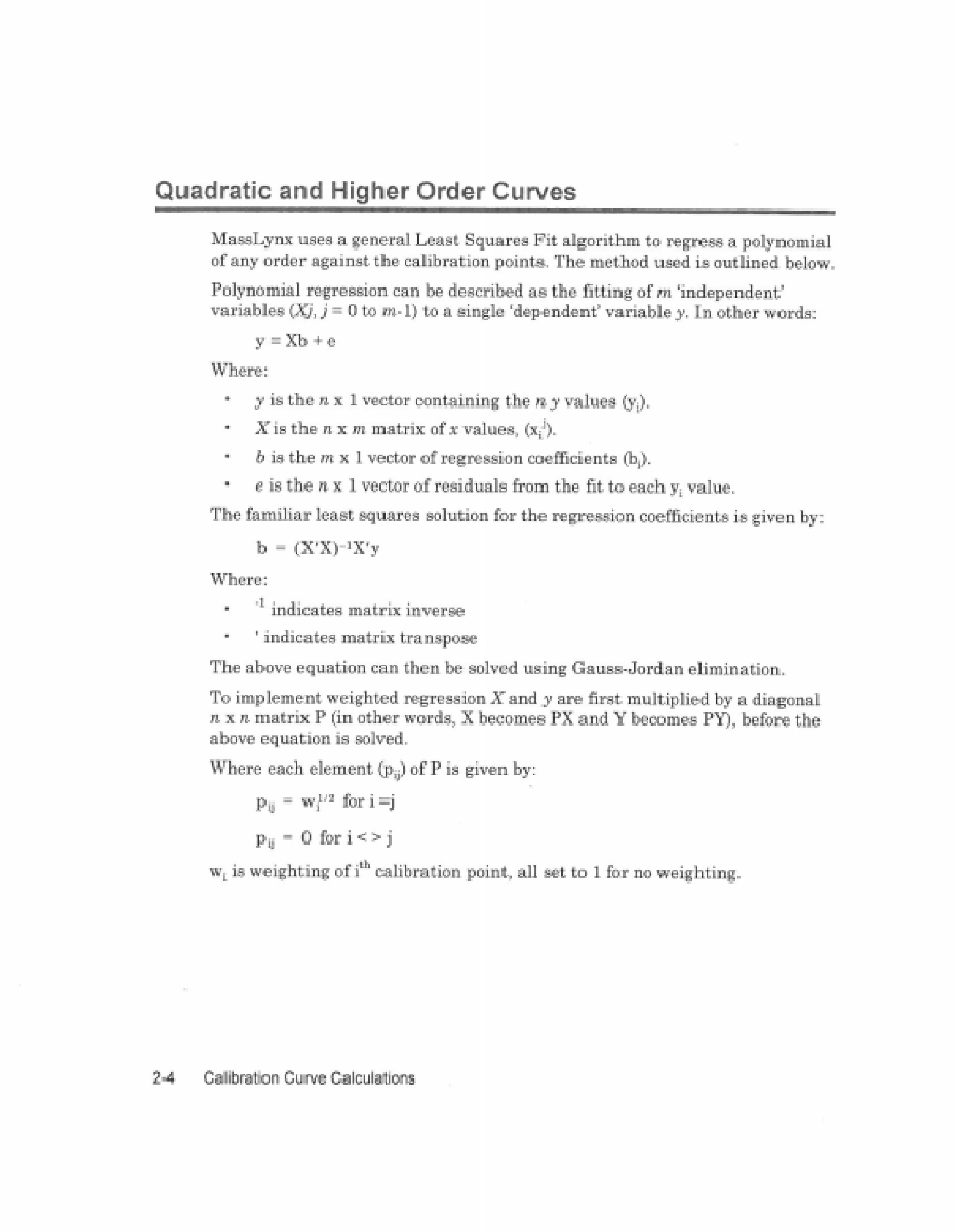
Appendix A

21.2 Figure 1. Extraction Manifold Set-up



Appendix B:



Quadratic and Higher Order Curves

MassLynx uses a general Least Squares Fit algorithm to regress a polynomial of any order against the calibration points. The method used is outlined below.

