Naval Facilities Engineering Systems Command
NAVFAC Northwest

FINAL
26 APRIL 2023

Project Specific Quality Assurance Project Plan

Keyport Area 8 Supplemental Remedial Investigation

Naval Base Kitsap

Keyport, WA

Department of the Navy
Naval Facilities Engineering Systems Command
1101 Tautog Circle
Silverdale, WA 98315-1101

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Department of the Navy
Naval Facilities Engineering Systems Command Northwest

Final

Project-Specific Quality Assurance Project Plan Keyport Area 8 Supplemental Remedial Investigation

NAVAL BASE KITSAP KEYPORT WA

April 2023

Prepared for NAVFAC Northwest by
AECOM Technical Services Inc
1111 3rd Avenue Suite 1600
Seattle WA 98101-3292

N62742-17-D-1800
CTO N4425520F4176

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Worksheet #1: Title and Approval Page

Final
Project-Specific Quality Assurance Project Plan
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Keyport Area 8 Supplemental Remedial Investigation

Naval Base Kitsap
Keyport, WA

Prepared for:

Department of the Navy
Naval Facilities Engineering Systems Command, Northwest

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Prepared under:
Comprehensive Long-Term Environmental Action Navy
Contract Number N62742-17-D-1800, CTO N4425520F4176

AECOM CTO Manager: Gregory T. Burgess Digitally signed by Gregory T. Burgess Date: 2023.04.20 09:25:47 -07'00' 4/20/23
Greg Burgess Date

AECOM QA Program Manager: 4/24/23
Scott Lewis Date

NAVFAC Northwest RPM: ROHRBAUGH.AMANDA.LYNN.1400915292 Digitally signed by ROHRBAUGH.AMANDA.LYNN.1400915292 Date: 2023.04.24 11:48:12 -07'00' 4/25/23
Amanda Rohrbaugh Date

NAVFAC QAO/Chemist:
Judith Solomon Date

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EXECUTIVE SUMMARY

The intent of this Supplemental Remedial Investigation (SRI) at Area 8 is to gain a better understanding of the current site conditions and site hydrogeology to support future remedial alternative selection to stop site contamination from seeping onto the adjacent beach. This will be achieved by 1) conducting an electrical resistivity tomography (ERT), Ground Penetrating Radar (GPR), and Electromagnetic (EM) geophysical survey, used in conjunction with soil and groundwater physical and chemical data, to determine the lateral and vertical extents of the saltwater wedge beneath the terrestrial portion of the site; 2) conducting a subsurface investigation using direct-push drilling methods and deep boring/well installation using sonic drilling methods, to determine the lateral and vertical current magnitude and extent of contamination in soil and groundwater at the site; and 3) updating the site CSM by reviewing the extent of contamination, contaminant fate and transport dynamics, relevant exposure pathways and using current geologic/hydrogeologic nomenclature. In addition to known site contaminants, soil and groundwater samples collected during the SRI will also be analyzed for 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS). Given the historical metal plating operations that occurred at Building A, the former plating shop, PFAS may have been used at the site. In addition, PFAS has been identified in groundwater at Area 8. PFAS sampling will be used to aid in development of the site conceptual model and to aid in the evaluation of remedial alternatives to ensure that PFAS concentrations are addressed, if warranted, and will not create unwanted byproducts or otherwise adversely impact the remedy.

Naval Base Kitsap (NBK) Keyport occupies 340 acres (including tidelands) adjacent to the town of Keyport in Kitsap County, Washington, on a small peninsula in the central portion of Puget Sound. NBK Keyport is bordered by Port Orchard Bay to the northwest and Port Orchard Bay to the north, east, and southeast (Figure 1). Area 8 occupies about 1 acre on the eastern portion of NBK Keyport and encompasses the location of Building A, the former plating shop (Figure 2).

The historical release of chemicals at Area 8 includes metals and volatile organic compounds (VOCs) present in plating solutions released during plating operations in Building A. Petroleum hydrocarbons (diesel and heavy oil) were also released to the environment from leaky underground storage tanks (USTs) and underground concrete vaults located in Area 8. The intent of this SRI at Area 8 is to gain a better understanding of the current site conditions and site hydrogeology to support future remedial alternative selection to stop site contamination from seeping onto the adjacent beach.

The Record of Decision (ROD) for Operable Unit (OU) 2 was signed on September 28, 1994 (DON, EPA, and Ecology 1994), and the ROD for OU 1 was signed on September 30, 1998 (DON, EPA, and WSDE 1998). Remedial action objectives were developed for Area 8 in the OU 2 ROD and are paraphrased below:

- Prevent human ingestion of groundwater containing metals and VOCs at concentrations above drinking water standards or acceptable human health risk levels.
- Protect sediments and surface water quality offshore of Area 8 in Port Orchard Bay from contaminants in groundwater that could cause future adverse impacts or human health risks.
- Prevent humans from coming into direct contact with, or ingesting, soil containing chemicals of concern (COCs) at concentrations that would present unacceptable risk to human health.
- Protect groundwater and surface water quality from soil containing COCs.

The selected remedy for Area 8 consists of institutional controls and groundwater monitoring. The purpose of the institutional controls was to prohibit residential use of the site and to prevent construction of domestic wells. The monitoring was to be used to establish COC trends in groundwater and to determine when institutional controls could be discontinued. In compliance with the monitoring program, the Navy agreed to install additional upgradient wells to confirm that no upgradient source of COCs exists. The selected remedy for Area 8 included the following components:

- Removal and off-site disposal of vadose zone soil from COC hot spots
- Groundwater monitoring in the water table aquifer
- Sediment and tissue monitoring to assess the potential long-term impacts of contaminated groundwater discharge to Port Orchard Bay
- Contingent groundwater control actions based on the risk assessment of sediment and tissue monitoring data
- Institutional controls

The ROD anticipated that after the soil removal component of the remedy, “residual contamination may continue to be discharged into Port Orchard Bay for many years” (DON, EPA, and Ecology 1994). The criteria in the ROD for whether contingent groundwater control measures or further investigations must be implemented are whether the “discharges accumulate over the long-term” and a post-ROD risk assessment of human health and the environment “shows unacceptable risks or exceedances of state sediment cleanup screening levels” (DON, EPA, and Ecology 1994).

Petroleum hydrocarbons and aromatic compounds, identified as heavy fuel oils, were detected in groundwater samples near former Bldgs. B and C. The source of these compounds is believed to be the former fuel storage vaults at these two buildings. The petroleum hydrocarbon contamination was remediated under Ecology’s Model Toxics Control Act (MTCA) by the Navy’s UST compliance program rather than under the Comprehensive Environmental Response, Compensation, and Liability Act by the Navy’s environmental restoration program. The remediation was conducted as an independent action under the MTCA regulations (Washington Administrative Code 173-340-450). This remediation consisted of soil removal, which included the installation of two slurry walls to stabilize excavation sidewalls during contaminated soil removal (DON 2018).

The ROD for OU 2 was modified by an Explanation of Significant Differences (ESD) dated March 15, 1996 (DON, EPA, and Ecology 1996). As a result of the ESD, the completion of soil removal at OU 2 Area 8 was delayed until after the plating building was demolished, and the determination of the amount of soil to be removed was changed to be based on total chromium analyses instead of hexavalent chromium analyses, indicating that all total chromium results were to be interpreted as hexavalent chromium.

The remedy selected for Area 8 was expected to be achieved by implementing institutional control measures.

Annual groundwater monitoring results suggest that the soil removal action has had a substantial positive effect on groundwater quality at the site. Cadmium concentrations in one well (MW8-11) decreased substantially after the removal action but have since stabilized at a concentration above the surface water remediation goal (RG). Well MW8-11 is located upgradient of Seep A, where cadmium concentrations are approximately 6.3 times greater than the surface water RG of 8 micrograms per liter (µg/L). Cadmium concentrations decreased substantially in water samples from Seep A immediately following the removal action, but they are currently showing an increasing trend.

A cadmium concentration of 0.8 milligrams per kilogram (mg/kg) in soil was considered to be protective of groundwater but was never identified as an RG. Soil samples collected from the limits of the 1992 excavation, and from the soil borings conducted prior to the 1998 to 1999 removal, show that cadmium concentrations greater than 0.8 mg/kg still remain in place.

One location from the 1998 to 1999 characterization event showed a cadmium concentration of 4,380 mg/kg in soil at 9 feet below ground surface (bgs). This sample was collected at a location just south of well MW8-11 and upgradient of Seep A. It is likely that elevated cadmium concentrations remain in soil and saturated soil at this location, causing cadmium concentrations in groundwater from well MW8-11 to remain stable and causing the increasing trend observed in samples from Seep A.

An optimization evaluation of the remedial program at Area 8 was conducted in 2006 (DON 2006). The optimization recommended that the extent and magnitude of cadmium be evaluated in soil, unsaturated soil, and groundwater in the immediate area of the 1998/1999 soil sample with a cadmium concentration of 4,380 mg/kg. The optimization indicated that if a mass of cadmium is found to be present in this area, this soil should be removed, given the substantial improvement of groundwater quality at the site as a result of similar soil removal actions conducted in the past.

Although no RG for sediment or tissue at the Area 8 beach was established in the ROD, a post-ROD evaluation of human health and ecological risks was required by the ROD based on concerns that COC concentrations in groundwater discharging to Port Orchard Bay might increase in the future and call into question the findings of the 1993 baseline human health risk assessment (HHRA)/ecological risk assessment (ERA). As specified in the ROD, the post-ROD risk assessments were to be performed using the same exposure assumptions as those in the baseline risk assessments. However, according to the five-year review process, it is presumed that if any substantial changes to exposure assumptions are found while assessing whether or not the remedy remains protective, then these changes would be incorporated into future risk assessments, as was done in the subject risk assessment.

Human health and ecological risks associated with exposure to potentially contaminated media at the beach adjacent to Area 8 (i.e., clam tissue, sediment, seep water, and marine water) were evaluated in the 2018 HHRA/ERA, completed in 2018 as required by the OU 2 ROD (DON 2018). The specific objectives of the risk assessments included characterization of human health and ecological site risks relative to background.

Tissue, sediment, seeps/outfalls, and marine surface water samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc, and these data were evaluated in the risk assessments. The HHRA found no unacceptable human health risk over reference areas. Multiple lines of evidence considered in the ERA suggested that the hazards to benthic organisms are low despite localized elevated concentrations of cadmium in seeps and sediment.

Toxicity testing of sediment and seep water locations at Area 8 and a reference area were performed in 2019 and evaluated in the 2020 ERA Addendum (DON 2021). The results indicated that Area 8 COCs in groundwater have impacted sediment, resulting in a risk to benthic invertebrates (clams) on the adjacent beach. The OU 2 ROD specifies that, if a risk is identified, groundwater controls will be instituted, and presents six options for controlling groundwater at the site. However, none of the options presented are technically feasible due to the tidally influenced nature of the site.

CONTENTS

APPENDICES

FIGURES (INCLUDED IN APPENDIX B)

TABLES

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ACRONYMS AND ABBREVIATIONS

°C	degree Celsius
AECOM	AECOM Technical Services, Inc.
API	American Petroleum Institute
ARI	Analytical Resources, Inc.
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
Bldg.	building
CASRN	Chemical Abstract Service Registry Number
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ChoC	Chain-of-Custody
CLARC	Cleanup Levels and Risk Calculation
COC	chemical of concern
COPC	chemical of potential concern
CPAH	carcinogenic polynuclear aromatic hydrocarbons
CSM	conceptual site model
CTO	contract task order
DCE	dichloroethene
DFTPP	decafluorotriphenylphosphine
DI	deionized
DL	detection limit
DOC	dissolved organic carbon
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation, United States
EB	equipment blank
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EDQW	Environmental Data Quality Workgroup
EIS	environmental impact statement
ELAP	Environmental Laboratory Accreditation Program
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
EPA	Environmental Protection Agency, United States
ERA	ecological risk assessment
ERT	electrical resistivity tomography
ESD	Explanation of Significant Differences
FB	field blank
FD	field duplicate
FFS	focused feasibility study
FS	feasibility study
GC/FID	gas chromatography flame ionization detector
GC/MS	gas chromatography mass spectrometry
GPS	global positioning system

GW	groundwater
HAL	Health Advisory Level
HFPODA	Hexafluoropropylene oxide dimer acid
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IAS	initial assessment study
ICAL	initial calibration
ICP	inductively coupled plasma
ID	identification
IDW	investigation-derived waste
IGS	Integrated Geosciences
LC/MS/MS	liquid chromatography with tandem mass spectrometry
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDC	Laboratory Data Consultants
LOD	limit of detection
LOQ	limit of quantitation
LTM	long-term monitoring
MB	method blank
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
MPC	measurement performance criteria
MS	matrix spike
MSA	method of standard addition
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
N/A	not applicable
NAVFAC	Naval Facilities Engineering Systems Command
Navy	Department of the Navy, United States
NBK	Naval Base Kitsap
ND	non-detect
NE	not established
NIRIS	Naval Installation Restoration Information Solution
no.	number
NPL	National Priorities List
NTR	Navy Technical Representative
OSD	Office of the Secretary of Defense
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PAL	project action limit
PDS	post digestion spike
PID	photoionization detector

PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PQO	project quality objective
PRISM®	Predictive Integrated Stratigraphic Modeling
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QAO	Quality Assurance Officer
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RG	remediation goal
ROD	Record of Decision
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
RPM	remedial project manager
SAP	sampling and analysis plan
SOP	standard operating procedure
SLs	screening levels
SPE	solid phase extraction
SRI	supplemental remedial investigation
SSHO	site safety and health officer
STD	standard
SVOC	semivolatile organic compound
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEF	toxicity equivalent factor
TOC	total organic carbon
U.S.	United States
UST	underground storage tank
UV	ultraviolet
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code
WP	work plan
XRF	X-ray fluorescence

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Worksheet #2: Work Plan/Quality Assurance Project Plan Identifying Information

Site Name/Number (No.):	Naval Base Kitsap (NBK) Keyport, Area 8
Operable Unit (OU):	OU 2
Contractor Name:	AECOM Technical Services, Inc. (AECOM)
Contract No.:	N62742-17-D-1800
Contract Title:	Comprehensive Long-Term Environmental Action Navy V
Contract Task Order (CTO) No.:	N4425520F4176

1. This quality assurance project plan (QAPP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Project Plans* (DoD 2005) and United States (U.S.) Environmental Protection Agency (EPA) *Guidance for Quality Assurance Project Plans, EPA QA/G-5* (EPA 2002).

2. Identify regulatory program:

   Primary: Model Toxics Control Act (MTCA)

   Secondary: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. This QAPP is a project-specific QAPP.

4. List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partner/Stakeholder	Role
Washington State Department of Ecology (Ecology)	State Regulatory Agency (Lead Regulator)
EPA Region 10	Federal Regulatory Agency
Suquamish Tribe	Project Stakeholder

5. Lead Agency: Naval Facilities Engineering Systems Command (NAVFAC) Northwest

6. If any required QAPP elements and required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:

Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management and Objectives		
Documentation		
1	Title and Approval Page	Page 1
2	Work Plan/Quality Assurance Project Plan Identifying Information	Page 14
3	Distribution List	Page 19
4	Project Personnel Sign-Off Sheet	Page 21
Project Organization		
5	Project Organizational Chart	Page 23
6	Communication Pathways	Page 25
7	Personnel Responsibilities Table	Page 27
8	Special Personnel Training Requirements Table	Page 29
Project Planning/Problem Definition		
9	Project Scoping Session Participants Sheet	Page 30
10	Conceptual Site Model	Page 33
11	Project Quality Objectives/Systematic Planning Process Statements	Page 43
12	Field Quality Control Samples	Page 51
13	Secondary Data Criteria and Limitations Table	Page 55
14	Summary of Project Tasks	Page 56
15	Reference Limits and Evaluation Tables	Page 63
16	Project Schedule/Timeline Table	Page 73
B. Measurement/Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	Page 75
18	Location-Specific Sampling Methods/SOP Requirements Table	Page 83
19	Field Sampling Requirements Table	Page 87
20	Field Quality Control Sample Summary Table	Page 91
21	Project Sampling SOP References Table	Page 93
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Page 95
Analytical Tasks		
23	Analytical SOP References Table	Page 97
24	Analytical Instrument Calibration Table	Page 101
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Page 115
Sample Collection		
26	Sample Handling System	Page 119
27	Sample Custody Requirements	Page 120
Quality Control Samples		
28	Laboratory QC Samples Table	Page 123
Data Management Tasks		
29	Project Documents and Records Table	Page 147
30	Analytical Services Table	Page 149
C. Assessment Oversight		
31	Planned Project Assessments Table	Page 153
32	Assessment Findings and Corrective Action Responses	Page 154
33	Quality Assurance Management Reports Table	Page 156

Worksheet #	Required Information	Crosswalk to Related Information
D. Data Review		
34-36	Data Verification and Validation (Steps I and IIa/IIb) Process Table	Page 159
37	Usability Assessment	Page 161

QC	quality control
SOP	standard operating procedure

This document also includes the following appendixes:

1. *Appendix A:* Project Scoping Session Minutes
2. *Appendix B:* Figures
3. *Appendix C:* Project Screening Levels and Historic Data Summary
4. *Appendix D:* Geophysical Workplan
5. *Appendix E:* Standard Operating Procedures (On CD-ROM)
6. *Appendix F:* Investigation-Derived Waste Sampling Information
7. *Appendix G:* Analytical Data Package Requirements
8. *Appendix H:* Accident Prevention Plan
9. *Appendix I:* Laboratory Accreditation
10. *Appendix J:* References
11. *Appendix K:* Responses to Stakeholder Comments

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Worksheet #3: Distribution List

Work Plan/Quality Assurance Project Plan Recipient	Title	Organization	Phone Number	E-mail Address
Amanda Rohrbaugh	Navy RPM	NAVFAC Northwest	360-396-0248	amanda.l.rohrbaugh.civ@us.navy.mil
Judith Solomon	Navy QAO/Chemist	NAVFAC Atlantic	757-322-4744	judith.solomon7.civ@us.navy.mil
Binod Chaudhary	Project Manager	Ecology	564-669-3015	bcha461@ECY.WA.GOV
Ben Leake	Project Manager	EPA	503-326-2859	leake.benjamin@epa.gov
Andrew Schmeising	Project Manager	Suquamish Tribe	360-394-7111	aschmeising@suquamish.nsn.us
Greg Burgess	Project Manager	AECOM	206-914-0533	greg.burgess@aecom.com
Anthony Palmieri	Technical Lead	AECOM	206-438-2417	anthony.palmieri@aecom.com
Sarah Welter	Field Lead/SSHO	AECOM	478-973-0578	sarah.welter@aecom.com
Jen Garner	Project Chemist	AECOM	206-438-2063	jen.garner@aecom.com
Kelly Bottem	Project Manager	Analytical Resources, Inc.	206-695-6211	kelly.bottem@arilabs.com
Mandy Barnhart	Project Manager	Eurofins	717-556-3860	amanda.barnhart@eurofinset.com
Emika Anazodo	Project Manager	Integrated Geosciences	713-316-1803	eanazodo@igslaboratories.com
Mingta Lin	Project Manager	Pyron Environmental, Inc.	360-867-9543	mingta_lin@comcast.net
Dale Abernathy	Project Manager	Holt Services	253-604-4878	dabernathy@holtservicesinc.com
Taylor Schulte	Project Manager	Bush, Roed & Hitchings	206-323-4144	taylors@brhinc.com

AECOM	AECOM Technical Services, Inc.
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency, United States
NAVFAC	Naval Facilities Engineering Systems Command
NTR	Navy Technical Representative
QAO	Quality Assurance Officer
RPM	Remedial Project Manager
SSHO	site safety and health officer

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Worksheet #4: Project Personnel Sign-Off Sheet

Listed below are key personnel who are required to read and understand the QAPP prior to performing field activities. The CTO manager or designee will send an acknowledgement e-mail form with a link to the QAPP to the key personnel listed below. Upon completion of review of the QAPP, the personnel will acknowledge that they have read the QAPP by checking the acknowledgement box in the e-mail form and reply (send) to the originator of the e-mail. A record of the acknowledgement will be automatically documented. The acknowledgement document will be appended to project records. The QAPP will be reviewed verbally with the project personnel listed below in a project kick-off meeting prior to field activities to verify the personnel understand the QAPP.