Polynomial regression can be described as the fitting of *m* 'independent' variables (Xj, $j = 0$ to m-1) to a single 'dependent' variable *y*. In other words:

$$y = Xb + e$$

Where:

- *y* is the *n* x 1 vector containing the *n* *y* values (y_i).
- *X* is the *n* x *m* matrix of *x* values, (x_i^j).
- *b* is the *m* x 1 vector of regression coefficients (b_j).
- *e* is the *n* x 1 vector of residuals from the fit to each y_i value.

The familiar least squares solution for the regression coefficients is given by:

$$b = (X'X)^{-1}X'y$$

Where:

- $^{-1}$ indicates matrix inverse
- ' indicates matrix transpose

The above equation can then be solved using Gauss-Jordan elimination.

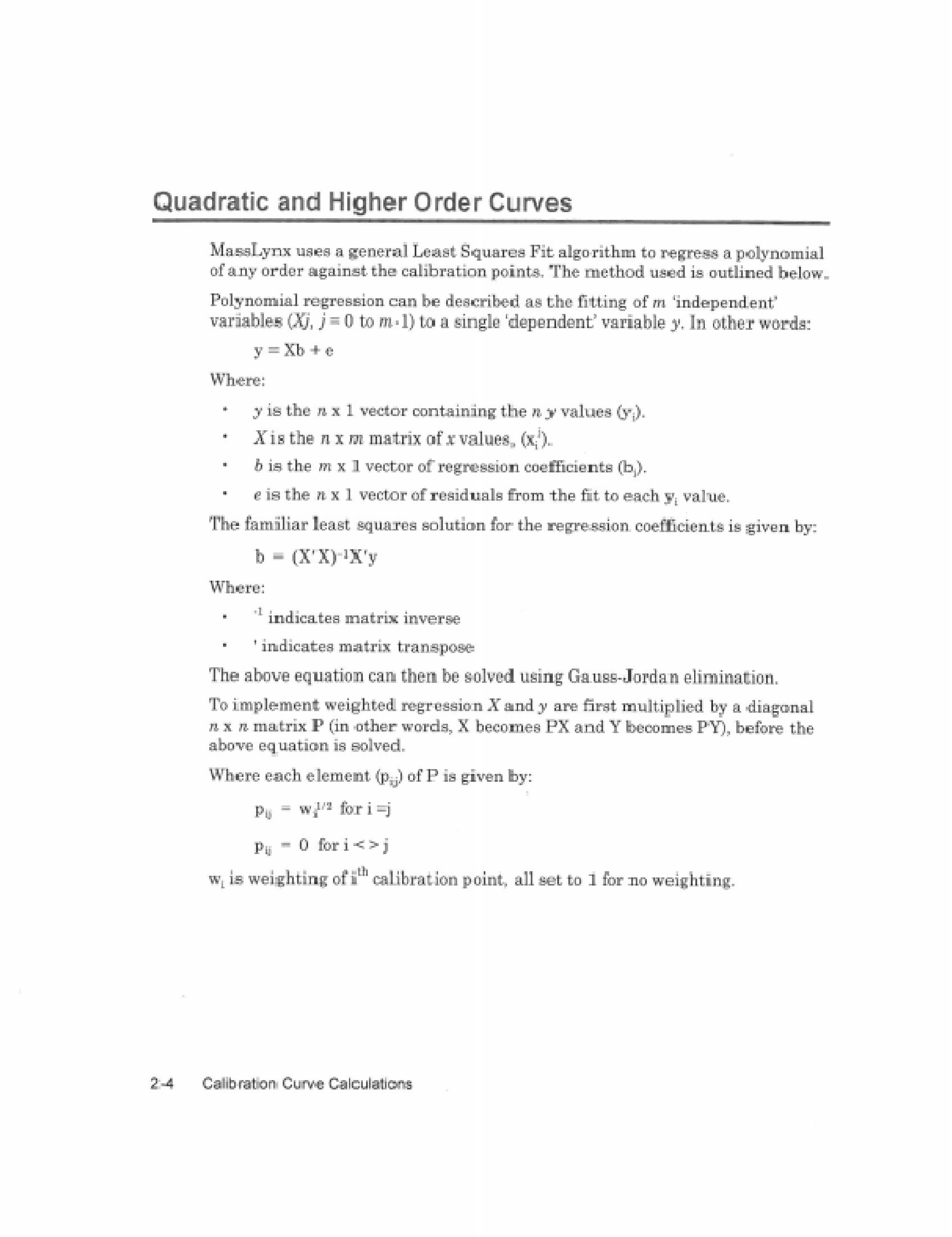
To implement weighted regression *X* and *y* are first multiplied by a diagonal *n* x *n* matrix P (in other words, X becomes PX and Y becomes PY), before the above equation is solved.