Project Personnel	Organization, Title
Greg Burgess	AECOM, CTO Manager
Anthony Palmieri	AECOM, CTO Technical Lead
Sarah Welter	AECOM, Field Lead/SSHO
Jen Garner	AECOM, Project Chemist

AECOM	AECOM Technical Services, Inc.
CTO	contract task order
SSHO	site safety and health officer

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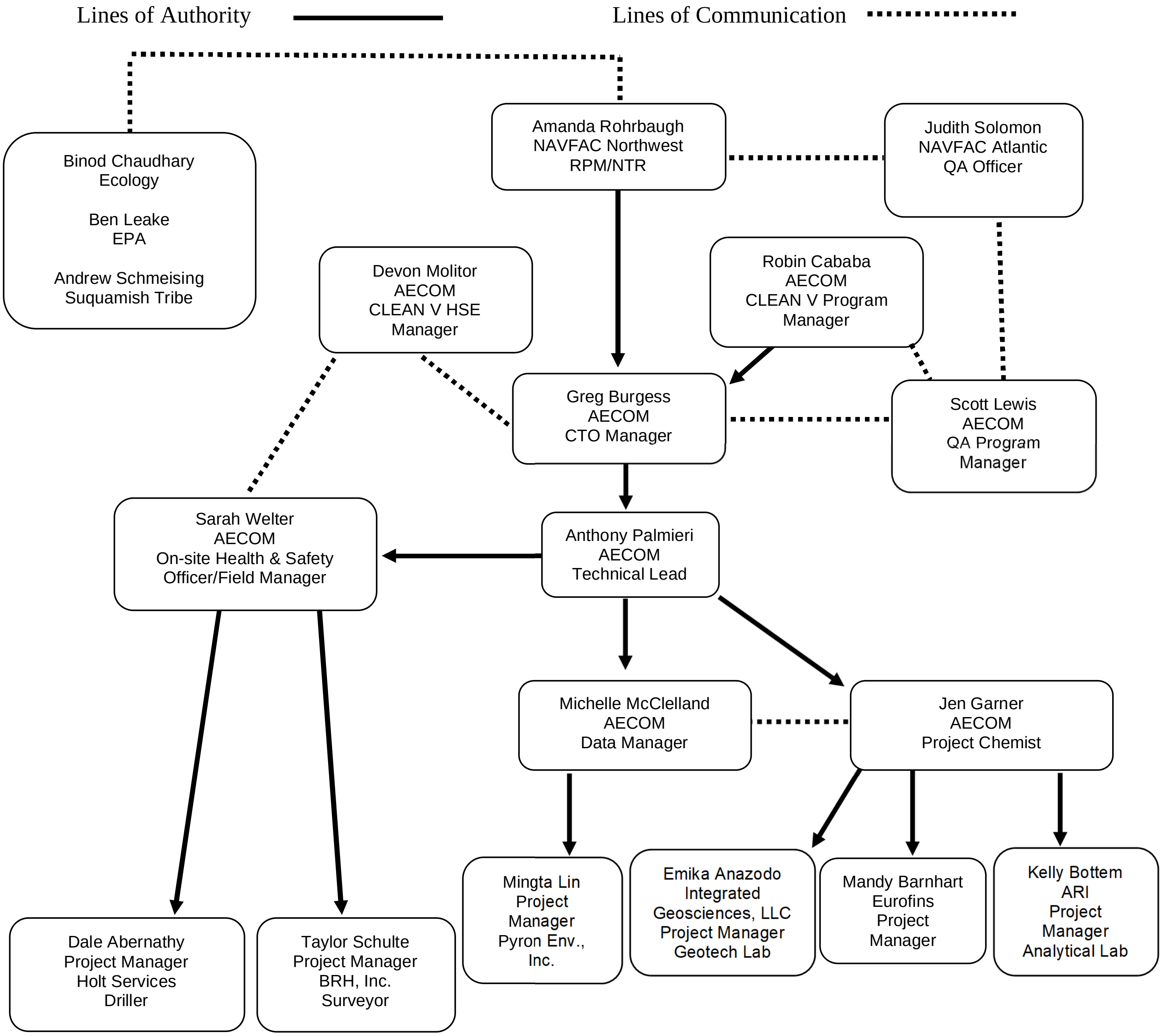
Worksheet #5: Project Organizational Chart



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Worksheet #6: Communication Pathways

The communication pathways for the WP/QAPP are shown below.

Communication Driver	Responsible Entity	Name	Phone Number	Procedure
Stakeholder Interface	Navy RPM	Amanda Rohrbaugh	360-396-0248	All project documentation will be forwarded by the Navy RPM. The Navy will be responsible for notifying project stakeholders (i.e., EPA Region 10, Ecology and the Suquamish Tribe) when significant corrective actions or changes occur. Corrective actions will be communicated within 24 hours.
Project Management	AECOM CTO Manager	Greg Burgess	206-914-0533	The AECOM CTO manager will direct and approve all communication to the Navy's RPM and provide monthly status reports to the Navy contracting officer. The AECOM CTO manager will notify the Navy RPM of field changes or modifications by close of business the following day.
QA/QC Management	AECOM QA Program Manager	Scott Lewis	808-356-5329	The AECOM QA program manager will designate responsible project quality personnel to perform specified QA and QC activities and report to project and program management. Issues, non-conformances, and corrective actions will be reported to Navy QA Officer within 1 day of non-conformance issuance.
Field Progress Reports	AECOM Field Manager	Sarah Welter	478-973-0578	The AECOM field manager will communicate relevant field information to the CTO manager and AECOM project chemist daily during field activities, by phone or e-mail.
Stop Work Due to Safety Issues	All Field Staff	All Field Staff	N/A	All field staff have the authority to stop work conducted by field subcontractors or field sampling personnel. Field work will then restart upon satisfactory implementation of the appropriate corrective actions.
WP/QAPP Changes Prior to Field/Laboratory work	AECOM CTO Manager	Greg Burgess	206-914-0533	Substantial changes to the planning documents will require the AECOM CTO manager to prepare amended worksheets and provide them to the Navy RPM and QAO for review and approval before the activities begin.
WP/QAPP Changes in the Field	AECOM Field Manager	Sarah Welter	478-973-0578	The AECOM field manager will notify the CTO manager of changes to the procedures specified in the QAPP during field activities. The AECOM CTO manager will determine the appropriate course of action and document these changes in the remedial investigation report.
Field Corrective Actions	AECOM Field Manager	Sarah Welter	478-973-0578	The AECOM field manager has the authority to stop work and issue corrective response actions to field sampling personnel. Modes of communication will be by phone or e-mail within 24 hours.
Daily ChoC Reports and Shipping Documentation	AECOM Field QC Coordinator/SSHO	Sarah Welter	478-973-0578	ChoCs and shipping records will be submitted via fax or e-mail to the AECOM project chemist at the end of each day that samples are collected.
Sample Receipt Variances	Laboratory Project Manager	Kelly Bottem (Analytical Resources, Inc.) Mandy Barnhart (Eurofins) Emika Anazodo (Integrated Geosciences)	206-695-6211 717-556-3860 713-373-7180	All variances in sample receipt will be reported to the AECOM project chemist by the laboratory within 24 hours of variance. A signed copy of the ChoCs and a completed Sample Condition Report will be provided to the project chemist within 24 hours of sample receipt.

Communication Driver	Responsible Entity	Name	Phone Number	Procedure
Reporting Laboratory Data Quality Issues	Laboratory Project Manager	Kelly Bottem (Analytical Resources, Inc.) Mandy Barnhart (Eurofins) Emika Anazodo (Integrated Geosciences)	206-695-6211 717-556-3860 713-373-7180	QA/QC issues that potentially affect data usability will be reported by the laboratory project manager to the AECOM project chemist by e-mail within 1 business day. If significant problems are identified from the laboratory that impact the usability of the data, the project chemist will inform the Navy RPM within 1 day of notification.
	Navy RPM	Amanda Rohrbaugh	360-396-0248	If significant problems with the laboratory are identified, the Navy RPM will inform the Navy QA Officer for evaluation to determine what corrective actions will be taken.
Reporting Lab Quality Variances	Laboratory Project Manager	Kelly Bottem (Analytical Resources, Inc.) Mandy Barnhart (Eurofins) Emika Anazodo (Integrated Geosciences)	206-695-6211 717-556-3860 713-373-7180	All laboratory QA/QC variance issues will be reported to the AECOM project chemist by the laboratory within 1 day of variance. The variance(s) will be reported to the AECOM CTO manager on the same business day and to the Navy within 2 business days.
Analytical Corrective Actions	AECOM Project Chemist	Jen Garner	206-438-2063	The AECOM project chemist will immediately notify the AECOM CTO manager and the laboratory project manager by e-mail of field or analytical procedures that were not performed in accordance with the planning documents. The AECOM project chemist will document the non-conformance, issue the corrective actions to be taken, and verify implementation of the corrective actions by the laboratory.
Reporting Data Validation Issues	Data Validation Project Manager	Mingta Lin	360-867-9543	All data validation issues will be reported to the AECOM project chemist by the data validators by phone or e-mail. The validators will generate memoranda to the laboratory in regard to incomplete deliverables or discrepancies. The issue(s) will also be reported to the AECOM CTO manager or the project chemist within 1 business day by phone or e-mail.
Data Validation Corrective Actions	AECOM Analytical & Data Validation Advisor	Jen Garner	206-438-2063	The AECOM analytical and data validation advisor will have the authority to issue corrective response actions to laboratory and data validation firms. Corrective actions may be issued to the laboratory as a result of data validation results. Modes of communication will be by phone or e-mail within 24 hours after audit.

ChoC	chain-of-custody
CTO	contract task order
N/A	not applicable
Navy	Department of the Navy, United States
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	quality assurance project plan
QC	quality control
RPM	remedial project manager
SSHO	site safety and health officer
WP	work plan

Worksheet #7: Personnel Responsibilities Table

Project-specific responsibilities are provided in the following table.

Name	Title	Organizational Affiliation	Responsibilities
Amanda Rohrbaugh	Navy RPM	Navy	Coordinates with regulatory agency/agencies and other stakeholders. Contract technical administration and project oversight.
Binod Chaudhary	Regulatory Project Manager	Ecology	Provides State regulatory oversight for the project.
Ben Leake	Regulatory Project Manager	EPA	Provides Federal regulatory oversight for the project.
Andrew Schmeising	Tribal Project Manager	Suquamish Tribe	Provides oversight for the project to ensure treaty rights are not adversely impacted.
Judith Solomon	QA Officer	Navy	Provides QA surveillance during the procurement process and, following award of contract, monitors compliance with contract and project performance standards.
Robin Cababa	CLEAN V Program Manager	AECOM	Ensures compliance with contractual and technical procedures across the program.
Scott Lewis	QA Program Manager	AECOM	Reviews all technical procedures. Oversees project QA and ensures that overall technical direction correlates with other Navy CLEAN sites.
Greg Burgess	CTO Manager	AECOM	Coordinates with the Navy and provides overall technical direction and guidance for the project. Shares responsibility with the Navy RPM for distribution of project-related documents. Identifies project problems or non-conformance and initiates corrective action.
Sarah Welter	SSHO (on-site)/ Field QC Coordinator	AECOM	Implements the site-specific accident prevention plan; prepares, implements, and oversees the AHAs; conducts daily tailgate health and safety meetings. Maintains the QA/QC field logbook, ensures collection of QA/QC samples as proposed in the QAPP, and documents collection. Provides QC review of field logbook maintained by the AECOM field manager.
Devon Molitor	Safety and Health Manager	AECOM	Directs and oversees the accident prevention plan and procedure.
Sarah Welter	Field Manager	AECOM	Plans and oversees the implementation of field sampling, monitors adherence to activity-specific SOPs, and coordinates subcontractors in the field.
Sarah Welter	Field Geologist	AECOM	Identifies sampling locations, directly oversees utility clearance, vegetation clearance, and intrusive activities (e.g., well installations). Describes soil, records the description in sampling logs, and records well construction details.
Jen Garner	Project Chemist	AECOM	Provides specific technical assistance for the project including development of the project work and analytical plans and reporting document. Assists with analytical laboratory and data validation procurement, oversight/management, and coordination. Oversees all field sampling activities to ensure adherence to the QAPP. Coordinates with the analytical laboratory and data validation firms. Reviews and evaluates analytical data and summarizes data validation reports. Assists with sample collection as needed.
Mingta Lin	Analytical & Data Validation Advisor	Pyron Environmental, Inc.	Assists with analytical and data validation, as well as data usability issues.
Michelle McClelland	Database Manager	AECOM	Manages and maintains the project database; provides data reports as needed.
Kelly Bottem	Laboratory Project Manager	Analytical Resources, Inc.	Manages analytical data generation.
Mandy Barnhart	Laboratory Project Manager	Eurofins	Manages analytical data generation.
Emika Anazodo	Laboratory Project Manager	Integrated Geosciences	Manages geotechnical/physical testing data generation.

Name	Title	Organizational Affiliation	Responsibilities
Laboratory Assigned	Laboratory Quality Assurance Officer	Laboratory Assigned	Performs laboratory QA oversight.
Michelle McClelland	Data Validation Task Manager	AECOM	Manages analytical data validation of work performed by the laboratory.
Taylor Schulte	Land Survey Subcontractor	Bush, Roed & Hitchings	Conducts land survey for special representation of SRI sampling locations and limits of debris boundaries.
Dale Abernathy	Drilling Subcontractor	Holt Services, Inc.	Performs drilling activities (i.e., subsurface soil borings and well installations).

AHA	activity hazard analysis
CLEAN	Comprehensive Long-Term Environmental Action Navy
LDC	Laboratory Data Consultants
NTR	Navy Technical Representative
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RPM	remedial project manager
SOP	standard operating procedure
SRI	supplemental remedial investigation
SSHO	site safety and health officer

Worksheet #8: Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
PFAS sampling	AECOM PFAS sampling training	AECOM University	Yearly	All sampling field staff	N/A	AECOM project directory, available upon request

PFAS	per- and polyfluoroalkyl substances

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Worksheet #9: Project Scoping Session Participants Sheet

Project Name: Keyport Area 8 Supplemental Remedial Investigation
Projected Date(s) of Sampling: Winter 2022
Contract Task Order Manager: Greg Burgess

Site Name: NBK Keyport, OU 2 Area 8
Site Location: Keyport, WA

Date of Session: November 18, 2020
Scoping Session Purpose: Supplemental Remedial Investigation Goals and Sampling Locations

Name	Project Role	Affiliation	Phone Number	E-mail Address
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Denice Taylor*	Tribe Project Manager	Suquamish Tribe	360-394-8449	dtaylor@suquamish.nsn.us
JoAnn Grady	Team Facilitator	Grady & Associates	907-321-3213	joanngrady@gmail.com
Greg Burgess	Project Manager	AECOM	206-914-0533	greg.burgess@aecom.com
Anthony Palmieri	Technical Lead	AECOM	206-438-2417	anthony.palmieri@aecom.com
Josie Smith	Project Chemist	AECOM	206-438-2168	josie.smith@aecom.com

EXWC Engineering and Expeditionary Warfare Center

[a] Team member has changed roles, retired, or left project team.

The project scoping session was held and the following subjects discussed:

Comments/Decisions:

- Project Background
  - Use of recent risk assessment to develop scope and potential alternatives
  - Presence of emerging contaminants
  - Presentation of prior investigations and results
  - Discuss conceptual site model (CSM) and site chemicals of concern (COCs)

- Data Gaps
  - Subslab vapor
  - Per- and polyfluoroalkyl substances (PFAS)
  - COPCs studied during the initial remedial investigation (RI) but removed from further consideration
- Proposed Scope
  - Tidal study using geophysics
  - Direct-push drilling investigation
  - Deep boring and well installation
- Current Schedule
  - Big tidal fluctuation is in late May through early June.

Consensus Decisions:

Historic data for the site needs to be reviewed to determine if chemical analytes need to be added to the scope of this investigation. This review should determine if current screening levels may be lower than reporting limits that were used during previous investigations.

Complete meeting minutes are included in Appendix A.

Worksheet #10: Conceptual Site Model

10.1 OVERVIEW

This section summarizes the purpose, scope, and approach.

10.2 SITE DESCRIPTION, HISTORY, AND ENVIRONMENTAL SETTING

10.2.1 Site Description(s) and History

NBK Keyport occupies 340 acres (including tidelands) adjacent to the town of Keyport in Kitsap County, Washington, on a small peninsula in the central portion of the west side of Puget Sound. NBK Keyport is bordered by Port Orchard Bay to the north, northwest, east, and southeast (Figure 1). Area 8 occupies about 1 acre on the eastern portion of NBK Keyport and encompasses the location of Building (Bldg.) A, the former plating shop (Figure 2). Bldg. A was demolished in 1999 and replaced by an asphalt-paved parking area. The site is located in a heavily industrialized part of the facility bordered by Port Orchard Bay to the south and east. Area 8 is predominantly flat and almost entirely paved or covered by buildings.

10.2.2 Summary of Pre-ROD Site Investigations

In September 1984, the U.S. Department of the Navy (Navy) conducted an initial assessment study (IAS) under the Navy Assessment and Control of Installation Pollutants program to identify areas of possible environmental contamination resulting from past methods of storage, handling, and disposal of hazardous substances at NBK Keyport (DON, EPA, and Ecology 1984). In October 1989, NBK Keyport was officially listed on the National Priorities List (NPL). In response to the NPL designation, the Navy, EPA, and Ecology entered an interagency federal facilities agreement in July 1990 for the investigation, remediation, and restoration of the site.

Subsequent to the IAS, six specific areas (Areas 1, 2, 3, 5, 8, and 9) were recommended for further investigation in the 1993 RI/feasibility study (FS). Under the ER, N Program, the RI/FS process for these six areas began in 1988 and the final RI/FS reports were submitted in October and November of 1993 (DON 1993c; 1993d). During the public comment period for the proposed plan, significant public concerns were submitted regarding Area 1 (the former base landfill). Therefore, it was determined that the site should be divided into two OUs for efficient administrative handling of the site remediation. OU 1 was designated to consist of Area 1 (the former base landfill) and OU 2 to consist of the remaining areas of concern (Areas 2, 3, 5, 8, and 9), including Area 8, the subject site.

The historical release of chemicals at Area 8 is associated with Bldg. A, the former plating shop, including spillage of chrome plating solution onto the ground; discharge of plating wastes into a waste trench; and leakage of plating solutions through cracks in the plating shop floor, waste disposal pipes, and sumps. Metals and volatile organic compounds (VOCs) were present in these plating solutions. Petroleum hydrocarbons (diesel and heavy oil) were also released to the environment from leaky underground storage tanks (USTs) and underground concrete vaults located in Area 8.

An evaluation of past data in relation to current reporting limits and action limits is included under Section 10.4. The following sections present a summary of past data only.

For groundwater at Area 8, concentrations of 10 metals (antimony, arsenic, cadmium, hexavalent chromium [Cr+6], copper, lead, manganese, nickel, thallium, and zinc) were found to exceed federal maximum contaminant levels (MCLs) or state MTCA Method B cleanup levels for the protection of drinking water. Groundwater at Area 8 is not used as a drinking water source at this time. A plume of metals was found to extend from the western portion of Bldg. A to the east and southeast toward Port Orchard Bay (DON, EPA, and Ecology 1994). The concentrations of metals generally decreased eastward toward the bay. Within the plume, the distributions of cadmium and chromium were well defined and could be traced to former operations at Bldg. A (e.g., the chromium plume could be traced to the former chrome room in Bldg. A).

In addition, the groundwater at Area 8 had 12 VOCs that exceeded the federal and state MCLs (for surface water protection criteria) or MTCA Method B levels (for protection of human health in groundwater). The most frequently detected organic compounds in samples from shallow groundwater monitoring wells and seeps were trichloroethene (TCE), 1,1,1-trichloroethane, 1,2-dichloroethene (DCE), and 1,1-DCE. These compounds form a plume in the upper aquifer that extends from the eastern and southern sides of Bldg. A eastward and southeastward to the intertidal zone of Port Orchard Bay (DON, EPA, and Ecology 1994).