Where each element (p_{ij}) of P is given by:

$$p_{ij} = w_i^{1/2} \text{ for } i = j$$

$$p_{ij} = 0 \text{ for } i <> j$$

w_i is weighting of i^{th} calibration point, all set to 1 for no weighting.



Quadratic and Higher Order Curves

MassLynx uses a general Least Squares Fit algorithm to regress a polynomial of any order against the calibration points. The method used is outlined below.

Polynomial regression can be described as the fitting of m 'independent' variables (Xj, $j = 0$ to $m-1$) to a single 'dependent' variable y. In other words:

$$y = Xb + e$$

Where:

- y is the n x 1 vector containing the n y values (y_i).
- X is the n x m matrix of x values, (x_i^j).
- b is the m x 1 vector of regression coefficients (b_j).
- e is the n x 1 vector of residuals from the fit to each y_i value.

The familiar least squares solution for the regression coefficients is given by:

$$b = (X'X)^{-1}X'y$$

Where:

- $^{-1}$ indicates matrix inverse
- ' indicates matrix transpose

The above equation can then be solved using Gauss-Jordan elimination.

To implement weighted regression X and y are first multiplied by a diagonal n x n matrix **P** (in other words, X becomes PX and Y becomes PY), before the above equation is solved.

Where each element (p_{ij}) of P is given by:

$$p_{ij} = w_i^{1/2} \text{ for } i = j$$

$$p_{ij} = 0 \text{ for } i <> j$$

w_i is weighting of i^{th} calibration point, all set to 1 for no weighting.