Based on the RI results, the areal extent of the VOC plume was larger than the extent of the inorganic plume. Three of the four VOCs were also detected at lower concentrations in groundwater samples from an intermediate-depth well (MW8-16, screened at 45 feet below ground surface [bgs]). No VOCs were found in the deepest well (MW8-15) above the Clover Park unit. The presence or absence of dense non-aqueous phase liquid was not conclusively determined during the RI. The principal source of these VOCs is believed to be solvents used in Bldg. A. It is also possible that some of the VOCs originated from the historical use of solvents in adjacent buildings. Petroleum hydrocarbons and aromatic compounds, identified as heavy fuel oils, were detected in groundwater samples from locations around Bldgs. B and C. The source of these compounds is believed to be former fuel storage vaults at these two buildings. The petroleum hydrocarbon contamination was remediated under the UST compliance program rather than CERCLA. The remediation was conducted as an independent action under MTCA (Washington Administrative Code [WAC] 173-340-450). As Area 8 groundwater discharges into Port Orchard Bay, there is a potential for chemical migration from the groundwater to the marine environment. During the RI, some beach seep samples from Area 8 exceeded the surface water quality criteria for metals. No exceedances were identified in surface water samples collected from Port Orchard Bay during the RI (DON 2010).

10.2.3 Summary of 1993 Baseline Risk Assessments

The Area 8 baseline human health risk assessment (HHRA) and ecological risk assessment (ERA) conducted in 1993 found no unacceptable health risks under an industrial exposure scenario for either humans or ecological receptors (no terrestrial habitat for ecological receptors is present at Area 8) (DON 1993b; 1993a). Although the land use will remain industrial for the foreseeable future, the baseline HHRA found that chemicals of potential concern (COPCs) in soils and groundwater at Area 8 posed an unacceptable risk to hypothetical future residents. Specifically, the baseline HHRA reported a cancer risk of 4×10^{-9} and a hazard index (HI) of 0.04 under a current land use scenario, but a cancer risk of 1×10^{-3} and a HI of 30 under a future residential scenario. Future residential exposure pathways that contributed to risk and were not evaluated for the industrial scenario included the following:

- Ingestion of groundwater as drinking water from the shallow aquifer (5×10^{-4} and HI = 30). Arsenic, 1,1-DCE, and TCE contributed to risk. Cadmium, chromium, and TCE contributed to the HI.
- Inhalation of volatiles during household use of water (5×10^{-4}). 1,1-DCE and TCE contributed to risk.
- Ingestion of homegrown produce (2×10^{-5} and HI = 4). Arsenic in soil contributed to risk. Cadmium in soil resulted in the hazard quotient (HQ) of 4.

The results of the baseline ERA indicated that shallow groundwater discharging from Area 8 to Port Orchard Bay did not pose significant risk to marine organisms.

10.2.4 Summary of ROD

The Record of Decision (ROD) for OU 2 was signed on September 28, 1994 (DON, EPA, and Ecology 1994). Remedial action objectives were developed for Area 8 in the OU 2 ROD, and are paraphrased below:

- Prevent human ingestion of groundwater containing metals and VOCs at concentrations above drinking water standards or acceptable human health risk levels.
- Protect sediments and surface water quality offshore of Area 8 in Port Orchard Bay from contaminants in groundwater that could cause future adverse impacts or human health risks.
- Prevent humans from coming into direct contact with or ingesting soil containing COCs at concentrations that would pose unacceptable risk to human health.
- Protect groundwater and surface water quality from soil containing COCs.

The selected remedy for Area 8 consisted of institutional controls and groundwater monitoring. The purpose of the institutional controls was to prohibit residential use of the site and to prevent construction of domestic wells. Monitoring data was to be used to establish COC trends in groundwater and to determine when institutional controls could be discontinued. In compliance with the monitoring program, the Navy agreed to install additional upgradient wells to confirm that no upgradient source of COCs exists. The selected remedy for Area 8 included the following components:

- Removal and off-site disposal of vadose zone soil from COC hot spots.
- Ongoing groundwater monitoring in the water table aquifer.
- Ongoing sediment and tissue monitoring to assess the potential long-term impacts of contaminated groundwater discharge to Port Orchard Bay.
- Contingent marine environment risk assessment based on evaluation of sediment and tissue monitoring data.
- Contingent groundwater control actions based on results of contingent risk assessment to mitigate identified marine environment risks.
- Institutional controls.

Per the ROD, it was anticipated that even after the soil removal component of the remedy, "residual contamination may continue to be discharged into Port Orchard Bay for many years" (DON, EPA, and Ecology 1994). The criteria in the ROD for determining whether contingent groundwater control measures or further investigations must be implemented are whether the "discharges accumulate over the long-term" and required a post-ROD risk assessment if marine monitoring indicated exceedance of marine criteria. Contingent groundwater controls were to be instituted if the post-ROD risk assessment "shows unacceptable risks or exceedances of state sediment cleanup screening levels" (DON, EPA, and Ecology 1994). No remediation goal (RG) for sediment or tissue at the Area 8 beach was established in the ROD, but post-ROD HHRA and ERA (DON 2018; 2020) were completed in 2018 at the beach adjacent to Area 8, as required by the OU 2 ROD, because elevated sediment concentrations were identified during monitoring. Per the ROD, the post-ROD risk assessment was to be performed using the same exposure assumptions as in the baseline risk assessments. However, according to the five-year review process, it is presumed that if any substantial changes to exposure assumptions are found while assessing whether or not the remedy remains protective, these changes would be incorporated into future risk assessments, as was done in the subject risk assessment.

The ROD for OU 2 was modified by an Explanation of Significant Differences (ESD) dated March 15, 1996 (DON, EPA, and Ecology 1996). As a result of the ESD, the completion of soil removal at OU 2 Area 8 was delayed until after the plating building was demolished. In addition, the ESD specified that the amount of soil to be removed would be based on total chromium analyses rather than hexavalent chromium analyses, assuming all total chromium results represented hexavalent chromium results.

For subsurface soil, arsenic, cadmium, and chromium were identified as COCs in the ROD. For groundwater, 10 inorganic chemicals (antimony, arsenic, cadmium, chromium [hexavalent], copper, lead, manganese, nickel, thallium, and zinc) and five VOCs (1,1-dichloroethane, 1,1-DCE, cis-1,2-DCE, TCE, and tetrachloroethene) were identified as COCs in the ROD. These five VOCs were detected above RGs subsequent to the signing of the ROD. The ROD listed RGs for many other VOCs and semivolatile organic compounds that either have never been detected or have not been detected above an RG since 1994.

10.2.5 Post-ROD Cleanup Activities

The selected remedy for Area 8 consisted of removal and off-site disposal of vadose zone soil from COC hot spots, groundwater monitoring in the water table aquifer, sediment and tissue monitoring to assess the potential long-term impacts of contaminated groundwater discharge to Port Orchard Bay, contingent groundwater control actions based on a post-ROD risk assessment of sediment and tissue monitoring data (if warranted by monitoring data), and institutional controls.

The remedy selected for Area 8 was not expected to meet either the groundwater RGs based on drinking water criteria or the goals for the protection of adjacent surface water throughout the site. Institutional control measures at the site were to be implemented for additional protectiveness.

Hot spot soil removal was conducted in phases. In 1992, a brick-lined trench was removed, and impacted soil immediately associated with this trench was removed for off-site disposal. From 1998 to 1999, additional site characterization was conducted to delineate the extent of COCs in soil that would require removal. The characterization resulted in the removal of soil from two areas roughly 50 by 50 feet in size. Each of these areas was excavated to a depth of approximately 9 feet bgs, which is roughly equivalent to the depth to water at the site. The soil removal actions used the MTCA Method

B cleanup levels for soil ingestion (80 milligrams per kilogram [mg/kg] for cadmium and 400 mg/kg for chromium) as the basis for defining the volume of soil removed.

Annual groundwater monitoring indicates that the lateral extent of COCs, particularly cadmium, chromium, and TCE, in groundwater at concentrations greater than surface water RGs has decreased substantially since completion of the soil removal action, and that concentrations overall have decreased dramatically. These results suggest that the soil removal action has had a substantial positive effect on groundwater quality at the site. Cadmium concentrations in one well (MW8-11) decreased substantially after the removal action but have since stabilized at a concentration above the surface water RG. Well MW8-11 is located upgradient of Seep A, where cadmium concentrations are approximately 6.3 times greater than the surface water RG of 8 micrograms per liter (µg/L). Cadmium concentrations decreased substantially in water samples from Seep A immediately following the removal action, but they are currently trending up.

A cadmium concentration of 0.8 mg/kg in soil was considered to be protective of groundwater but was never identified as an RG. Soil samples collected from the limits of the 1992 excavation and from the soil borings conducted prior to the 1998/1999 removal show that cadmium concentrations greater than 0.8 mg/kg are still in place.

Remedial actions, including soil sampling and removal of TPH impacted soils and the demolition of two 52,000-gallon diesel aboveground storage tanks (ASTs) and associated piping located in two underground concrete tanks at Building C, were conducted between 1996 and 1999. Diesel and oil impacts were detected in the soil south and east of Building C on the south side of the project area and to the north and east of Building A (DON 2018).

The initial phase of activities was conducted prior to the demolition of site Buildings A and D, at the time housing the plating facility. Soil samples were collected to delineate TPH impacts from the petroleum storage at Building C. Soil borings were advanced using hollow stem auger drill rigs, and samples were collected using split spoon samples from 0.5 feet to approximately 20 feet bgs. The soil samples were analyzed for diesel to heavy-oil range petroleum hydrocarbons by NWTPH-Dx. Concentrations ranged from non-detect to 20,000 mg/kg. Selected samples collected from directly adjacent to Building C were also sampled for TPH fractionation, PAHs, and BTEX. Total petroleum hydrocarbon fractions, PAHs and toluene, ethylbenzene, and xylenes were detected in multiple samples.

The two 52,000-gallon steel ASTs located in the underground vault at Building C and associated piping were removed in 1998. Contaminated soil sourcing from Building C was removed down to visibly “clean bottom” where possible, approximately 9 ft (on the eastern side of the site) to 20 ft bgs (on the southern side of the site). Groundwater was identified at 10 ft bgs. A total of 12,070 tons of soil were excavated, an estimated 90 percent of impacted soil from Building C. Areas with permanent utilities and excessive groundwater infiltration prevented the removal of all impacted soil. Four monitoring wells were removed during excavation activities, with only one monitoring well located close to the seawall replaced.

A strong petroleum odor was detected in the soil on the northeast side of the site adjacent to Building A during the initial excavation. Soil sampling was continued in this area to delineate the boundaries of contamination associated with two waste storage tanks at Building A. The soil samples were analyzed for diesel to heavy-oil range petroleum hydrocarbons and VOCs, with select sample locations sampled for TPH fractionation, PAHs, and BTEX. Diesel-range petroleum hydrocarbons concentrations ranged from non-detect to 670 mg/kg. Heavy oil-range petroleum hydrocarbon concentrations ranged from non-detect to 1300 mg/kg. Multiple VOCs including acetone, methylene chloride, and xylene were detected in the soil samples collected. Sampling was obstructed to the north by Building E, but the south and west impacted soil boundaries were identified. Based on field observations, the impacted soil existed predominately below the water table and may continue under Building E. Contamination extended to the east and northeast corners of the site. Excavation of impacted soils was not conducted due to building obstructions and location below the water table. During the 1998/1999 characterization event, a soil sample collected from a location just south of well MW8-11 and upgradient of Seep A had a cadmium concentration of 4,380 mg/kg at 9 feet bgs. It is likely that elevated cadmium concentrations remain in soil and saturated soil at this location, keeping cadmium concentrations in groundwater at well MW8-11 stable and causing cadmium concentrations to trend upward as observed in samples from Seep A.

An optimization evaluation of the remedial program at Area 8 was conducted in 2006 (DON 2006). Per the optimization, an evaluation was recommended to determine the extent of cadmium in soil, unsaturated soil, and groundwater in the immediate area of the 1998/1999 soil sample with a cadmium concentration of 4,380 mg/kg. If a mass of cadmium in soil were found in the area, then the soil should be removed as per the optimization since past soil removal actions have resulted in substantial improvement to groundwater quality at the site.

Human health and ecological risks associated with exposure to potentially contaminated media at the beach adjacent to Area 8 (i.e., clam tissue, sediment, seep water, and marine water) were evaluated in the 2018 HHRA/ERA, completed in 2018 as required by the OU 2 ROD (DON 2018). The specific objectives of the risk assessments included characterization of human health and ecological site risks relative to background.

Tissue, sediment, seeps/outfalls, and marine surface water samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc, and these data were evaluated in the risk assessments. The HHRA found no unacceptable human health risk over reference areas. Multiple lines of evidence considered in the ERA suggested that the hazards to benthic organisms are low despite localized elevated concentrations of cadmium in seeps and sediment.

Toxicity testing of sediment and seep water locations at Area 8 and a reference area were performed in 2019 and evaluated in the 2020 ERA Addendum (DON 2020). The results indicated that Area 8 COCs in groundwater have impacted sediment resulting in a risk to benthic invertebrates (clams) on the adjacent beach. The OU 2 ROD specifies that, if a risk is identified, groundwater controls would be instituted. Although six options for controlling groundwater at the site were proposed, none of the options are technically feasible due to the tidally influenced nature of the site, as summarized below:

Alternative 1: No Remedial Action – This alternative wouldn’t reduce risk to benthic invertebrates.

Alternative 2: Limited Action – This was the selected remedy for Area 8 and would control exposures to target compounds through institutional controls and rely on natural attenuation to restore the site. The 1996 ESD resulted in the completion of soil removal after the plating building was demolished, and the determination of the amount of soil to be removed was changed to be based on total chromium analyses instead of hexavalent chromium analyses, indicating that all total chromium results were to be interpreted as hexavalent chromium.

Alternative 3: Soil Vapor Extraction and Institutional Controls – This alternative is not an effective remedy for treating metals.

Alternative 4: Source Treatment and Removal with Aquifer Flushing – Any anthropogenic soil flushing would not be cost effective compared to the risk driver.

Alternative 5: Dewater Aquifer and Soil Vapor Extraction – This alternative is not an effective remedy for treating metals.

Alternative 6: In-Situ Steam Stripping – This alternative is not an effective remedy for treating metals.

Soil source removal has demonstrated to be effective at reducing cadmium and chromium concentrations in groundwater at the site, and will be considered as a viable remedial alternative option following this supplement RI.

PFAS were added to the Area 8 long-term monitoring (LTM) analyte list in 2018 to determine whether these contaminants were present in groundwater at the site. Groundwater results were compared to the EPA Health Advisory Level (HAL) which, at the time, were 70 µg/L for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), both separately and combined. PFOS/PFOA were detected at concentrations exceeding the EPA HAL at wells MW8-11 and MW8-12 at 74 and 77 µg/L, respectively. PFAS was also detected at wells MW8-8, MW8-9, and MW8-16 but at concentrations below the EPA HAL. DoD has established risk-based screening levels (SLs) for PFAS in soil and groundwater, as described in a memorandum from the Office of the Secretary of Defense (OSD) dated 6 July 2022 (DoD 2022). The SLs established in the OSD memorandum apply to six compounds: PFOS, PFOA, perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS) and hexafluoropropylene oxide dimer acid (HFPODA). The groundwater screening levels for these compounds are 4 ng/L for PFOS, 6 ng/L for PFOA, 601 ng/L for PFBS, 6 ng/L for PFNA, 39 ng/L for PFHxS, and 6 ng/L for HFPODA. When the 2018 LTM results were compared to the current OSD screening criteria, exceedances (PFOS and PFOA only) occurred at wells MW8-8, MW8-9, MW8-11, MW8-12, and MW8-16. PFBS, PFHxS and PFNA were also detected in these wells, but at concentrations below the OSD SLs. The 2018 analyte list did not include HFPODA.

10.2.6 Geology and Soils

Area 8 sits on a peninsula that was built up to support industrial activities and the former pier at NBK Keyport. As a result, shallow soils beneath the site consist of fill material from dredging and other activities. Four geologic units have been explored at Area 8: the shallow fill deposits, Vashon advance outwash, the Kitsap Clay, and a thick sequence of older glacial deposits. The fill deposits are the uppermost deposits at the site, generally ranging from 3 to 13 feet in thickness. These fill deposits primarily consist of silty sand and gravel fill material with proportions of silt, sand, and gravel varying in lateral extent and in thickness. The Vashon advance outwash deposits rest below the fill deposits and consist of dense, fine-to-coarse sand with gravel and some silt. Grain size tends to increase towards the top of this deposit. Figure 3 shows the locations of borings and wells previously used to describe the geologic setting beneath Area 8, together with the location of a generalized cross section. The cross section (Figure 4) indicates that the Vashon advance outwash deposits are thickest in the area of MW8-15 at approximately 160 feet thick. The cross section suggests that a channel was eroded within the underlying unit, and the Vashon advance outwash deposit thins from the well MW8-15 area to both the east and west. The trough appears to trend from the northwest to the southeast toward Port Orchard Bay. The lower portion of the Vashon advance outwash unit contains very fine sand with some silt lenses at the MW8-15 location. Kitsap Clay is identified beneath the Vashon advance outwash unit, which was penetrated in the area of MW8-15. It is estimated to be approximately 16 feet thick in the area of MW8-15 and is described as sandy clay and silt with some silty gravel. Kitsap Clay is a low-permeability unit that limits vertical downward migration of groundwater and contaminants in groundwater. The borehole for well MW8-15 extends approximately 17 feet into the older glacial deposits below the Kitsap Clay, which are thought to be much thicker. These deposits are described as very fine to coarse sand with some gravel (DON 1993c).

The previously collected geologic information was used to conduct a sequence stratigraphy study. The boring locations used for this study and three updated cross section locations for Area 8 are shown on Figure 5. Updated cross sections using sequence stratigraphy methods are shown on Figure 6, Figure 7, and Figure 8.

As stated in the Executive Summary, one objective of this SRI is to update the CSM. The current site CSM, from a geology/hydrogeology perspective, is still heavily based on the 1993 RI interpretations. This includes antiquated formation names, oversimplification of the depositional environment and groundwater/surface flow dynamics and interaction, and relevant exposure pathways. Inclusion of the 1993 RI Area 8 cross section is provided as Figure 4. The cross sections presented in Figure 5, Figure 6, and Figure 7 were generated using ESS, relying on existing borehole data, to start the CSM updating process. The SRI Report will include an updated CSM, utilizing all site data collected to date and collected under this SRI. At this time, there are no coordinated efforts between the Area 8 ESS interpretations and other ESS efforts being conducted concurrently at other Keyport OUs under different Task Orders. However, coordination of these ESS efforts may be done under a future Task Order.

10.2.7 Groundwater Hydrogeology

Two aquifers, referred to as the upper and intermediate aquifers, were identified beneath the site during site investigations. The upper aquifer consists of unconfined groundwater within the fill and Vashon advance outwash deposits. Groundwater generally has been encountered at depths of 7 to 10 feet bgs. Area 8 is positioned along the shoreline of Port Orchard Bay, so groundwater surface elevations are strongly influenced by tidal fluctuations. Groundwater generally flows westward during high tide in the area east of Bldg. A, with a flow reversal to the east during low tides. Groundwater surface elevation fluctuates up to 1.2 feet per day as a result of tidal influences. Hart Crowser (1992) estimated that the net flow is eastward toward Port Orchard Bay at rates of 0.5 to 5 feet per day. Hydraulic conductivity of saturated soil at the site has been estimated to range from 2×10^{-2} to 5×10^{-3} centimeters per second. Mixing of seawater with groundwater is indicated by saline conditions encountered in wells between Building A and Port Orchard Bay (Hart Crowser 1992).

10.3 EXPOSURE PATHWAYS

10.3.1 Human Health Exposure

Although the 2018 HHRA and ERA (DON 2018) results indicate that several COCs are present in the Area 8 beach sediment and clam tissue samples at concentrations exceeding background and reference area concentrations, the incremental site risk over background for Suquamish subsistence and recreational receptors meets target health goals. As such, no additional investigation of human health exposure to ROD COCs is recommended, and groundwater controls are not considered necessary to protect human health from ROD COCs at Area 8. PFAS have been detected in Area 8 monitoring wells and a risk assessment addendum to address these emerging contaminants is planned for 2024.

10.3.2 Ecological Exposure

The 2018 HHRA and ERA (DON 2018) concluded that ROD COCs posed no significant hazards to free-swimming aquatic life or semi-aquatic birds and mammals and that groundwater controls are not considered necessary to protect these receptor groups from ROD COCs. A risk assessment addendum to address emerging contaminants is planned for 2024. The 2020 ERA Addendum (DON 2020) concluded that hazards to benthic organisms (clams) from contaminated sediments are present based on bioassay results. Localized elevated concentrations of cadmium were also detected in both seep water and sediment. Both the sediment incidental ingestion and marine tissue ingestion pathways are considered complete. The current ecological CSM is shown on Figure 9.

10.3.3 PFAS Exposure Pathways

The intent of PFAS sampling and analysis during this SRI is to define the vertical and horizontal extent of PFAS in groundwater and upland soil, in an effort to quantify the magnitude of these constituents and locate/define "hot spots" or source areas. It is not yet known if PFAS has impacted the adjacent beach. Potential impacts to benthic invertebrates and other potential receptors may be evaluated in the SRI Report, as the data and DoD guidance allow. Data may also be re-evaluated in the future based on a comparison to other screening levels promulgated at a later date, should vetted and appropriate screening levels become available in the future. Archived data may be used in future decision-making, as appropriate. Sampling media on the beach (sediment, porewater, tissue, etc.) is not scoped under this Task Order. If PFAS additional upland sampling and/or sampling on the beach is determined to be necessary, it will need to be conducted under a new Task Order.

10.4 HISTORICAL DATA ASSESSMENT

Several data collection activities were conducted at the Keyport Area 8 site from 1990 through 2019. These data were used to identify COCs in soil and groundwater at the site and to initiate and monitor actions to protect the environment or human and/or ecological health as described in the ROD. The data is stored in the Naval Installation Restoration Information Solution (NIRIS) data system. AECOM retrieved the Keyport Area 8 data from NIRIS to review in context of the planned data collection activity described in the SRI. The purpose of the review was to evaluate the data collected to date based on current regulatory screening levels to determine whether additional compounds beyond the known COCs should be addressed during this SRI.

The proposed analytical program for soil and groundwater samples collected during the SRI is presented in Worksheet #15. The analyses include metals, chlorinated VOCs, 1,4-dioxane, PAHs, PFAS, and semivolatile organic compounds (SVOCs) (other than PAHs). The intent of the analytical program is to collect data used to compare against current regulatory screening levels for soil direct contact (primarily MTCA Method B levels) and groundwater for the protection of surface water (MTCA Method B levels).

AECOM reviewed the NIRIS archived data for soil collected from 1990 through 1999 and groundwater collected from 1991 through 2019. Detected compounds and reporting limits were reviewed to assess whether additional analytes should be included in the analytical program. A comparison of historical soil data reporting limits and current action limits for site media are provided in Appendix C. Through these comparisons, the analytical program, as described herein, addresses the known COCs as indicated in the ROD and is inclusive of potential COCs (PAHs, 1,4-dioxane, and other metals, VOCs, and SVOCs) and PFAS.

Recommended current screening levels that will be used to evaluate the data collected during this SRI are provided in Appendix C. The lowest of all applicable values for each analyte has been selected as the recommended project screening level for that analyte.

Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements

Data quality objectives are an integrated set of qualitative and quantitative decision statements that define data quality requirements based on the end use of the data. The EPA has developed a seven-step process to clarify study objectives, define the appropriate type of data, and specify acceptability levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (EPA 2006).

11.1 STEP 1 – STATE THE PROBLEM

This step identifies the issues to be addressed. The overall problem statement consists of two parts, as follows:

1. A Post-ROD HHRA/ERA was completed in 2018 at the beach adjacent to OU 2 Area 8 as required by the OU 2 ROD (DON 2018). This risk assessment confirmed there is no unacceptable risk to human health; however, a risk to benthic invertebrates (clams) associated with sediment contamination originating from Area 8 groundwater contamination was identified. The OU 2 ROD specifies that, if a risk is identified, groundwater controls will be instituted, and presents six options for controlling groundwater at the site. However, none of the options presented are technically feasible due to the tidally influenced nature of the site. Therefore, additional data regarding the current site conditions and site hydrogeology is needed to support evaluation of other methods for stopping contaminants from reaching the Area 8 beach during the planned future focused feasibility study (FFS), including:
    a) What is the lateral and vertical extent of the saltwater wedge below the terrestrial portion of the site, based on subsurface geophysical and groundwater geochemical data?
    b) What is the current magnitude and extent of known COCs in soil and groundwater at the site?
    c) Are any previously analyzed chemicals, not identified as COCs based on information available at that time, present at concentrations above current screening levels? If so, what is the current magnitude and extent of these COPCs in soil and groundwater?
2. PFAS has been identified in site wells. Therefore, data is needed to determine the following:
    a) What is the current magnitude and extent of PFAS, specifically PFOS, PFOA, PFBS, PFHxS, PFNA and HFPODA in soil and groundwater at Area 8.

11.2 STEP 2 – IDENTIFY THE DECISION

The purpose of this step is to define the decisions that will be made using data collected under this QAPP to address the problem. The overall decisions to be made based on the data collected under this QAPP are:

1. What are the lateral and vertical extent of the saltwater wedge below the terrestrial portion of the site?
2. Based on the presence/absence of the saltwater wedge, is production of drinking water at the site viable, or should a groundwater reclassification be pursued?
3. Has the current magnitude and extent of contamination, contaminant fate and transport pathways, and relevant exposure pathways been defined sufficiently to update the site CSM?

4. Does the current magnitude and extent of contamination, assuming direct groundwater discharge to the intertidal zone, support continued impacts to benthic macroinvertibrates?
5. Does the current magnitude and extent of PFOS, PFOA, PFBS, PFHxS, PFNA, and HFPODA in soil and/or groundwater at the site support impacts to benthic macroinvertibrates and other potential receptors? If so, should additional sampling to evaluate the magnitude and extent of these compounds in adjacent beach sediment and pore water be performed during the future risk assessment addendum?
6. Based on all data collected, are the site data of sufficient quantity and quality to conduct a remedial alternatives analysis under the future FFS?

All decisions will be made in collaboration with the Project Stakeholder Team.

11.3 STEP 3 – IDENTIFY THE INFORMATION INPUTS TO THE DECISION

Inputs to the decision will consist of the analytical results of soil and groundwater samples collected in the sampling and analysis program described throughout subsequent worksheets.

- Conduct a geophysical survey (Mobilization 1) to determine the lateral and vertical extent of the saltwater wedge beneath the terrestrial portion of the site.
  - Use electrical resistivity tomography, ground-penetrating radar, and ground conductivity methods over a 24-hour tide cycle during the largest predicted tidal swing of the year. This was completed in June 2021 under a separate work plan (DON 2021, Appendix D).
  - Deploy groundwater data loggers following field Mobilization 3 to assess tidal fluctuation and groundwater geochemistry.
  - Evaluate geophysical survey data as a project team to assess whether subsurface features and obstructions affect shallow groundwater flow at the site.
- Conduct a subsurface investigation using direct-push drilling methods (Mobilization 2) to determine the current magnitude and extent of known COCs, PFAS, and 1,4-dioxane in soil and groundwater at the site (qualitatively), based on COPC selection as described in Worksheet #10.
  - Install 31 direct-push borings to a depth up to 50 feet bgs, collecting up to three soil samples and one grab groundwater sample per boring, and up to an additional three soil and/or groundwater samples per boring for archive:
    - Collect one soil sample from unsaturated soil above the groundwater interface.
    - Collect a second soil sample from the air/groundwater interface.
    - Collect a third soil sample from the bottom of the borehole.
    - Collect up to an additional three soil samples based on the results of photoionization detector (PID) and X-ray fluorescence (XRF) field screening, odors/staining, or changes in lithology.
  - Analyze soil and grab groundwater samples for COCs, PFAS, and 1,4-dioxane as described in Worksheet #18, based on COPC selection as described in Worksheet #10.

  - Compare quantitative data to applicable screening levels for soil and groundwater, as identified in Appendix C.
  - Evaluate Mobilization 2 data, as a project team, to select Mobilization 3 investigation locations and analytes.
- Install additional groundwater monitoring wells (Mobilization 3) at the site based on the results of the direct push investigation.
  - Install 10 sonic soil borings to a depth up to 50 feet bgs, collecting up to three soil samples and one grab groundwater sample per boring, and up to an additional three soil and/or groundwater samples per boring for archive.
    - Complete all borings as permanent groundwater monitoring wells.
  - Install six deep sonic soil borings to a depth up to 150 feet bgs, collecting up to three soil samples and one grab groundwater sample per boring, and up to an additional three soil and/or groundwater samples per boring for archive.
    - Complete three deep borings as permanent groundwater monitoring wells.
  - Collect groundwater samples from each newly installed monitoring well and existing site monitoring wells.
- Conduct an evaluation of groundwater reclassification regulations and guidance, with the project team.

11.4 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

The general site location is shown on Figure 1. The spatial boundaries of the site are shown on Figure 2 and are not expected to change based on this investigation.

The investigation will provide a supplemental assessment of the spatial distribution of COCs in soil and groundwater over a brief snapshot in time (fall/winter 2022) that represents the temporal boundaries of this study. This is in contrast to the groundwater monitoring (under separate SAPs), which assesses long-term trends. Conversely, the saltwater wedge evaluation will be conducted during a time of year (summer) when tidal fluctuations are historically largest. Ultimately, these data will be used to evaluate remedial alternatives during the planned future FFS.

11.5 STEP 5 – DEVELOP A DECISION RULE

The process or rules for making the decisions listed under Step 2 are described in this section. Rules include how field decisions will be made and how data will be interpreted.

The decision rules for soil and groundwater sampling rely on a step-wise approach to address the problem statement. One soil sample will be collected from unsaturated soil above the groundwater interface, a second soil sample from the air/groundwater interface, and a third from the bottom of the borehole. Field screening of continuous soil cores from direct-push borings will be used to select intervals for up to an additional three grab soil and groundwater sample collection, and to select the exact location for subsequent sonic boring locations where permanent groundwater monitoring wells will be installed. The results of the field screening and laboratory results from the grab soil and groundwater samples will be displayed on plan-view maps of the site, and the spatial pattern will be evaluated by the Project Stakeholder Team to select locations for permanent groundwater monitoring wells, or determine if data gaps exist.

The soil and groundwater analytical results will be compared to the project action limits (PALs) presented on Worksheet #15. The PALs for soil are based on the lowest criterion under MTCA for Method B direct contact, soil protection of groundwater, or soil protection for groundwater to marine surface water for metals, VOCs, 1,4-dioxane, PAHs and SVOCs.

Under MTCA, groundwater must be evaluated based on direct impact to surface water where there is an interface between the two. The PALs for groundwater for metals, VOCs, 1,4-dioxane, PAHs, and SVOCs are based on the lowest of MTCA Method B groundwater cleanup levels, federal or Washington State drinking water standards (MCLs), or surface water for protection of marine aquatic life (WAC 173-201A, 40CFR131.45, or Clean Water Act (304). An exception to the lowest level was made for total metals. The surface water criteria protective of aquatic life is generally based on dissolved fraction, but human health criteria are based on total fraction. The project action limits for total metals are based on drinking water and human health criteria from the references noted.

PALs for PFOS, PFOA, PFBS, PFHxS, PFNA and HFPODA presented in Worksheet #15 for soil and groundwater are based on calculated risk-based screening levels using EPA's regional screening level calculator and a hazard quotient of 0.1 (OSD 2022). The PFAS screening levels for soil are based on industrial/commercial worker scenario at depths of 2 to 15 feet. The groundwater screening levels are based on tap water in residential use.

The intent of sampling and analysis during this SRI is to define the vertical and horizontal extent of PFAS in groundwater and upland soil, in an effort to quantify the magnitude of these constituents and locate/define "hot spots" or source areas. It is acknowledged that the regulatory framework around PFAS is constantly in flux, and that new guidance may emerge during the course of or after this investigation is complete. At this time, the Navy will follow DoD guidance, and the Navy is in the process of identifying ecological screening levels. In addition, data may be re-evaluated in the future based on comparison to new ecological screening levels at a later date, should additional vetted and appropriate screening levels become available in the future. Archived data may be used in future decision-making, as appropriate.

The analytical methods selected for this program were selected to achieve results reportable below or at least equivalent to the selected screening levels. However, there are some chemical analytes where the Limit of Quantitation (LOQ) is greater than the screening level. The laboratory will report the data such that the LOQ (equivalent to the practical quantitation level [PQL]), the limit of detection (LOD) and the method detection limit (MDL) are presented for each analyte. Results reported as detected above the MDL will be compared to screening levels.

If a chemical analyte is not detected above the screening level, then the chemical analyte is assumed not to be present and will be eliminated from further evaluation. If a chemical analyte is not detected but the LOQ, LOD, and MDL are all above the screening level such that a definitive evaluation is not possible, then the uncertainty associated with the results will be assessed. Non-detect results will be reported to the LOD and this will be the result used in the uncertainty analysis. Based on the uncertainty analysis and in consultation with the Project Stakeholder Team, a determination will be made if the compound warrants further consideration for site assessment or if based on the uncertainty analysis, the compound is not a concern at the site.

Decision 1: If the geophysical and groundwater geochemistry data show the boundaries of the saltwater wedge, then the saltwater wedge has been defined and no additional geophysical and groundwater geochemistry data collection is required.

If the geophysical and groundwater geochemistry data do not show the boundaries of the saltwater wedge, then the saltwater wedge has not been defined and the Project Stakeholder Team may choose to collect additional geophysical and groundwater geochemistry data to support remedial alternatives evaluation.

Decision 2: If the identified boundaries of the saltwater wedge extend across the site such that production of residential drinking water is unrealistic due to saltwater intrusion, pursue reclassification of site groundwater to non-potable water to support more realistic future upland groundwater RGs.

If the identified boundaries of the saltwater wedge do not extend across the site such that production of residential drinking is viable, then do not pursue groundwater reclassification.

Decision 3a: If additional chemical analytes investigated during the 1993 RI, but not identified as COCs based on information available at that time, are measured in soil and groundwater at concentrations less than screening levels, then those chemicals will not be considered COPCs, as decided by the project team, and no further data collection is required.

If additional chemical analytes investigated during the 1993 RI, but not identified as COCs based on information available at that time, are measured in soil and groundwater at concentrations greater than screening levels, then the Project Stakeholder Team will decide which chemicals should be considered COPCs and will determine if further data collection is required to support the future planned FFS.

Decision 3b: If COC/COPC (excluding PFAS) groundwater concentrations at sample locations bounding the groundwater plume laterally are less than screening levels, then the current lateral limits of groundwater impact have been defined, as decided by the project team, and no additional groundwater data collection is required.

If COC/COPC (excluding PFAS) groundwater concentrations at sample locations bounding the groundwater plume laterally are greater than screening levels, then the current lateral limits of groundwater impact have not been defined and additional groundwater data will be recommended by the project team to support remedial alternatives evaluation under the future planned FFS.

Decision 3c: If COC/COPC (excluding PFAS) soil concentrations at sample locations bounding the soil impact area plume laterally and vertically are less than screening levels, then the current extent of soil impacts will have been defined and no additional soil data collection is required.

If COC/COPC (excluding PFAS) soil concentrations at sample locations bounding the soil impact area plume laterally and vertically are greater than screening levels, then the current extent of soil impacts has not been defined and additional soil data collection will be recommended to support remedial alternatives evaluation during the future planned FFS.

Decision 3d: If the current magnitude and extent of contamination, contaminant fate and transport pathways, and relevant exposure pathways have been defined sufficiently to update the site CSM, as decided by the project team, then no additional data collection is required.

If the current magnitude and extent of contamination, contaminant fate and transport pathways, and relevant exposure pathways have not been defined sufficiently to update the site CSM, as decided by the project team, then additional data collection is required.

Decision 4: If COC/COPC concentrations in groundwater samples along the existing shoreline are less than screening levels, then the current extent of groundwater impacts will have been defined, the magnitude and extent of contamination does not support continued impacts to the beach, as decided by the project team, and no future pore water sample collection on the beach will be recommended.

If COC/COPC concentrations in groundwater samples along the existing shoreline are greater than screening levels, then the current extent of groundwater impacts will not have been defined, the current magnitude and extent of contamination may support continued impacts to the beach, as decided by the project team, and additional pore water sample collection on the beach will be recommended. Also, additional contaminants may be added to the future risk assessment addendum, as appropriate.

Decision 5: If PFOS, PFOA, PFBS, PFHxS, PFNA and HFPODA are all measured at concentrations less than screening criteria in soil and groundwater sample locations bounding the wells where PFAS have been detected, then the magnitude and extent of PFOS, PFOA, PFBS, PFHxS, PFNA and HFPODA are considered defined and additional investigations to define impacts of PFAS to the adjacent beach will not be recommended.

If PFOS, PFOA, PFBS, PFHxS, PFNA and HFPODA are measured at a concentration greater than screening criteria in soil and groundwater sample locations, then the magnitude and extent of these compounds have not been defined and additional investigations to define impacts of PFAS to the adjacent beach will be recommended.

Decision 6: If no additional data collection is required for Decisions 1 through 5, then the site data are sufficient to conduct a remedial alternatives analysis under the future FFS.

If additional data collection is required for any of Decisions 1 through 5, then the project team will review the data and determine if site data are sufficient to conduct a remedial alternatives analysis under the future FFS.

Given that PFAS are emerging contaminants and the science for evaluating and addressing PFAS contamination is still developing, the Navy will determine the next steps in conjunction with regulators and stakeholders regarding the path forward for PFAS.

11.6 STEP 6 – SPECIFY LIMITS ON DECISION ERROR

The decision error will be limited by managing the error in the data used to derive the decision, as specified below.

Errors in screening level data, including the field PID and XRF detector, will be managed by following the equipment manufacturer's calibration and operation information and NAVFAC Northwest Standard Operating Procedures (SOPs), and by use of a consistent field process for PID measurement. Because the PID data are qualitative, the relative difference between PID results is needed for decision making rather than the numerical result itself.

Errors in field sampling will be limited by following the decontamination procedures outlined in Worksheet #17 and NAVFAC Northwest SOP III-I, and by collecting equipment rinsate blanks, trip blanks, and field blanks. Furthermore, errors in field sampling pertaining to PFAS will be limited by ensuring that all field sampling staff have completed AECOM's PFAS Sampling Training.

Field sampling locations have been selected by the Project Stakeholder Team during the project scoping meeting, and after reviewing existing site data, with the intent of ensuring that the data collected meets the project goal of supporting a remedial alternatives analysis under the future FFS.

Precise limits on quantitative analytical data error are provided in Worksheet #12 (*Field Quality Control Samples*), Worksheet #15 (Reference Limits and Evaluation Tables), and Worksheet #28 (*Laboratory QC Samples Table*).

Errors in relative land survey horizontal and elevation data used to establish top of casing elevations for all new wells will be managed by performing closed loop surveys with an error of no more than 0.01 foot.

11.7 STEP 7 – OPTIMIZE THE DESIGN

The sampling design has been optimized by establishing a step-wise approach. Data collected during Mobilization 2 will be validated, evaluated by the Project Stakeholder Team, and used to optimize the location of the Mobilization 3 sampling locations.

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Worksheet #12: Field Quality Control Samples

Measurement Performance Criteria Table – Field QC Samples

Matrix: Soil

Quality Control Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Cyanide, Total	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	TOC	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	Metals [a]	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	Hexavalent Chromium	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	VOCs	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	1,4-Dioxane	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	PAHs	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	PFAS	One per 20 samples	Precision	RPD ≤ 50%.
Field Duplicate	SVOCs	One per 20 samples	Precision	RPD ≤ 50%.
Temperature Blank	All	One per cooler	Representativeness	Temperature < 6°C.
Trip Blank	VOCs, PFAS	One per cooler containing sample volume for VOC and PFAS analysis	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Field Blank (lab-supplied reagent water)	PFAS	One per event	Contamination/Bias	No target compounds >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Equipment (Rinsate) Blank for direct-push drilling (lab-supplied reagent water)	Cyanide, Metals, Hexavalent Chromium, VOCs, 1,4-Dioxane, PAHs, PFAS, SVOCs	One per day for both soil and groundwater sampling	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Equipment (Rinsate) Blank for sonic drilling (lab-supplied reagent water)	Cyanide, Metals, VOCs, 1,4-Dioxane, PAHs, PFAS, SVOCs	One per day during sonic drilling	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.

Note: RPD will be calculated as RPD=[S-D] x 100 / [(S+D)/2] where S is the result for the parent sample and D is the result for the duplicate sample.