Appendix D

Area 6 Monitoring Well Construction Summary Table

Appendix D

Area 6 Groundwater Monitoring Well Construction Summary

Well Name	Easting	Northing	Well Diameter (inches)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Total Depth (feet bgs)	Depth to Screen Top (feet bgs)	Depth to Screen Bottom (feet bgs)	Most Recent Depth to Groundwater (feet btoc)	Measurement Date
BID-625[a]	1202392.88	489379.60	2	UNK	UNK	104	94	104	UNK	UNK
6-D-1	1200954.00	485471.50	UNK	210.1	211.89	252	241	251	197.13	December 2002
6-D-2	1200954.00	486048.60	UNK	170.5	172.87	217	206	216	158.03	December 2002
6-D-3	1203128.00	488250.60	UNK	181.6	183.01	200.5	190	199.5	168.19	December 2002
6-D-4	1200713.00	487495.50	UNK	171.1	UNK	UNK	193	203	UNK	UNK
6-D-5[a]	1200733.60	487550.92	UNK	UNK	173.91	204	193	203	157.79	December 2002
6-DW-38	1201868.00	483104.60	UNK	UNK	190.76	165.41	Unknown	Unknown	117.57	January 2017
6-I-1	1200742.00	487502.90	4	171.3	173.99	178	163	177	106.42	November 2006
6-I-2	1200167.00	486925.10	UNK	188.5	UNK	UNK	UNK	UNK	UNK	UNK
6-I-3	1200388.00	486351.60	4	196.2	198.62	177	166	176	126.02	November 2006
6-I-4	1200369.00	485462.60	UNK	194.8	UNK	UNK	UNK	UNK	UNK	UNK
6-I-5	1199966.00	488322.90	UNK	106	UNK	UNK	UNK	UNK	UNK	UNK
6-I-6	1199353.00	487629.40	UNK	136.9	UNK	UNK	UNK	UNK	UNK	UNK
6-I-7	1199132.00	486730.50	UNK	213.16	UNK	UNK	UNK	UNK	UNK	UNK
6-I-8	1200449.00	487821.40	UNK	UNK	157	158	147	157	91.03	November 2006
6-S-1	1203139.00	486064.00	UNK	170.9	173.04	98	87	97	90.64	January 2017
6-S-2	1203586.00	488231.00	4	182.1	183.59	104.5	93.5	103.5	92.48	January 2017
6-S-3	1201913.00	484800.00	UNK	201.2	202.92	134	123	133	126.95	January 2017
6-S-4	1200975.00	485469.00	4	210.2	212.97	140.5	129.5	139.5	135.93	January 2017
6-S-5	1203388.00	487038.00	UNK	181.5	183.6	106	95	105	96.30	January 2017
6-S-6	1200387.00	486369.00	UNK	195.5	197.47	123	112	122	116.20	January 2017
6-S-7	1200542.00	488637.00	4	95.4	96.92	39.5	28.5	38.5	7.88	January 2017
6-S-8	1202158.00	488648.00	4	161.8	163.67	84	73	83	74.14	June 2003
6-S-9	1201426.00	487101.00	UNK	177.9	174.24	106	95	105	87.61	January 2017
6-S-10	1200810.00	487873.00	UNK	148.9	152.28	101	90	100	63.83	January 2017
6-S-11	1200189.00	486925.00	UNK	188.3	190.75	142	130	140	107.25	January 2017
6-S-12	1200128.00	486186.00	UNK	190.4	193.09	145.5	134.5	144.5	112.88	November 2006
6-S-13	1200375.00	485501.00	UNK	194.7	197.82	156.5	145	155	120.67	August 2007
6-S-14	1200760.00	486480.00	4	207.49	211.49	156	145	155	129.40	January 2017
6-S-15	1200840.00	486877.90	UNK	186.5	200.57	133.5	122.5	132.5	116.40	January 2017
6-S-16	1202127.00	485994.00	UNK	191.9	195.73	127	116	126	114.40	January 2017
6-S-17	1202048.00	485524.40	4	205.73	206.09	138	117	137	127.07	January 2017
6-S-18	1201439.00	484811.30	UNK	217.47	219.37	75	59.5	69.5	UNK	UNK
6-S-19	1201439.00	484811.30	4	216.68	219.37	164.5	143.5	163.5	144.23	January 2017
6-S-20	1199955.00	488284.20	UNK	106	109.16	60	19	59	UNK	UNK
6-S-21	1200449.00	487808.80	UNK	155.1	157.74	104.5	63.5	103.5	70.82	May 2007
6-S-22	1200724.60	487531.72	UNK	170.7	173.49	121	110	120	88.94	November 2006
6-S-23	1200738.00	486543.30	UNK	204.3	211.72	132	121	131	131.13	November 2006
6-S-24	1200128.00	486109.30	UNK	190.1	192.56	116.5	105	115.5	111.99	January 2017
6-S-25	1200411.00	485485.80	UNK	195.5	197.92	126	115	125	120.49	January 2017

Appendix D

Area 6 Groundwater Monitoring Well Construction Summary

Well Name	Easting	Northing	Well Diameter (inches)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Total Depth (feet bgs)	Depth to Screen Top (feet bgs)	Depth to Screen Bottom (feet bgs)	Most Recent Depth to Groundwater (feet btoc)	Measurement Date
6-S-26	1200934.00	488323.90	4	125.63	128.48	74.5	63.5	73.5	38.01	January 2017
6-S-27	1200405.00	485125.00	4	UNK	198.58	130	120	130	121.44	January 2017
6-S-28	1200480.00	485125.00	4	UNK	198.6	155	146	166	120.92	November 2006
6-S-29	1201155.00	484800.00	4	UNK	213.14	164	144	164	137.42	January 2017
6-S-30	1200439.00	487859.00	4	156.24	156.24	82.62	72	82	68.06	January 2017
6-S-31	1200423.00	487408.90	4	191.91	194.49	122.95	112	122	107.18	January 2017
6-S-40	1203046.00	485728.60	2	170.12	169.96	140	120	140	90.79	January 2017
6-S-41	1202558.00	485059.20	UNK	182.58	178.32	115	95	115	100.68	January 2017
6-S-42	1201992.00	484225.40	2	189.59	185.25	130	110	130	110.32	January 2017
6-S-43	1201485.00	483607.00	UNK	178.43	174.01	130	110	130	99.73	January 2017
6-S-44[a]	1200624.61	487602.06	4	UNK	UNK	96	86	96	UNK	UNK
MW-1	1199813.00	483971.00	UNK	UNK	152.81	128	121	126	79.68	August 2007
MW-2	1200492.00	484165.00	UNK	UNK	187.84	99	90	95	UNK	UNK
MW-3B	1201078.00	483855.00	UNK	UNK	178.23	115	109	114	103.32	January 2017
MW-4	1201040.00	484764.00	UNK	UNK	209.6	134	129	134	UNK	UNK
MW-5	1200740.00	485266.00	UNK	UNK	207.06	133	127	132	129.47	January 2017
MW-6	1200298.00	484635.00	UNK	UNK	188.93	131	124	129	112.56	January 2017
MW-7	1200440.00	487090.00	UNK	UNK	199.46	149	118.4	148.4	114.83	January 2017
MW-8	1200695.00	485740.00	UNK	UNK	205.9	162	122	162	126.96	November 2006
MW-9	1201720.00	485130.00	UNK	UNK	212.51	153	132	152	135.31	January 2017
MW-10	1200965.00	486020.00	4	216.01	216.21	161	121	161	136.90	January 2017
MW-11	1202140.00	487160.00	4	UNK	172.8	109	83	108	85.39	January 2017
MW-12	1202505.00	487815.00	UNK	UNK	182.82	120	98	118	92.97	January 2017
MW-13	1203080.00	487485.00	4	UNK	194.43	121	101	121	105.49	January 2017
MW-14	1202810.00	487055.00	4	UNK	182.97	109	93	108	95.81	July 2001
MW-15	1202090.00	487195.00	UNK	UNK	172.23	109	89	109	86.71	July 2004
N6-37	1200709.00	487499.00	UNK	170.9	172.25	95.5	85.5	95.5	85.89	January 2017
N6-38	1200538.00	487721.00	UNK	163.3	162.85	89.5	79.5	89.5	75.69	January 2017
P-1	1200210.00	488940.00	2	UNK	96.96	20	5	20	3.83	August 2015
P-2	1200600.00	488955.00	2	UNK	96.98	20	5	20	2.44	February 2016
P-3	1200275.00	488865.00	2	UNK	96.67	20	5	20	3.43	August 2015
P-4	1200590.00	488890.00	2	93.77	96.71	20	5	20	3.09	February 2016
P-5	1201919.00	484967.70	UNK	UNK	204.55	138.5	128	138	130.71	January 2017
P-6	120184.30	485013.40	UNK	UNK	205.32	139.5	129	139	128.37	July 2001
P-7	1200829.00	486788.60	UNK	UNK	204.68	140	129.5	139.5	122.20	January 2017
P-8	1200754.00	486866.60	UNK	UNK	201.6	135.4	125	135	119.92	July 2001
PW-1	1200640.00	487510.00	UNK	UNK	170.81	118.5	87.5	117.5	87.08	January 2017
PW-2	1201045.00	485180.00	UNK	UNK	212.79	168.5	132.5	167.5	135.90	January 2017
PW-3	1200415.00	486710.00	6	UNK	198.42	149	108	148	118.71	January 2017
PW-4	1201040.00	484930.00	UNK	UNK	209.03	164	128	163	134.57	January 2017

Appendix D

Area 6 Groundwater Monitoring Well Construction Summary

Well Name	Easting	Northing	Well Diameter (inches)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Total Depth (feet bgs)	Depth to Screen Top (feet bgs)	Depth to Screen Bottom (feet bgs)	Most Recent Depth to Groundwater (feet btoc)	Measurement Date
PW-5	1200530.00	485490.00	UNK	UNK	197.47	156	120	155	122.03	January 2017
PW-6	1200675.00	485485.00	UNK	UNK	201.53	157.5	116.5	156.5	126.77	January 2017
PW-7	1200810.00	485480.00	UNK	UNK	209.34	164	133	163	134.97	January 2017
PW-8	1201385.00	485195.00	6	UNK	217.82	160	146	166	143.81	January 2017
PW-9	1201155.00	484880.00	6	UNK	205.51	150	130	150	136.32	January 2017
PW-10	1201039.00	485382.00	6	209.69	214.69	155.1	142	152	UNK	UNK

Notes:

Well construction information is summarized from a combination well summary tables from published reports (Sealaska, 2017), well completion diagrams, and NIRIS data.

Horizontal projection associated with well coordinates is North American Datum 1983 (NAD83), State Plane, Washington, North, U.S. Feet

bgs = below ground surface

btoc = below top of casing

msl = mean sea level

UNK = unknown

[a] Coordinates for this well location are approximate