%	percent
°C	degree Celsius
LOQ	limit of quantitation
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
RPD	relative percent difference
SVOC	semivolatile organic compound
TOC	total organic carbon
VOC	volatile organic compound

[a] Metals include arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, and zinc.

Matrix: Groundwater

Quality Control Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Anions	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Cyanide, Total	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	DOC	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Sulfide	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Dissolved Gases	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Total Metals [a]	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Dissolved Metals [a]	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Hexavalent Chromium	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	VOCs	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	Low-level Vinyl Chloride	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	1,4-Dioxane	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	PAHs	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	PFAS	One per 20 samples	Precision	RPD ≤ 35%.
Field Duplicate	SVOCs	One per 20 samples	Precision	RPD ≤ 35%.
Temperature Blank	All	One per cooler	Representativeness	Temperature <6°C.
Trip Blank	VOCs, low-level vinyl chloride, PFAS	One per cooler containing sample volume for VOC, low-level vinyl chloride, and PFAS analysis	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Filter Blank	Dissolved Metals, DOC	One initial verification blank per filter blank lot	Contamination/Bias	No target compounds >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Field Blank (lab-supplied reagent water)	PFAS	One per exposure area	Contamination/Bias	No target compounds >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.

Quality Control Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Equipment (Rinsate) Blank for direct-push drilling (lab-supplied reagent water)	Cyanide, Metals, Hexavalent Chromium, VOCs, low-level Vinyl Chloride, 1,4-Dioxane, PAHs, PFAS, SVOCs	One per day during direct-push drilling (see Matrix: Soil table for soil; equipment blank is for both soil and groundwater sampling)	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Equipment (Rinsate) Blank for monitoring wells (lab-supplied reagent water)	Cyanide, Metals, VOCs, low-level Vinyl Chloride, 1,4-Dioxane, PAHs, PFAS, SVOCs	Associated with sampling equipment used to sample newly installed and existing wells	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.

Note: RPD will be calculated as RPD=[S-D] x 100 / ((S+D)/2) where S is the result for the parent sample and D is the result for the duplicate sample.

%	percent
°C	degree Celsius
DOC	dissolved organic carbon
LOQ	limit of quantitation
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
RPD	relative percent difference
SVOC	semivolatile compound
VOC	volatile organic compound

[a] Metals include arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc for total and dissolved fractions. Calcium and magnesium are included for dissolved metals fraction.

Matrix: IDW (Solids and Aqueous)

Quality Control Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Trip Blank (lab-supplied reagent water)	VOCs, TPH (Gx), PFAS	One per cooler containing sample volume for VOCs, TPH (Gx), and PFAS analysis	Contamination/Bias	No target compounds >1/2 LOQ (LOQ for common laboratory contaminants) or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.

LOQ	limit of quantitation
PFAS	per- and polyfluoroalkyl substances
TPH (Gx)	total petroleum hydrocarbons-gasoline range
VOC	volatile organic compound

Worksheet #13: Secondary Data Criteria and Limitations Table

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator	How Data Will Be Used	Limitations on Data Use
Historic Data	Department of the Navy investigations conducted between 1990 through 2020. See Appendix J (References) for specific workplans/reports being used.	Department of the Navy	To assess analytical program constituents	No limitations

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Worksheet #14: Summary of Project Tasks

14.1 MOBILIZATION 1 – GEOPHYSICAL SURVEY

14.1.1 Utility Designation and Subsurface Obstruction Evaluation Tasks

1. Performed a site walk to identify any site constraints or limited-access areas that could affect the survey.
2. Prepared for road closures of 4th Street, H Street, and 3rd Street in accordance with a separate traffic control plan.
3. Perform utility clearance and subsurface obstruction evaluation in accordance with NAVFAC Northwest SOP I-A-6 (Appendix E).

14.1.2 Saltwater Wedge Evaluation Tasks

1. Deployed electrical resistivity tomography (ERT) transect cables, installing 0.5-inch diameter stainless steel electrodes on 10-foot spacings, along two transects prescribed in the Geophysical Workplan (Appendix D), and in general accordance with NAVFAC Northwest SOP I-B-2 (Appendix E).
2. Recorded resistivity measurements approximately 8 times over a 32-hour period (full 24-hour tidal cycle and 4 hours on each side of the cycle to evaluate inland tidal lag effects).
3. Following each ERT measurement, conducted electromagnetic and ground-penetrating radar data collection adjacent to ERT transects to supplement ERT data.

14.2 MOBILIZATION 2 – DIRECT-PUSH SUBSURFACE INVESTIGATION

14.2.1 Direct-push Drilling Tasks

1. Mark direct-push boring locations as shown on Figure 10.
2. Mobilize direct-push drill rig and support vehicle to initial location.
3. Prior to drilling, review lithology, depth to water, and vertical contamination distribution in nearby borings and monitoring wells. Select planned sample depths per the rationale in Worksheet #17.
4. Perform geologic logging of soil cores as borings are advanced, recording lithology and PID/XRF screening results along core in accordance with NAVFAC Northwest SOP I-E.
5. Collect three soil samples from the direct-push cores from each boring, in accordance with NAVFAC Northwest SOP I-F, OSD 2021 guidance (OSD 2022), and the Environmental Data Quality Workgroup's *Bottle Selection and other Sampling Considerations When Sampling for PFAS* guidance (EDQW 2017), selecting sampling depth per the rational in Worksheet #17.
6. Drive grab groundwater sampling tool or install temporary polyvinyl chloride (PVC) casing, as necessary, to collect qualitative grab groundwater samples from one interval in each of the direct-push borings selected based on PID/XRF readings and field observations. Collect grab groundwater samples in accordance with NAVFAC Northwest SOP I-C-4 and Environmental Data Quality Workgroup (EDQW) (EDQW 2017) guidance for PFAS samples.
7. Complete the chain-of-custody (ChoC) for samples collected in accordance with NAVFAC Northwest SOP III-E.
8. Quality assurance (QA) check sample container labels against ChoC.

9. Package soil and groundwater samples for submittal to off-site laboratory in accordance with NAVFAC Northwest SOP III-G.
10. Decontaminate any reusable sampling equipment in between sample collection and/or boreholes using Liquinox, with a final deionized (DI) water rinse in accordance with NAVFAC Northwest SOP III-I.

14.3 MOBILIZATION 3 – DEEP BORING AND WELL INSTALLATION

14.3.1 Sonic Drilling and Well Installation Tasks

1. Mark sonic boring locations as shown on Figure 11, and as modified by the project team based on the results of the direct-push sampling.
2. Mobilize sonic drill rig and support vehicle to initial location.
3. Prior to drilling, review lithology, depth to water, and vertical contamination distribution in nearby borings and monitoring wells. Select planned sample depths per the rationale in Worksheet #17, or as agreed to by the project team based on the results of the direct-push sampling.
4. Perform geologic logging of soil cores as borings are advanced, recording lithology and PID and XRF screening results along core in accordance with NAVFAC Northwest SOP I-E.
5. Collect three soil samples from the extruded sonic cores for laboratory analysis, per the rational in Worksheet#17, recording the temperature of the soil core at the point of sampling.
6. Collect grab groundwater samples from each boring in accordance with NAVFAC Northwest SOP I-C-4.
7. Install well as described in Worksheet #17 and in accordance with NAVFAC Northwest SOP I-C-1. Otherwise, abandon the borehole in accordance with NAVFAC Northwest SOP I-B-4.
8. Well screen interval to be selected based on the rationale in Worksheet #17, along with project team input and boring field screening data.
9. Develop monitoring wells in accordance with NAVFAC Northwest SOP I-C-2.
10. Collect samples in accordance with SOP I-B-1 and EDQW (EDQW 2017) guidance for PFAS samples.
11. Complete the ChoC for samples collected in accordance with NAVFAC Northwest SOP III-E.
12. QA check sample container labels against ChoC.
13. Package soil and groundwater samples for submittal to off-site laboratory in accordance with NAVFAC Northwest SOP III-G.

14.3.2 Groundwater Measurement and Sampling Tasks

1. Locate groundwater sample locations as shown on Figure 11, including both historical wells to be sampled and newly installed wells.
2. Collect synoptic depth to groundwater measurements from all groundwater monitoring wells within the study area boundaries in accordance with NAVFAC Northwest SOP I-D-5.
3. Label sample containers with sample identification (ID), site ID, sampler initials, and collection date and time in accordance with NAVFAC Northwest SOP III-E.

4. Use the results of the Area 8 saltwater wedge evaluation and OU 1 tidal study to determine representative sampling lag times, as appropriate.
5. Use bladder or peristaltic pump to low-flow purge well prior to sampling, while measuring field parameters in accordance with NAVFAC Northwest SOP I-C-5.
6. Collect groundwater sample into sample containers at the conclusion of purging in accordance with NAVFAC Northwest SOP I-C-3 and I-C-5, and EDQW (EDQW 2017) guidance for PFAS samples.
7. Complete the ChoC for samples collected in accordance with NAVFAC Northwest SOP III-E.
8. QA check sample container labels against ChoC.
9. Package groundwater samples for submittal to off-site laboratory.

14.3.3 Land Surveying Tasks

1. Survey horizontal locations and top of casing elevations for newly installed groundwater monitoring wells in accordance with NAVFAC Northwest SOP I-G. Mark top of casing elevation survey point with indelible marker for future measurements.

14.4 EQUIPMENT DECONTAMINATION

1. Grossly decontaminate heavily soiled non-dedicated sampling equipment (e.g., drill bits, augers, drill string, etc.) using potable water deployed by a steam power washer in accordance with NAVFAC Northwest SOP III-I.
2. Wash non-dedicated equipment with a non-phosphate detergent (Citranox®, Liquinox®, or other suitable phosphate and PFAS-free detergent) and potable water solution.
3. Rinse non-dedicated equipment with potable water.
4. Rinse non-dedicated equipment with PFAS-free DI water.

14.5 INVESTIGATION-DERIVED WASTE MANAGEMENT

Investigation derived waste (IDW) consisting of soil cuttings, purge water, and water/slurry generated during decontamination processes, will be collected in properly labeled U.S. Department of Transportation (DOT)-approved containers and temporarily stored on-site for subsequent off-site disposal. To the extent possible, IDW will be segregated by boring location, depth, and media to keep similar wastes together. Drums will be labeled with the following information:

- Contents/Media (e.g., soil, asphalt cuttings, decontamination water)
- Start and end dates of accumulation
- Source location(s) (e.g., boring number[s] such as “SB-62 through SB-65”)
- Navy contact information

A drum inventory will be maintained as drums are accumulated. Containerized IDW will be sampled for waste characterization as directed by the NBK Keyport Hazardous Waste Department and analyzed for the analytes required by the NBK Keyport Hazardous Waste Department. The analytes to be measured, and LOD, detection limit (DL), and LOQ metrics are tabulated in Appendix F. Sample containers for the IDW testing are also specified in Appendix F. Waste will be properly disposed of by the NBK Keyport Hazardous Waste Department. Used personal protective equipment and disposable sampling equipment, unless grossly contaminated, will be disposed of in a municipal waste container designated by the Navy. If disposable sampling equipment is grossly contaminated, the equipment will be decontaminated prior to disposal.

14.5.1 Data Management Tasks

All analytical data, field notes, data sheets, and other data necessary to support the project will be maintained in an AECOM electronic database. All hard copies of analytical data, field notes, data sheets, and other data necessary to support the project will be maintained in the AECOM Seattle office as detailed in Worksheet #29 and transferred to the Navy at the end of the task order.

14.5.2 Documentation and Records

All field observations and measurements will be recorded in a field notebook and project-specific field data sheets. All samples will have global positioning system (GPS) locations. ChoC forms, air bills, and sample logs will be prepared and retained for each sample. See Worksheet #21 for a list of documentation SOPs. All data will be included in the final investigation report.

14.5.3 Assessment/Audit Tasks

The project chemist, QA program manager, and field manager will be responsible for assessment and audit tasks (see Worksheet #7). The CTO manager will be responsible for coordinating the field audit.

14.5.4 Data Reporting

The analytical laboratory will verify, reduce, and report data as specified in their DoD Environmental Laboratory Accreditation Program (ELAP)-evaluated laboratory QA plan. Reported data will be provided as hard copy and electronic data deliverables (EDDs). The laboratory deliverables will be consistent with Appendix A of the *Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*, Version 5.3 (DoD and DOE 2019), as provided in Appendix F.

Analytical data will be submitted by the laboratory to both the AECOM Project Chemist and the data validation firm in hard copy and electronic file format (pdf and paper copy of the analytical report and a compatible electronic file that can be uploaded to the project database [EDD]). The EDD will be uploaded to an EQuIS (Environmental Data Management Software) database. The reports and database will be parsed through internal verification and validation checks. Internal verification and validation checks are performed to identify data entries that exceed the specified quality control (QC) criteria. If QC criteria are not met or if errors are identified due to an incorrect or incomplete laboratory submittal, the data package will be returned to the laboratory for correction and resubmittal.

The analytical data will be reviewed before it is validated to address time-critical issues such as re-extraction, matrix interference, and holding times. The data usage and the appropriate QA/QC level will be evaluated.

14.5.5 Data Review Tasks

Data quality checks (i.e., evaluating the precision and accuracy) will be performed once the analytical data are received from the laboratory. AECOM will verify the data content is complete and that the specified limits of quantitation and limits of detection reported are aligned to Worksheet #15.

All analytical laboratory data results will be validated by a third-party data validation firm or AECOM. The first 10 percent of project field data for each media (soil and groundwater) generated by the laboratory will undergo Stage 4 validation by a third-party validation firm to confirm that the laboratory has complied with the requirements outlined in both the analytical methods and the DoD QSM Version 5.3 (DoD and DOE 2019). IDW data will undergo Stage 2A validation by AECOM. The remaining data will undergo Stage 2B validation by a third-party data validation firm. Data will be validated as described in *DoD General Data Validation Guidelines* dated November 4, 2019 (DoD 2019) as supported by *DoD Data Validation Guidelines Module 1 (Data Validation Procedure for Organic Analysis by GCMS,* (2020a), *Module 2 (Data Validation Procedure for Metals by ICP-OES,* (2020b), *Module 3 (Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15,* (2020c), and *Module 4 (Data Validation Procedure for Organic Analysis by GC*, (2021).

The AECOM Project Chemist will also review the results of field duplicate pairs collected during the field effort to evaluate the reproducibility of field sampling techniques. At completion of validation, assigned data qualifiers will be entered to the EQuIS database. At completion of database checks, the information will be uploaded from EQuIS to the NIRIS system.

All documents produced for the project will be kept in a secured facility for the life of the project. Upon closure of the project, laboratory documents will be archived with the project report in the administration record file at NAVFAC Northwest.

Data received from the validation firm will also be uploaded into AECOM's Microsoft Sample Quantitation Limit server 2005 which is managed via EQuIS (Environmental Data Management Software).

14.5.6 Supplemental RI Report Preparation

Following data validation, data interpretation and data evaluation completion, a SRI Report will be prepared. The report will include an executive summary, a description of the project background, a description of the fieldwork performed, supporting exhibits, a summary of findings, and any identified data gaps. Additionally, the report will include recommendations to address any data gaps and conclusions, as indicated by the data evaluation and in collaboration with the project team.

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Worksheet #15: Reference Limits and Evaluation Tables

Table 15-1: Soil

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
Chemical Characteristics	EPA 9012B	57-12-5	Cyanide, Total	COPC	—	MTCA Protection of Marine SW	0.010	***0.500***	***0.450***	***0.180***	mg/kg
	Lloyd Kahn Method	7440-44-0	Total Organic Carbon	N/A	—	NE	NE	300	200	100	mg/kg
Physical Characteristics	API RP40 and ASTM D2937	N/A	Density – Grain and Bulk	N/A	—	NE	NE	N/A	N/A	N/A	N/A
	ASTM D-422	N/A	Grain Size	N/A	—	NE	NE	N/A	N/A	N/A	N/A
	API RP40	N/A	Permeability (Intrinsic)	N/A	—	NE	NE	N/A	N/A	N/A	N/A
	API RP40	N/A	Porosity – Total and Air-Filled	N/A	—	NE	NE	N/A	N/A	N/A	N/A
	SM 2540-G	STL00234	Total Solids	N/A	—	NE	NE	1.00	N/A	0.100	%
Metals	EPA 6020B	7440-38-2	Arsenic	ROD COC	—	MTCA Protection of Marine SW	0.15	0.200	0.160	0.0669	mg/kg
		7440-43-9	Cadmium	ROD COC	—	MTCA Protection of GW	0.035	0.0500	0.0400	0.0200	mg/kg
		7440-47-3	Chromium	ROD COC	—	MTCA Method A	2,000	0.200	0.150	0.0769	mg/kg
		7440-48-4	Cobalt	COPC	—	MTCA Protection of GW	0.22	0.100	0.0500	0.0200	mg/kg
		7440-50-8	Copper	COPC	—	MTCA Protection of Marine SW	0.069	0.200	0.150	0.0440	mg/kg
		7439-92-1	Lead	COPC	—	MTCA Protection of Marine SW	56	0.100	0.0800	0.0380	mg/kg
		7440-02-0	Nickel	COPC	—	MTCA Protection of Marine SW	0.54	0.200	0.160	0.0814	mg/kg
		7440-22-4	Silver	COPC	—	MTCA Protection of Marine SW	0.016	0.0500	0.0400	0.0203	mg/kg
		7440-66-6	Zinc	COPC	—	MTCA Protection of Marine SW	5	15.0	4.00	2.00	mg/kg
	EPA 7471B	7439-97-6	Mercury	COPC	—	MTCA Protection of Marine SW	0.0013	***0.0600***	***0.0400***	***0.0200***	mg/kg
Hexavalent Chromium	EPA 7196A	18540-29-9	Hexavalent Chromium	COPC	—	MTCA Protection of GW	0.00089	***0.420***	***0.300***	***0.140***	mg/kg
VOCs	EPA 8260D	71-55-6	1,1,1-Trichloroethane	COPC	—	MTCA Protection of GW	84	5.00	2.00	0.600	µg/kg
		79-34-5	1,1,2,2-Tetrachloroethane	COPC	—	MTCA Protection of GW	0.08	***5.00***	***1.00***	***0.400***	µg/kg
		79-00-5	1,1,2-Trichloroethane	COPC	—	MTCA Protection of Marine SW	0.33	***5.00***	***2.00***	***0.500***	µg/kg
		75-34-3	1,1-Dichloroethane	COPC	—	MTCA Protection of GW	2.6	5.00	2.00	0.500	µg/kg
		75-35-4	1,1-Dichloroethene	COPC	—	MTCA Protection of GW	2.5	5.00	2.00	0.500	µg/kg
		107-06-2	1,2-Dichloroethane	COPC	—	MTCA Protection of GW	1.6	5.00	2.00	0.600	µg/kg
		78-87-5	1,2-Dichloropropane	COPC	—	MTCA Protection of Marine SW	1.0	5.00	2.00	0.500	µg/kg
		120-82-1	1,2,4-Trichlorobenzene	COPC	—	MTCA Protection of Marine SW	0.072	***10.0***	***8.00***	***5.00***	µg/kg
		95-50-1	1,2-Dichlorobenzene	COPC	—	MTCA Protection of GW	400	5.00	2.00	0.500	µg/kg
		541-73-1	1,3-Dichlorobenzene	COPC	—	MTCA Protection of Marine SW	1.3	5.00	2.00	0.500	µg/kg
		106-46-7	1,4-Dichlorobenzene	COPC	—	MTCA Protection of GW	68	5.00	1.00	0.400	µg/kg
		71-43-2	Benzene	COPC	—	MTCA Protection of Marine SW	0.56	5.00	2.00	0.500	µg/kg
		75-27-4	Bromodichloromethane	COPC	—	MTCA Protection of Marine SW	0.89	5.00	1.00	0.400	µg/kg
		75-25-2	Bromoform	COPC	—	MTCA Protection of Marine SW	5	10.0	8.00	5.00	µg/kg
		74-83-9	Bromomethane	COPC	—	MTCA Protection of GW	3.3	5.00	2.00	0.700	µg/kg
		75-15-0	Carbon disulfide	COPC	—	MTCA Protection of GW	250	5.00	2.00	0.600	µg/kg
		56-23-5	Carbon tetrachloride	COPC	—	MTCA Protection of Marine SW	0.15	***5.00***	***2.00***	***0.500***	µg/kg
		108-90-7	Chlorobenzene	COPC	—	MTCA Protection of GW	51	5.00	2.00	0.500	µg/kg
		75-00-3	Chloroethane	COPC	—	NE	NE	5.00	4.00	1.00	µg/kg
		67-66-3	Chloroform	COPC	—	MTCA Protection of GW	4.8	5.00	2.00	0.600	µg/kg
		74-87-3	Chloromethane	—	—	NE	NE	5.00	2.00	0.600	µg/kg
		156-59-2	cis-1,2-Dichloroethene	COPC	—	MTCA Protection of GW	5.2	***5.00***	***2.00***	***0.500***	µg/kg

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
VOCs (cont'd)	EPA 8260D (cont'd)	10061-01-5	cis-1,3-Dichloropropene	COPC	—	MTCA Protection of GW	0.14	***5.00***	***1.00***	***0.400***	µg/kg
		124-48-1	Dibromochloromethane	COPC	—	MTCA Protection of Marine SW	0.70	5.00	1.00	0.500	µg/kg
		100-41-4	Ethylbenzene	COPC	—	MTCA Protection of Marine SW	10	5.00	1.00	0.400	µg/kg
		75-09-2	Methylene Chloride	COPC	—	MTCA Protection of GW	1.5	***5.00***	***4.00***	***2.00***	µg/kg
		127-18-4	Tetrachloroethene	COPC	—	MTCA Protection of Marine SW	1.6	5.00	2.00	0.500	µg/kg
		108-88-3	Toluene	COPC	—	MTCA Protection of Marine SW	44	5.00	2.00	0.600	µg/kg
		156-60-5	trans-1,2-Dichloroethene	COPC	—	MTCA Protection of GW	32	5.00	2.00	0.500	µg/kg
		79-01-6	Trichloroethene	COPC	—	MTCA Protection of Marine SW	0.27	***5.00***	***2.00***	***0.500***	µg/kg
		75-69-4	Trichlorofluoromethane	COPC	—	MTCA Protection of GW	790	5.00	2.00	0.700	µg/kg
		75-01-4	Vinyl chloride	COPC	—	MTCA Protection of Marine SW	0.056	***5.00***	***2.00***	***0.600***	µg/kg
		1330-20-7	Xylenes, total	COPC	—	MTCA Protection of Marine SW	55	10.0	2.00	1.40	µg/kg
SVOCs	EPA 8270E SIM	123-91-1	1,4-Dioxane	COPC	—	MTCA Protection of GW	0.13	***20***	***10***	***4.61***	µg/kg
PAHs	EPA 8270E SIM	56-55-3	Benzo(a)anthracene	COPC	0.1 [b]	MTCA Protection of Marine SW	0.057	***1.67***	***1.33***	***0.667***	µg/kg
		50-32-8	Benzo(a)pyrene	COPC	1 [b]	MTCA Protection of Marine SW	0.016	***1.67***	***1.33***	***0.667***	µg/kg
		205-99-2	Benzo(b)fluoranthene	COPC	0.1 [b]	MTCA Protection of Marine SW	0.096	***1.67***	***1.33***	***0.667***	µg/kg
		191-24-2	Benzo(g,h,i)perylene	COPC	—	NE	NE	1.67	1.33	0.667	µg/kg
		207-08-9	Benzo(k)fluoranthene	COPC	0.1 [b]	MTCA Protection of Marine SW	0.94	1.67	1.33	0.667	µg/kg
		83-32-9	Acenaphthene	COPC	—	MTCA Protection of Marine SW	160	1.67	1.33	0.667	µg/kg
		208-96-8	Acenaphthylene	COPC	—	NE	NE	1.67	1.33	0.333	µg/kg
		120-12-7	Anthracene	COPC	—	MTCA Protection of Marine SW	2,400	1.67	1.33	0.667	µg/kg
		218-01-9	Chrysene	COPC	0.01 [b]	MTCA Protection of Marine SW	2.9	1.67	1.33	0.333	µg/kg
		53-70-3	Dibenz(a,h)anthracene	COPC	0.1 [b]	MTCA Protection of Marine SW	0.029	***1.67***	***1.33***	***0.667***	µg/kg
		206-44-0	Fluoranthene	COPC	—	MTCA Protection of Marine SW	300	1.67	1.33	0.667	µg/kg
		86-73-7	Fluorene	COPC	—	MTCA Protection of Marine SW	80	1.67	1.33	0.667	µg/kg
		193-39-5	Indeno(1,2,3-cd)pyrene	COPC	0.1 [b]	MTCA Protection of Marine SW	0.31	***1.67***	***1.33***	***0.667***	µg/kg
		91-20-3	Naphthalene	COPC	—	MTCA Protection of GW	240	3.33	2.67	1.33	µg/kg
		85-01-8	Phenanthrene	COPC	—	NE	NE	2.33	2.00	1.00	µg/kg
		129-00-0	Pyrene	COPC	—	MTCA Protection of Marine SW	550	1.67	1.33	0.667	µg/kg
		90-12-0	1-Methylnaphthalene	COPC	—	MTCA Protection of GW	4.2	1.67	1.33	0.667	µg/kg
		91-57-6	2-Methylnaphthalene	COPC	—	MTCA Protection of GW	88	3.33	2.67	1.33	µg/kg
		—	Total cPAH TEQ	—	—	See note [c]	0.016	N/A	N/A	N/A	µg/kg
SVOCs	EPA 8270E	108-60-1	2,2'-oxybis(1-chloropropane)	COPC	—	MTCA Protection of GW	0.23	***43.3***	***40.0***	***20.0***	µg/kg
		95-95-4	2,4,5-Trichlorophenol	COPC	—	MTCA Protection of Marine SW	1,100	36.7	33.3	16.7	µg/kg
		88-06-2	2,4,6-Trichlorophenol	COPC	—	MTCA Protection of Marine SW	0.19	***36.7***	***33.3***	***16.7***	µg/kg
		120-83-2	2,4-Dichlorophenol	COPC	—	MTCA Protection of Marine SW	4.3	***43.3***	***40.0***	***20.0***	µg/kg
		105-67-9	2,4-Dimethylphenol	COPC	—	MTCA Protection of Marine SW	76	36.7	33.3	16.7	µg/kg
		51-28-5	2,4-Dinitrophenol	COPC	—	MTCA Protection of GW	9.2	***1000***	***333***	***167***	µg/kg
		121-14-2	2,4-Dinitrotoluene	COPC	—	MTCA Protection of Marine SW	0.16	***167***	***66.7***	***33.3***	µg/kg
		606-20-2	2,6-Dinitrotoluene	COPC	—	MTCA Protection of GW	0.051	***36.7***	***33.3***	***16.7***	µg/kg
		91-58-7	2-Chloronaphthalene	COPC	—	MTCA Protection of Marine SW	280	33.3	26.7	13.3	µg/kg
		95-57-8	2-Chlorophenol	COPC	—	MTCA Protection of Marine SW	11	***36.7***	***33.3***	***16.7***	µg/kg
		95-48-7	2-Methylphenol (o-Cresol)	COPC	—	MTCA Protection of GW	470	50.0	40.0	20.0	µg/kg

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
SVOCs (cont'd)	EPA 8270E (cont'd)	88-74-4	2-Nitroaniline	COPC	—	MTCA Protection of GW	64	50.0	33.3	16.7	µg/kg
		88-75-5	2-Nitrophenol	COPC	—	NE	NE	50.0	40.0	20.0	µg/kg
		91-94-1	3,3'-Dichlorobenzidine	COPC	—	MTCA Protection of Marine SW	0.011	***167***	***66.7***	***33.3***	µg/kg
		99-09-2	3-Nitroaniline	COPC	—	NE	NE	167	66.7	33.3	µg/kg
		534-52-1	4,6-Dinitro-2-methylphenol	COPC	—	MTCA Protection of GW	1.3	***500***	***333***	***167***	µg/kg
		101-55-3	4-Bromophenyl-phenylether	COPC	—	NE	NE	36.7	33.3	16.7	µg/kg
		59-50-7	4-Chloro-3-methylphenol	COPC	—	MTCA Protection of Marine SW	28	50.0	40.0	20.0	µg/kg
		106-47-8	4-Chloroaniline	COPC	—	MTCA Protection of GW	0.17	***167***	***66.7***	***33.3***	µg/kg
		7005-72-3	4-Chlorophenyl-phenylether	COPC	—	NE	NE	36.7	33.3	16.7	µg/kg
		106-44-5	4-Methylphenol (p-Cresol)	COPC	—	MTCA Protection of GW	940	50.0	33.3	16.7	µg/kg
		100-01-6	4-Nitroaniline	COPC	—	MTCA Protection of GW	1.7	***167***	***66.7***	***33.3***	µg/kg
		100-02-7	4-Nitrophenol	COPC	—	NE	NE	500	333	167	µg/kg
		65-85-0	Benzoic Acid	COPC	—	MTCA Protection of GW	18,000	500	333	167	µg/kg
		100-51-6	Benzyl Alcohol	COPC	—	MTCA Protection of GW	490	500	333	167	µg/kg
		111-91-1	bis(2-Chloroethoxy)methane	COPC	—	MTCA Protection of GW	14	***36.7***	***33.3***	***16.7***	µg/kg
		111-44-4	bis(2-Chloroethyl)ether	COPC	—	MTCA Protection of GW	0.014	***36.7***	***33.3***	***16.7***	µg/kg
		117-81-7	bis(2-Ethylhexyl) phthalate	COPC	—	MTCA Protection of Marine SW	5.1	***167***	***133***	***66.7***	µg/kg
		85-68-7	Butyl Benzyl Phthalate	COPC	—	MTCA Protection of Marine SW	0.18	***167***	***133***	***66.7***	µg/kg
		86-74-8	Carbazole	COPC	—	NE	NE	36.7	33.3	16.7	µg/kg
		132-64-9	Dibenzofuran	COPC	—	MTCA Protection of GW	76	36.7	33.3	16.7	µg/kg
		84-66-2	Diethyl Phthalate	COPC	—	MTCA Protection of Marine SW	74	167	133	66.7	µg/kg
		131-11-3	Dimethyl phthalate	COPC	—	MTCA Protection of Marine SW	190	167	133	66.7	µg/kg
		84-74-2	di-n-Butyl Phthalate	COPC	—	MTCA Protection of Marine SW	15	***167***	***133***	***66.7***	µg/kg
		117-84-0	di-n-Octyl Phthalate	COPC	—	MTCA Protection of GW	23,000	167	133	66.7	µg/kg
		118-74-1	Hexachlorobenzene	COPC	—	MTCA Protection of Marine SW	0.0004	***16.7***	***13.3***	***6.67***	µg/kg
		87-68-3	Hexachlorobutadiene	COPC	—	MTCA Protection of Marine SW	0.011	***50.0***	***40.0***	***20.0***	µg/kg
		77-47-4	Hexachlorocyclopentadiene	COPC	—	MTCA Protection of Marine SW	1.7	***500***	***333***	***167***	µg/kg
		67-72-1	Hexachloroethane	COPC	—	MTCA Protection of Marine SW	0.0097	***167***	***66.7***	***33.3***	µg/kg
		78-59-1	Isophorone	COPC	—	MTCA Protection of GW	32	66.7	33.3	16.7	µg/kg
		98-95-3	Nitrobenzene	COPC	—	MTCA Protection of GW	6.5	***36.7***	***33.3***	***16.7***	µg/kg
		621-64-7	n-Nitroso-di-n-propylamine	COPC	—	MTCA Protection of GW	0.007	***66.7***	***50.0***	***33.3***	µg/kg
		86-30-6	n-Nitrosodiphenylamine	COPC	—	MTCA Protection of Marine SW	2	***36.7***	***33.3***	***16.7***	µg/kg
		87-86-5	Pentachlorophenol	COPC	—	MTCA Protection of Marine SW	0.0018	***167***	***133***	***66.7***	µg/kg
		108-95-2	Phenol	COPC	—	MTCA Protection of GW	2,300	36.7	33.3	16.7	µg/kg
Per- and Polyfluoroalkyl Substances	LC-MS/MS DoD QSM v5.3 Table B-15	335-67-1	Perfluorooctanoic acid (PFOA)	COPC	—	OSD, 2022	250	0.600	0.400	0.200	ng/g
		1763-23-1	Perfluorooctanesulfonic acid (PFOS)	COPC	—	OSD, 2022	160	0.600	0.400	0.200	ng/g
		375-95-1	Perfluorononanoic acid (PFNA)	COPC	—	OSD, 2022	250	0.600	0.400	0.200	ng/g
		355-46-4	Perfluorohexanesulfonic acid (PFHxS)	COPC	—	OSD, 2022	1,600	0.600	0.400	0.200	ng/g
		375-85-9	Perfluoroheptanoic acid (PFHpA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		375-73-5	Perfluorobutanesulfonic acid (PFBS)	COPC	—	OSD, 2022	25,000	2.00	1.60	0.400	ng/g

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
Per- and Polyfluoroalkyl Substances (cont'd)	LC-MS/MS DoD QSM v5.3 Table B-15 (cont'd)	335-76-2	Perfluorodecanoic acid (PFDA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		307-55-1	Perfluorododecanoic acid (PFDoA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		307-24-4	Perfluorohexanoic acid (PFHxA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		376-06-7	Perfluorotetradecanoic acid (PFTA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		72629-94-8	Perfluorotridecanoic acid (PFTrDA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		2058-94-8	Perfluoroundecanoic acid (PFUnA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		13252-13-6	Hexafluoropropylene oxide dimer acid (HFPODA)	COPC	—	OSD, 2022	350	3.00	1.60	0.400	ng/g
		2355-31-9	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	COPC	—	NE	NE	2.00	0.400	0.200	ng/g
		2991-50-6	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	COPC	—	NE	NE	2.00	0.400	0.200	ng/g
		763051-92-9	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g
		756426-58-1	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	COPC	—	NE	NE	2.00	0.400	0.200	ng/g
		919005-14-4	4,8-Dioxa-3H-perfluorononanoic acid (DONA)	COPC	—	NE	NE	0.600	0.400	0.200	ng/g

Note: Laboratory information for chemical analysis provided by Eurofins Lancaster Laboratories Environment Testing, LLC located in Lancaster, PA, Eurofins Seattle located in Tacoma, WA, and Analytical Resources, Inc. located in Tukwila, WA. Information for density, permeability, and porosity provided by Integrated Geosciences Laboratories, LLC located in Houston, TX.

Values where lowest detection limit exceeds the PAL are ***shown in bold text***.

Soil sample chemical results will be reported on a dry weight basis.

µg/kg	microgram per kilogram
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
bgs	below ground surface
CASRN	Chemical Abstract Service Registry Number
CLARC	Cleanup Levels and Risk Calculation
COC	chemical of concern (chemical with ROD Remediation Goal)
COPC	chemical of potential concern
DL	detection limit
DoD	Department of Defense, United States
dw	dry weight
GW	groundwater
LC	liquid chromatography
LOD	limit of detection
LOQ	limit of quantitation
MDL	method detection limit
mg/kg	milligram per kilogram
MS	mass spectrometry
MTCA	Model Toxics Control Act
N/A	not applicable
NE	not established
ng/g	nanogram per gram
PAH	polynuclear aromatic hydrocarbon
QL	quantitation limit
QSM	Quality Systems Manual
ROD	Record of Decision
SM	Standard Method
SVOC	semi-volatile organic compound
SW	surface water
TEF	toxicity equivalency factor
VOC	volatile organic compound
WAC	Washington Administrative Code

[a] Project action limit references:
OSD, 2022 – Assistant Secretary of Defense, 2022. Risk Screening Levels Calculated for PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA in Groundwater and Soil using USEPA's Regional Screening Level Calculator. Hazard quotient (HQ) = 0.1. July 6.
The project action limits are based on incidental ingestion of soil applied to the soil interval 2 to 15 feet bgs for the industrial/commercial worker scenario.
(MTCA Cleanup Regulation, Chapter 173-340 WAC; As presented on Washington State Department of Ecology (Ecology) website CLARC tables posted July 2021, (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables). The lowest value reported for Soil for Protection of GW, Soil for Protection of GW to Marine SW, and direct contact is presented as the Project Action Limit.
The project action limit shown for cis-1,3-dichloropropene is based on the CLARC value for total 1,3-dichloropropene (CAS #542-75-6).

[b] These compounds are considered carcinogenic PAHs (cPAHs) and are subject to WAC-173-340 Toxicity Equivalent Concentration calculations. The TEFs for cPAHs are based on the relative toxicity compared to benzo(a)pyrene. The TEFs were obtained from Table 708-2 in WAC 173-340.

Table 15-2: Groundwater

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
Anions	EPA 300.0	24959-67-9	Bromide	N/A	—	NE	NE	0.500	0.400	0.250	mg/L
		16887-00-6	Chloride	N/A	—	WAC 246-290-310	250	0.400	0.300	0.200	mg/L
		16984-48-8	Fluoride	N/A	—	MTCA Method B, non-cancer	0.96	0.100	0.0900	0.0500	mg/L
		14797-55-8	Nitrate as N	N/A	—	MCL, 40 CFR141	10	0.100	0.0900	0.0500	mg/L
		14797-65-0	Nitrite as N	N/A	—	MCL, 40 CFR141	1	0.100	0.0900	0.0500	mg/L
		STL00217	Nitrate Nitrite as N	N/A	—	NE	NE	0.100	0.100	0.0500	mg/L
		14808-79-8	Sulfate	N/A	—	WAC 246-290-310	250	1.00	0.900	0.300	mg/L
Chemical Characteristics	EPA 9012B	57-12-5	Cyanide, Total	COPC	—	WAC 246-290-310	0.2	0.0100	0.0090	0.0050	mg/L
	SM5310_DOC_C	7440-44-0	Dissolved Organic Carbon	N/A	—	NE	NE	1.00	0.900	0.500	mg/L
	SM4500_S2_D	18496-25-8	Sulfide	N/A	—	NE	NE	0.300	0.250	0.100	mg/L
Physical Characteristics	Field Meter	N/A	Conductivity	N/A	—	NE	NE	N/A	N/A	N/A	µmho/cm
	Field Meter	N/A	Dissolved Oxygen	N/A	—	NE	NE	N/A	N/A	N/A	mg/L
	Field Meter	N/A	Oxidation-Reduction Potential (ORP)	N/A	—	NE	NE	N/A	N/A	N/A	millivolts
	Field Meter	N/A	pH	N/A	—	NE	NE	N/A	N/A	N/A	pH units
	Field Meter	N/A	Salinity	N/A	—	NE	NE	N/A	N/A	N/A	mg/L
	Field Meter	N/A	Temperature	N/A	—	NE	NE	N/A	N/A	N/A	Degrees C
Dissolved Gases	RSK_175	124-38-9	Carbon Dioxide	N/A	—	NE	NE	12,000	8,000	2,600	µg/L
		74-84-0	Ethane	N/A	—	NE	NE	5.00	2.00	1.00	µg/L
		74-85-1	Ethene	N/A	—	NE	NE	5.00	2.00	1.00	µg/L
		74-82-8	Methane	N/A	—	NE	NE	6.00	5.90	3.00	µg/L
Metals, Total	EPA 6020B	7440-38-2	Arsenic	ROD COC	—	MTCA Method B, cancer	0.058	***2.00***	***1.60***	***0.680***	µg/L
		7440-43-9	Cadmium	ROD COC	—	MCL, 40 CFR141	5	0.500	0.400	0.151	µg/L
		7440-47-3	Chromium	COPC	—	MCL, 40 CFR141	100	2.00	0.800	0.334	µg/L
		7440-48-4	Cobalt	COPC	—	MTCA Method B, non-cancer	4.8	0.500	0.400	0.156	µg/L
		7440-50-8	Copper	ROD COC	—	MCL, 40 CFR141	1,300	1.00	0.900	0.362	µg/L
		7439-92-1	Lead	ROD COC	—	MCL, 40 CFR141	15	0.500	0.200	0.0710	µg/L
		7439-96-5	Manganese	COPC	—	MTCA Method B, non-cancer	750	2.00	1.90	0.950	µg/L
		7440-02-0	Nickel	ROD COC	—	WAC 246-290-310	100	1.50	0.800	0.400	µg/L
		7782-49-2	Selenium	COPC	—	MCL, 40 CFR141	0.05	***1.00***	***0.600***	***0.278***	µg/L
		7440-22-4	Silver	COPC	—	MTCA Method B, non-cancer	80	0.500	0.300	0.100	µg/L
		7440-28-0	Thallium	COPC	—	MCL, 40 CFR141	0.002	***0.500***	***0.300***	***0.130***	µg/L
		7440-62-2	Vanadium	COPC	—	MTCA Method B, non-cancer	80	4.00	2.00	0.794	µg/L
		7440-66-6	Zinc	ROD COC	—	MTCA Method B, non-cancer	4,800	15.0	8.00	4.00	µg/L
	EPA 1631E	7439-97-6	Mercury	COPC	—	WAC 173-201A	0.025	0.000500	0.000200	0.0000800	µg/L
	EPA 7196A	18540-29-9	Hexavalent Chromium	ROD COC	—	MTCA Method B, cancer	0.046	0.0300	0.0200	0.0100	µg/L
Metals, Dissolved	EPA 6020B	7440-38-2	Arsenic	ROD COC	—	MTCA Method B, cancer	0.058	***2.00***	***1.60***	***0.680***	µg/L

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
Metals, Dissolved (cont'd)	EPA 6020B (cont'd)	7440-43-9	Cadmium	ROD COC	—	MCL, 40CFR141	5	0.500	0.400	0.151	µg/L
		7440-70-2	Calcium	N/A	—	NE	NE	200	150	96.0	µg/L
		7440-47-3	Chromium	COPC	—	MCL, 40 CFR141	100	2.00	0.800	0.334	µg/L
		7440-48-4	Cobalt	COPC	—	MTCA Method B, non-cancer	4.8	0.500	0.400	0.156	µg/L
		7440-50-8	Copper	ROD COC	—	Surface Water WAC 173-201A, aquatic life, marine, chronic	31	30.0	20.0	12.0	µg/L
		7439-92-1	Lead	ROD COC	—	Surface Water CWA 304, aquatic life, marine, chronic	5.6	***15.0***	***11.3***	***7.10***	µg/L
		7439-95-4	Magnesium	N/A	—	NE	NE	100	75.1	40.0	µg/L
		7439-96-5	Manganese	COPC	—	MTCA Method B, non-cancer	750	2.00	1.90	0.950	µg/L
		7440-02-0	Nickel	ROD COC	—	Surface Water WAC 173-201A, aquatic life, marine, chronic	8.2	10.0	5.00	2.10	µg/L
		7782-49-2	Selenium	COPC	—	MCL, 40 CFR141	0.05	***1.00***	***0.600***	***0.278***	µg/L
		7440-22-4	Silver	COPC	—	Surface Water WAC 173-201A, aquatic life, marine, acute	1.9	***10.0***	***7.50***	***5.00***	µg/L
		7440-28-0	Thallium	COPC	—	MCL, 40 CFR141	0.002	***0.500***	***0.300***	***0.130***	µg/L
		7440-62-2	Vanadium	COPC	—	MTCA Method B, non-cancer	80	4.00	2.00	0.794	µg/L
		7440-66-6	Zinc	ROD COC	—	Surface Water WAC 173-201A, aquatic life, marine, chronic	81	20.0	10.0	3.70	µg/L
	EPA 1631E	7439-97-6	Mercury	COPC	—	WAC 173-201A	0.025	0.000500	0.000200	0.0000800	µg/L
VOCs	EPA 8260D	71-55-6	1,1,1-Trichloroethane	COPC	—	MCL, 40 CFR141	200	1.00	0.500	0.300	µg/L
		79-34-5	1,1,2,2-Tetrachloroethane	COPC	—	MTCA Method B, cancer	0.22	1.00	0.500	0.200	µg/L
		79-00-5	1,1,2-Trichloroethane	COPC	—	MTCA Method B, cancer	0.77	1.00	0.500	0.200	µg/L
		75-34-3	1,1-Dichloroethane	ROD COC	—	MTCA Method B, cancer	7.7	1.00	0.500	0.200	µg/L
		75-35-4	1,1-Dichloroethene	ROD COC	—	MCL, 40 CFR141	7	1.00	0.500	0.200	µg/L
		107-06-2	1,2-Dichloroethane	COPC	—	MTCA Method B, cancer	0.48	1.00	0.500	0.300	µg/L
		78-87-5	1,2-Dichloropropane	COPC	—	MTCA Method B, cancer	1.2	1.00	0.500	0.200	µg/L
		120-82-1	1,2,4-Trichlorobenzene	COPC	—	40 CFR 131.45 Protection of SW	0.037	***5.00***	***1.00***	***0.300***	µg/L
		95-50-1	1,2-Dichlorobenzene	COPC	—	MCL, 40 CFR141	600	5.00	0.500	0.200	µg/L
		541-73-1	1,3-Dichlorobenzene	COPC	—	40 CFR 131.45 Protection of SW	2	5.00	0.500	0.200	µg/L
		106-46-7	1,4-Dichlorobenzene	COPC	—	MTCA Method B, cancer	8.1	5.00	0.500	0.200	µg/L
		71-43-2	Benzene	COPC	—	MTCA Method B, cancer	0.8	1.00	0.500	0.200	µg/L
		75-27-4	Bromodichloromethane	COPC	—	MTCA Method B, cancer	0.71	1.00	0.500	0.200	µg/L

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
VOCs (cont'd)	EPA 8260D (cont'd)	75-25-2	Bromoform	COPC	—	MTCA Method B, cancer	5.5	4.00	2.00	1.00	µg/L
		74-83-9	Bromomethane	COPC	—	MTCA Method B, non-cancer	11	1.00	0.500	0.300	µg/L
		75-15-0	Carbon disulfide	COPC	—	MTCA Method B, non-cancer	800	5.00	0.500	0.200	µg/L
		56-23-5	Carbon tetrachloride	COPC	—	WAC 173-201A	0.3563	1.00	0.500	0.200	µg/L
		108-90-7	Chlorobenzene	COPC	—	MCL, 40 CFR141	100	1.00	0.500	0.200	µg/L
		75-00-3	Chloroethane	COPC	—	NE	NE	1.00	0.500	0.200	µg/L
		67-66-3	Chloroform	COPC	—	MTCA Method B, cancer	1.4	1.00	0.500	0.200	µg/L
		74-87-3	Chloromethane	COPC	—	NE	NE	1.00	0.500	0.200	µg/L
		156-59-2	cis-1,2-Dichloroethene	ROD COC	—	MTCA Method B, non-cancer	16	1.00	0.500	0.200	µg/L
		10061-01-5	cis-1,3-Dichloropropene	COPC	—	MTCA Method B, cancer	0.44	1.00	0.500	0.200	µg/L
		124-48-1	Dibromochloromethane	COPC	—	MTCA Method B, cancer	0.52	1.00	0.500	0.200	µg/L
		100-41-4	Ethylbenzene	COPC	—	40 CFR 131.45 Protection of SW	31	1.00	0.800	0.400	µg/L
		75-09-2	Methylene Chloride	COPC	—	MCL, 40CFR141	5	1.00	0.500	0.300	µg/L
		127-18-4	Tetrachloroethene	ROD COC	—	40 CFR 131.45 Protection of SW	2.9	1.00	0.500	0.200	µg/L
		108-88-3	Toluene	COPC	—	40 CFR 131.45 Protection of SW	130	1.00	0.500	0.200	µg/L
		156-60-5	trans-1,2-Dichloroethene	COPC	—	MCL, 40 CFR141	100	1.00	0.500	0.200	µg/L
		79-01-6	Trichloroethene	ROD COC	—	MTCA Method B, cancer	0.54	1.00	0.500	0.200	µg/L
		75-69-4	Trichlorofluoromethane	COPC	—	MTCA Method B, non-cancer	2,400	1.00	0.500	0.200	µg/L
		1330-20-7	Xylenes, total	COPC	—	MCL, 40 CFR141	1,000	6.00	2.80	1.40	µg/L
VOCs	EPA 8260D SIM	75-01-4	Vinyl chloride	COPC	—	MTCA Method B, cancer	0.029	0.0200	0.01	0.005	µg/L
SVOCs	EPA 8270E SIM	123-91-1	1,4-Dioxane	COPC	—	MTCA Method B, cancer	0.44	0.2	0.05	0.036	µg/L
PAHs	EPA 8270E SIM	56-55-3	Benzo(a)anthracene	COPC	0.1 [b]	40 CFR 131.45 Protection SW	0.00016	***0.01***	***0.005***	***0.000750***	µg/L
		50-32-8	Benzo(a)pyrene	COPC	1 [b]	40 CFR 131.45 Protection SW	0.000016	***0.01***	***0.005***	***0.00248***	µg/L
		205-99-2	Benzo(b)fluoranthene	COPC	0.1 [b]	40 CFR 131.45 Protection SW	0.00016	***0.01***	***0.005***	***0.000460***	µg/L
		191-24-2	Benzo(g,h,i)perylene	COPC	—	NE	NE	0.01	0.005	0.00142	µg/L
		207-08-9	Benzo(k)fluoranthene	COPC	0.1 [b]	40 CFR 131.45 Protection SW	0.0016	***0.01***	***0.005***	***0.00321***	µg/L
		83-32-9	Acenaphthene	COPC	—	40 CFR 131.45 Protection SW	30	0.01	0.005	0.00289	µg/L
		208-96-8	Acenaphthylene	COPC	—	NE	NE	0.01	0.005	0.00185	µg/L
		120-12-7	Anthracene	COPC	—	40 CFR 131.45 Protection SW	100	0.01	0.005	0.00116	µg/L
		218-01-9	Chrysene	COPC	0.01 [b]	40 CFR 131.45 Protection SW	0.016	***0.01***	***0.005***	***0.00090***	µg/L

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
PAHs (cont'd)	EPA 8270E SIM (cont'd)	53-70-3	Dibenz(a,h)anthracene	COPC	0.1 [b]	40 CFR 131.45 Protection SW	0.000016	***0.01***	***0.005***	***0.00134***	µg/L
		132-64-9	Dibenzofuran	COPC	—	MTCA Method B, non-cancer	8	0.01	0.005	0.00152	µg/L
		206-44-0	Fluoranthene	COPC	—	40 CFR 131.45 Protection SW	6	0.01	0.005	0.00171	µg/L
		86-73-7	Fluorene	COPC	—	40 CFR 131.45 Protection SW	10	0.01	0.005	0.00152	µg/L
		193-39-5	Indeno(1,2,3-cd)pyrene	COPC	0.1 [b]	40 CFR 131.45 Protection SW	0.00016	***0.01***	***0.005***	***0.00101***	µg/L
		91-20-3	Naphthalene	COPC	—	MTCA Method B, non-cancer	160	0.01	0.005	0.00131	µg/L
		85-01-8	Phenanthrene	COPC	—	NE	NE	0.01	0.005	0.00130	µg/L
		129-00-0	Pyrene	COPC	—	40 CFR 131.45 Protection SW	8	0.01	0.005	0.00118	µg/L
		90-12-0	1-Methylnaphthalene	COPC	—	MTCA Method B, cancer	1.5	0.01	0.005	0.00091	µg/L
		91-57-6	2-Methylnaphthalene	COPC	—	MTCA Method B, non-cancer	32	0.01	0.005	0.00102	µg/L
			Total cPAHs TEQ	COPC	—	Note [c]	0.000016				
SVOCs	EPA 8270E	108-60-1	2,2'-oxybis(1-chloropropane)	COPC	—	MTCA B GW	0.63	***2.00***	***1.00***	***0.500***	µg/L
		95-95-4	2,4,5-Trichlorophenol	COPC	—	CWA	600	2.00	1.00	0.500	µg/L
		88-06-2	2,4,6-Trichlorophenol	COPC	—	WAC 173-201A	0.28	***2.00***	***1.00***	***0.500***	µg/L
		120-83-2	2,4-Dichlorophenol	COPC	—	40 CFR 131.45 Protection SW	10	2.00	1.00	0.500	µg/L
		105-67-9	2,4-Dimethylphenol	COPC	—	WAC 173-201A	97	10.0	9.00	3.00	µg/L
		51-28-5	2,4-Dinitrophenol	COPC	—	MTCA B GW	32	30.0	28.0	14.0	µg/L
		121-14-2	2,4-Dinitrotoluene	COPC	—	WAC 173-201A	0.18	***5.00***	***2.00***	***1.00***	µg/L
		606-20-2	2,6-Dinitrotoluene	COPC	—	MTCA B GW	0.058	***2.00***	***1.00***	***0.500***	µg/L
		91-58-7	2-Chloronaphthalene	COPC	—	40 CFR 131.45 Protection SW	100	1.00	0.800	0.400	µg/L
		95-57-8	2-Chlorophenol	COPC	—	WAC 173-201A	17	2.00	1.00	0.500	µg/L
		95-48-7	2-Methylphenol (o-Cresol)	COPC	—	MTCA B POT GW CUL	800	2.00	1.00	0.500	µg/L
		88-74-4	2-Nitroaniline	COPC	—	MTCA B GW	160	5.00	2.00	1.00	µg/L
		88-75-5	2-Nitrophenol	COPC	—	NE	NE	5.00	2.00	1.00	µg/L
		91-94-1	3,3'-Dichlorobenzidine	COPC	—	WAC 173-201A	0.0033	***10.0***	***8.00***	***4.00***	µg/L
		99-09-2	3-Nitroaniline	COPC	—	NE	NE	5.00	4.00	2.00	µg/L
		534-52-1	4,6-Dinitro-2-methylphenol	COPC	—	MTCA B GW	1.3	***21.0***	***20.0***	***8.00***	µg/L
		101-55-3	4-Bromophenyl-phenylether	COPC	—	NE	NE	2.00	1.00	0.500	µg/L
		59-50-7	4-Chloro-3-methylphenol	COPC	—	WAC 173-201A	36	5.00	2.00	1.00	µg/L
		106-47-8	4-Chloroaniline	COPC	—	MTCA B GW	0.44	***10.0***	***9.00***	***4.00***	µg/L
		7005-72-3	4-Chlorophenyl-phenylether	COPC	—	NE	NE	2.00	1.00	0.500	µg/L
		106-44-5	4-Methylphenol (p-Cresol)	COPC	—	MTCA B GW	1,600	2.00	1.00	0.500	µg/L
		100-01-6	4-Nitroaniline	COPC	—	MTCA B GW	4.4	3.00	2.00	0.900	µg/L

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
SVOCs (cont'd)	EPA 8270E (cont'd)	100-02-7	4-Nitrophenol	COPC	—	NE	NE	30.0	20.0	10.0	µg/L
		65-85-0	Benzoic Acid	COPC	—	MTCA B GW	64,000	25.0	24.0	12.0	µg/L
		100-51-6	Benzyl Alcohol	COPC	—	MTCA B GW	1,600	10.0	8.00	4.00	µg/L
		111-91-1	bis(2-Chloroethoxy)methane	COPC	—	MTCA B GW	48	2.00	1.00	0.500	µg/L
		111-44-4	bis(2-Chloroethyl)ether	COPC	—	MTCA B GW	0.04	***2.00***	***1.00***	***0.500***	µg/L
		117-81-7	bis(2-Ethylhexyl) phthalate	COPC	—	40 CFR 131.45 Protection SW	0.046	***5.00***	***4.00***	***2.00***	µg/L
		85-68-7	Butyl Benzyl Phthalate	COPC	—	40 CFR 131.45 Protection SW	0.013	***5.00***	***4.00***	***2.00***	µg/L
		86-74-8	Carbazole	COPC	—	NE	NE	2.00	1.00	0.500	µg/L
		84-66-2	Diethyl Phthalate	COPC	—	40 CFR 131.45 Protection SW	200	5.00	4.00	2.00	µg/L
		131-11-3	Dimethyl phthalate	COPC	—	40 CFR 131.45 Protection SW	600	5.00	4.00	2.00	µg/L
		84-74-2	di-n-Butyl Phthalate	COPC	—	40 CFR 131.45 Protection SW	8	5.00	4.00	2.00	µg/L
		117-84-0	di-n-Octyl Phthalate	COPC	—	MTCA B GW	160	11.0	10.0	5.00	µg/L
		118-74-1	Hexachlorobenzene	COPC	—	40 CFR 131.45 Protection SW	0.000005	***0.500***	***0.220***	***0.110***	µg/L
		87-68-3	Hexachlorobutadiene	COPC	—	40 CFR 131.45 Protection SW	0.01	***2.00***	***1.00***	***0.500***	µg/L
		77-47-4	Hexachlorocyclopentadiene	COPC	—	40 CFR 131.45 Protection SW	1	***11.0***	***10.0***	***5.00***	µg/L
		67-72-1	Hexachloroethane	COPC	—	40 CFR 131.45 Protection SW	0.02	***5.00***	***1.00***	***0.500***	µg/L
		78-59-1	Isophorone	COPC	—	MTCA B GW	92	2.00	1.00	0.500	µg/L
		98-95-3	Nitrobenzene	COPC	—	MTCA B GW	16	2.00	1.00	0.500	µg/L
		621-64-7	n-Nitroso-di-n-propylamine	COPC	—	MTCA B GW	0.013	***2.00***	***1.00***	***0.500***	µg/L
		86-30-6	n-Nitrosodiphenylamine	COPC	—	WAC 173-201A	0.69	2.00	1.00	0.500	µg/L
		87-86-5	Pentachlorophenol	COPC	—	40 CFR 131.45 Protection SW	0.002	***5.00***	***4.00***	***1.00***	µg/L
		108-95-2	Phenol	COPC	—	MTCA B GW	4,800	2.00	1.00	0.500	µg/L
Per- and Polyfluoroalkyl Substances	LC-MS/MS DoD QSM v5.3 Table B-15	335-67-1	Perfluorooctanoic acid (PFOA)	COPC	—	OSD, 2022	6	2.00	1.00	0.500	ng/L
		1763-23-1	Perfluorooctanesulfonic acid (PFOS)	COPC	—	OSD, 2022	4	2.00	1.00	0.500	ng/L
		375-95-1	Perfluorononanoic acid (PFNA)	COPC	—	OSD, 2022	6	2.00	1.00	0.500	ng/L
		355-46-4	Perfluorohexanesulfonic acid (PFHxS)	COPC	—	OSD, 2022	39	2.00	1.00	0.500	ng/L
		375-85-9	Perfluoroheptanoic acid (PFHpA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		375-73-5	Perfluorobutanesulfonic acid (PFBS)	COPC	—	OSD, 2022	601	2.00	1.00	0.500	ng/L
		335-76-2	Perfluorodecanoic acid (PFDA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		307-55-1	Perfluorododecanoic acid (PFDoA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		307-24-4	Perfluorohexanoic acid (PFHxA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		376-06-7	Perfluorotetradecanoic acid (PFTA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		72629-94-8	Perfluorotridecanoic acid (PFTrDA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		2058-94-8	Perfluoroundecanoic acid (PFUnA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L

Analyte Group	Analytical Method	CASRN	Analyte	COPC or ROD COC	TEF	Project Action Limit Reference [a]	Project Action Limit [a]	LOQ (Project QL)	LOD	DL (MDL)	Units
Per- and Polyfluoroalkyl Substances (cont'd)	LC-MS/MS DoD QSM v5.3 Table B-15 (cont'd)	13252-13-6	Hexafluoropropylene oxide dimer acid (HFPODA)	COPC	—	OSD, 2022	6	3.00	1.00	0.500	ng/L
		2355-31-9	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	COPC	—	NE	NE	2.00	1.20	0.600	ng/L
		2991-50-6	N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	COPC	—	NE	NE	3.00	1.00	0.500	ng/L
		763051-92-9	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		756426-58-1	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L
		919005-14-4	4,8-Dioxa-3H-perfluorononanoic acid (DONA)	COPC	—	NE	NE	2.00	1.00	0.500	ng/L

Note: Values where lowest detection limit exceeds the PAL are ***shown in bold text***.

Laboratory information for chemical analysis provided by Eurofins Lancaster Laboratories Environment Testing, LLC located in Lancaster, PA, Eurofins Seattle (inclusive of Eurofins Frontier Global Sciences LLC) located in Tacoma, WA, and Analytical Resources Inc. located in Tukwila, WA.

µg/L	microgram per liter
µmho/cm	microsiemen per centimeter
CASRN	Chemical Abstract Service Registry Number
CFR	Code of Federal Regulations
CLARC	Cleanup Levels and Risk Calculation
COC	chemical of concern (chemical with ROD Remediation Goal)
COPC	chemical of potential concern
CWA	Clean Water Act
DL	detection limit
DoD	Department of Defense, United States
GW	groundwater
HFPODA	Hexafluoropropylene oxide dimer acid
LC	liquid chromatography
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
mg/L	milligram per liter
MDL	method detection limit
MS	mass spectrometry
MTCA	Model Toxics Control Act
N/A	not applicable
NE	not established
ng/L	nanogram per liter
OSD	Office of the Secretary of Defense
PAH	polynuclear aromatic hydrocarbon
PAL	project action limit
QL	quantitation limit
QSM	Quality Systems Manual
ROD	Record of Decision
SIM	selective ion monitoring
SM	Standard Method
SVOC	semi-volatile organic compound
SW	surface water
TEF	toxicity equivalency factor
TEQ	toxicity equivalent
VOC	volatile organic compound
WAC	Washington Administrative Code

[a] Project action limit and project action limit references:
OSD, 2022 – Assistant Secretary of Defense, 2022. Risk Screening Levels Calculated for PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA in Groundwater and Soil using USEPA's Regional Screening Level Calculator. Hazard quotient (HQ) = 0.1. July 6.
MCL, 40 CFR141, National Primary Drinking Water Regulations.
MTCA Method B, cancer or MTCA Method B, non-cancer – MTCA Cleanup Regulation, Chapter 173-340 WAC; as presented on Washington State Department of Ecology (Ecology) website CLARC tables posted July 2021, (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables). If values are presented in the CLARC for both cancer and non-cancer basis, the lower of the two values is identified as the project action limit. The project action limit shown for cis-1,3-dichloropropene and trans-1,3-dichloropropene is based on the CLARC value for total 1,3-dichloropropene (CAS #542-75-6).
WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington, update September 17, 2021.
WAC 246-290-310, MCLs and maximum residual disinfectant levels; Washington State-specific drinking water standards.
40 CFR131.45, Revision of Certain Federal Water Quality Criteria Applicable to Washington State
CWA section 304(a), Water Quality Criteria Standards, surface water, EPA
When criteria for multiple resources were available, the lowest criteria is shown as the Project Action Limit with the exception of total metals. The surface water criteria protective of aquatic life is based generally on dissolved fraction, but human health criteria are based on total fraction. The project action limits for total metals are based on drinking water and human health criteria from the references noted in the table.

[b] These compounds are considered carcinogenic PAHs (cPAHs) and are subject to WAC-173-340 Toxicity Equivalent Concentration calculations. Benzo(a)pyrene's toxicity is well characterized. Thus, the TEF for each cPAH is an estimate of that cPAH's toxicity relative to that of benzo(a)pyrene. The TEFs were obtained from Table 708-2 in WAC 173-340.

[c] Each cPAH sample result is multiplied by its corresponding TEF to produce a toxic equivalent (TEQ). The seven cPAH TEQs are summed to obtain the Total TEQ. The Total TEQ is compared to the media specific cleanup level for benzo(a)pyrene.

Worksheet #16: Project Schedule/Timeline Table

Activities	Organization	Due Date	Deliverable
Prepare and submit Draft QAPP	AECOM	July 8, 2022	Draft Project-Specific QAPP
Stakeholder Review	EPA, Ecology, Suquamish Tribe	December 2022	Deconflicted Stakeholder comments
Stakeholder Comment Resolution Meeting	NAVFAC NW, EPA, Ecology, Suquamish Tribe, AECOM	February 2023	Meeting Notes
Final WP/QAPP	AECOM	March 2023	Final Project-Specific QAPP
Mobilization 2 Field Work	AECOM	April 2023	N/A
Perform Mobilization 2 Lab analysis, data validation and evaluation	AECOM	May 2023	N/A
Well Placement/Data Summary Meeting	NAVFAC NW, EPA, Ecology, Suquamish Tribe, AECOM	June 2023	Data Summary Figures and Tables
Mobilization 3 Field Work	AECOM	June 2023	N/A
Perform Mobilization 3 Lab analysis, data validation and evaluation	AECOM	July - September, 2023	N/A
Data Summary Meeting	AECOM	September 2023	Figures and Tables
Prepare and submit Draft Supplemental RI Report	AECOM	August – September 2023	Internal Draft Supplemental RI Report
Government review and comment of Draft Supplemental RI Report	NAVFAC NW	October 2023	N/A
Response to Government Comments	AECOM	November 2023	N/A
Draft Supplemental RI	AECOM	November 2023	Draft Supplemental RI Report
Stakeholder Review	EPA, Ecology, Suquamish Tribe	December 2023	Deconflicted Stakeholder Comments
Response to Stakeholder Comments	AECOM	January 2024	Responses to comments
Stakeholder Comment Resolution Meeting	NAVFAC NW, EPA, Ecology, Suquamish Tribe, AECOM	February 2024	Meeting Notes
Draft-Final Red-Line Supplemental RI Report	AECOM	February 2024	Red-Line Report and RTCs
Government/Stakeholder Review	NAVFAC NW, EPA, Ecology, Suquamish Tribe	March 2024	Deconflicted Stakeholder Comments
Response to Government/Stakeholder Comments	AECOM	March 2024	Responses to Comments
Final Supplemental RI Report	AECOM	April 2024	Final Supplemental RI Report

AECOM	AECOM Technical Services, Inc.
EPA	Environmental Protection Agency, United States
Ecology	Washington State Department of Ecology
NAVFAC	Naval Facilities Engineering Systems Command
N/A	not applicable
NW	northwest
QAPP	quality assurance project plan
RI	remedial investigation
RTC	response to comment
WP	work plan

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Worksheet #17: Sampling Design and Rationale

17.1 OVERVIEW

Analytical methods and respective sample volumes are presented in Worksheet #19. The designated sample volumes for each analysis are designed to provide the required sample volume for each analysis and are based on method-specific requirements.

17.2 SAMPLING RATIONALE

The rationale for selection of the target matrices and analyses is detailed in Worksheet #10, and the selected chemicals, media, and representative species are summarized in Worksheet #15. During this investigation, the target sampling matrices include soil and groundwater to evaluate the current magnitude and extent of contamination at the site. Preliminary COPCs include metals, VOCs, polynuclear aromatic hydrocarbons (PAHs), 1,4-dioxane, SVOCs, and PFAS. Each matrix will also be analyzed for relevant physical characteristics. The specific sampling locations, rationale, matrices, analyses for samples, and intended data use are detailed in Worksheet #18.

17.3 PERMITS AND NOTIFICATIONS

An outage request will be submitted to the NBK Public Works Department to close parking lots and roads as needed during the investigation and obtain installation approval of boring locations. In addition, once utility notification has been completed, as specified under Section 17.4, a dig permit request will be submitted to the NBK Public Works Department to obtain installation approval of boring locations prior to initiating intrusive work.

17.4 UTILITY NOTIFICATION

Prior to conducting intrusive work, AECOM will contact Washington State 811, the local one-call utility location system. Prior to conducting the utility location work, AECOM will perform a site walk to mark the proposed soil sampling locations. Utility clearance will be conducted in all work areas where intrusive work will occur to identify the locations of underground utilities. This work will be conducted in accordance with NAVFAC Northwest SOP I-A-6 (Appendix E). In addition, all field staff will review the AECOM ground disturbance field checklist prior to conducting any intrusive work, as prescribed in the Accident Prevention Plan (Appendix H).

17.5 PFAS SAMPLING CONSIDERATIONS

PFAS have been detected in groundwater monitoring wells at Area 8; therefore, PFAS sampling will be conducted in accordance with current EDQW guidance (EDQW 2017). Additionally, all AECOM field staff are required to take AECOM's internal PFAS Sampling Training, with annual refreshers, before conducting fieldwork.

Hundreds of commercially available products exist that may contain residual PFAS, and many are found in the sampling environment. These can be divided into two basic categories: 1) the sampling equipment and 2) the items within the sampling environment not related to the sampling equipment. Common sampling equipment includes items such as bailers, pumps, tubing, disposable scoops, and sample containers constructed of or containing parts made from low-density polyethylene, polytetrafluorethylene, polyvinylidene, polychlorotrifluoroethylene, ethylene-tetrafluoroethylene, fluorinated ethylene propylene, or any other fluoropolymer. These items should not be used in the PFAS sampling environment. Additionally, latex gloves, Sharpie® markers and pens, certain decontamination liquids (e.g., Decon 90®), aluminum foil, ice packs, paper towels containing recycled material, and coated field notebooks (e.g., Rite in the Rain®) should not be used in the sampling environment. Items within the sampling environment not related to the sampling equipment include, but are not limited to, stain- and water-resistant synthetic fabrics found in outerwear and boots (e.g., Gore-Tex™), treated vehicle upholstery, personal care items such as sunscreens and insect repellants, food wrappers/containers, and residual fabric softeners on washed clothing. As a precautionary measure, the practical elimination of all of these items from the sampling environment is required.

17.6 SAMPLE LOCATIONS

Samples will be collected at the proposed locations shown on Figure 10 and Figure 11, with the rationale for each location listed in Worksheet #18. New locations will also be established based on conditions encountered by the field team during sampling activities. Existing locations will be re-occupied and coordinates for new locations established during field activities will be collected using either a handheld standalone GPS unit or via the Collector application linked to the AECOM's Enterprise Geographic Information System Portal. New location information will be collected in accordance with NAVFAC Northwest SOP I-A-10 and recorded on Form 11-1A, which is included as an attachment to the SOP (Appendix E).

New locations will be named using the established convention used for existing locations near the new locations, where applicable. New locations will be named with a prefix indicating the location type (e.g., GP for GeoProbe, MW for monitoring well, and SB for soil boring) followed by a two to three digit sequential number. Dashes will not be used in the new location IDs unless required to follow the naming convention for an established location. Naming conventions are also shown in Worksheet #18.

17.7 FIELD QUALITY CONTROL SAMPLES

Field QC samples will include field duplicates (FDs), matrix spike (MS)/matrix spike duplicate (MSD) analysis (additional volume required), temperature blanks, trip blanks, equipment blanks (EBs), and field blanks (FBs). FDs will be collected for soil and groundwater matrices. Field duplicates will not be collected for IDW samples. Field duplicates will be assigned a separate sample name from the location ID generally following the same naming convention outlined in Section 17.13. The duplicate sample ID will not reveal the location where the duplicate was collected, and an alternate time of collection will be recorded on the ChoC form provided to the laboratory with the samples. Examples of field duplicate names are provided in Section 17.13.1.

Triple volume will be collected for MS/MSD analysis in association with soil and groundwater samples. A separate sample ID will not be assigned for MS/MSD samples; rather, they will be considered as extra volume for a particular sample, and MS/MSD analysis will be requested on the ChoC form provided to the laboratory with the samples.

Temperature blanks and trip blanks will be obtained from the laboratory along with sample containers. One temperature blank will be included in each cooler shipped to the laboratory. One trip blank will be included in each cooler that contains samples requiring VOC and PFAS analysis. The field team will group samples requiring VOC analysis together in the same shipping containers wherever possible to minimize the number of trip blanks required. Samples collected for PFAS analysis will also be shipped in a separate cooler with a PFAS-specific trip blank.

EB samples will be collected to evaluate the success of equipment decontamination in the field. Disposable sampling equipment will be used wherever possible to limit data error due to decontamination failure and the number of EB samples generated for the project. EB samples will be collected on the first and last days of each mobilization during which re-useable equipment is used and decontaminated. If the mobilization is expected to exceed four days, an additional EB sample will be collected approximately midway between the first and last days of sampling. No field events are expected to last longer than four days. EB samples will be collected by rinsing the sampling portion of decontaminated sampling equipment with PFAS-free DI water into laboratory-supplied, pre-cleaned, and labeled sample containers and analyzed for the same parameters associated with the samples collected that day.

One FB sample will be collected per sampling event and analyzed for PFAS to evaluate adjacent activities impact the collection of soil and groundwater samples.

17.8 SOIL SAMPLING

17.8.1 Mobilization 2 – Direct-push Subsurface Investigation

All drilling activities proposed for Mobilization 2 will be conducted by a State of Washington-licensed well drilling contractor using direct-push methods in accordance with NAVFAC Northwest SOP I-F (Appendix E). The proposed sampling locations for this mobilization are shown on Figure 10. Borings will be advanced to a maximum depth of 50 feet bgs or refusal, whichever is encountered first. In general, up to three soil samples will be collected from each boring and up to an additional three soil and/or groundwater samples per boring for archive. If refusal is encountered before the targeted depth of 50 ft bgs, a sample soil will be collected from the bottom of the borehole. The project team will evaluate the data from this sampling event during the Data Reduction Meeting to decide if a data gap exists, and if further evaluation should be conducted during Mobilization 3. Soil samples will be collected in general accordance with NAVFAC Northwest SOP I-B-1 (Appendix E), with the exception of the PFAS-specific considerations outlined in Section 17.5, and analyzed for the location specific parameters detailed in Worksheet #18. After removal of asphalt, a hand auger will be used to clear the top 5 feet of the boring in accordance with AECOM utility clearance protocols. A Geoprobe® DT45 or DT60 dual-tube sampling system (or equivalent), lined with an acetate core sleeve, will be used to collect continuous soil cores to the target depth. Direct push technology will be used to collect up to three soil samples per boring, if possible. All drilling materials will be PFAS-free.

The soil reserved for PID screening will be screened by inserting the PID probe into the plastic bag containing the soil, assessing organic vapors from one-foot intervals or more frequently based on lithology/color/odor changes, and documenting the results in the field logbook or field form. The same bag of soil will be used for XRF screening at the same intervals, and XRF screening will only occur after PID screening of the bag is complete. General headspace analysis procedures are described in NAVFAC Northwest SOP I-D-8 (Appendix E). The PID and XRF will be calibrated in accordance with the manufacturer's instructions at the beginning and end of each day. Photographs of the soil samples will also be taken. At a minimum, depth interval, PID and XRF concentrations, moisture, relative density, color (using a Munsell soil color chart), texture (using the Unified Soil Classification System), and the depth to groundwater/perched water will be recorded. Additional observations to be recorded may include inclusions, interbeds, organic material, and/or cultural debris.

In general, up to three soil samples will be collected from each boring and up to an additional three soil and/or groundwater samples per boring for archive. These samples will be collected as follows:

1. One sample collected from relatively clean, unsaturated fill material above the contaminant mass and water table, 2–6 feet bgs.
2. The second sample collected from within the interval with the highest observed contaminant concentrations. Field results of the PID and/or XRF, visual, and olfactory screening will be used to select the depth zone representing the highest VOC concentrations.
3. The third sample will be collected from the bottom of the boring.
4. Up to an additional three soil samples will be collected based on the results of PID and XRF field screening, odors/staining, or changes in lithology.

In the event no clear PID or XRF response is obtained at a particular boring, grab soil samples will be collected from 2–6 feet bgs, mid-boring, and the bottom of the boring, or as determined by other field monitoring techniques and will be submitted to the laboratory for VOCs analysis. In either case, the depth interval sampled will be documented on field sampling forms and boring logs. Soil samples will initially be collected from undisturbed sample cores using micro-sampler techniques and submitted to the laboratory for VOCs analysis. The remaining soil from the selected sample interval will be placed in the clean, stainless-steel bowl pan, homogenized, and placed in the pre-cleaned laboratory supplied jars, as specified in Worksheet #19. The soil samples will be immediately placed on wet ice and kept chilled until received at the laboratory.

Reusable sampling equipment, such as the hand auger, will be decontaminated in between collection of each sample using a Liquinox wash, tap water rinse, and a final rinse with DI water. Soil borings will be abandoned by backfilling the open hole with hydrated bentonite chips to within 12 inches of ground surface and the surface will be restored to match the existing surrounding surface (e.g., grass, soil or asphalt [cold patch]).

Soil cuttings will be placed in labeled, DOT-approved containers for shipment of solid waste and stored in an area designated by NAVFAC Northwest. Drums will be labeled with the following information:

- Contents/Media (e.g., soil)
- Start and end dates of accumulation
- Source location(s) (e.g., boring number[s] such as "SB-62 through SB-72")
- Navy contact information

It is expected that only a small amount of soil cuttings will be generated for this project and only one partial drum of soil cuttings will be accumulated for disposal. Characterization and disposal of soil cuttings will be performed in accordance with Navy and NBK Keyport base-specific requirements.

17.8.2 Mobilization 3 – Deep Soil Boring and Monitoring Well Installation

As discussed in Section 17.8.1, the project team will evaluate the data from the Mobilization 2 sampling event during the Data Reduction Meeting to decide if a data gap exists, and if further evaluation should be conducted during Mobilization 3. All drilling activities proposed for Mobilization 3 will be conducted by a State of Washington-licensed well drilling contractor using sonic drilling methods. The proposed locations for this mobilization are shown on Figure 11. These locations are preliminary only and will be adjusted based on the finding of Mobilization 2. Sonic drilling, also known as vibratory drilling, uses an eccentrically oscillating drill head to produce high-frequency vibratory energy that is then transmitted down a drill string to a core barrel to quickly advance through the subsurface. Other than the soil or rock that is retrieved from inside the core barrel as a sample, drill cuttings are limited and are forced into the walls of the borehole. A drilling fluid such as water or air is usually not required with this drilling method. However, water may be used to cool the drill bit, if necessary, or to control heave. This method was selected for use due to the dense glacial soils that exist at depth beneath the site and to provide a continuous core.

Continuous soil cores will be collected during drilling and immediately logged upon retrieval. A tubular plastic sleeve with a sealed bottom will be placed beneath the core barrel. The core barrel will then be vibrated, causing the soil sample to be extruded into the plastic sleeve. Each plastic sleeve will be filled with no more than 5 feet of soil core. The plastic sleeve will then be marked with the sample interval using indelible ink. Cores will be approximately 6 inches in diameter, based on installation of 2-inch-diameter groundwater monitoring wells at some drilling locations (discussed in Section 17.9 below).

Sonic drilling uses a double-cased system using an inner core barrel and a larger override casing. This ensures that the borehole is continuously casing to the total depth, minimizing the potential for downhole cross contamination. To further prevent cross contamination across separate water-bearing units, bentonite slurry seals may be injected into the subsurface when a significant aquitard (e.g., the Kitsap Clay between the Lower Vashon unit and older glacial drift deposits) is encountered. When an aquitard is identified using the core sample collected with the smaller diameter inside core barrel, bentonite slurry will be injected into the outer casing to a depth of several feet above the contact with the aquitard. After the bentonite has properly sealed, a smaller diameter casing will be advanced through the bentonite seal into the next sampling interval. This smaller casing will then be the outer casing that seals the borehole annulus.

Recovered soil will be visually examined for evidence of contamination and classified in accordance with NAVFAC Northwest SOP I-E. Soil will be field screened with a PID by inserting the PID probe into the plastic sleeve containing the soil core, assessing organic vapors along the length of the core, and documenting the results in the field logbook and boring logs. Soil will be collected in plastic bags from the same intervals and used for XRF screening. Unusual odors will also be described on the logs, if observed. General headspace analysis procedures are described in NAVFAC Northwest SOP I-D-8 (Appendix E). The PID and XRF will be calibrated in accordance with manufacturer's instructions at the beginning and end of each day. Up to three soil samples per boring will be collected for analytical analysis, and will be selected based on the methodology prescribed in Section 17.8.1. One grab groundwater sample will also be collected per boring location in accordance with NAVFAC Northwest SOP I-C-4. An additional three soil and/or groundwater samples per boring may be collected for archive.

IDW soil cuttings and core-barrel samples will be contained in labeled, DOT-approved containers and staged in a location specified by the Navy.

17.9 WELL INSTALLATION

Groundwater monitoring wells will be installed in accordance with Washington State regulations (WAC Chapter 173-160) and NAVFAC Northwest SOP I-C-1 (Appendix E). The location of the wells to be installed will be determined based on interpretation of the data collected during Mobilization 2, in collaboration with the Project Stakeholder group.

Up to 10 monitoring wells will be installed to a depth up to 50 feet bgs and will be constructed of 2-inch diameter, flush-threaded Schedule 40 PVC that will have a sand trap at the bottom with an estimated 10 feet of 0.010 slot well screen and blank well casing to ground surface, and will be sealed with a lockable compression cap. The filter pack within the annular space around the screen will consist of 2/12 Monterrey sand and will be placed at least 2 feet above the top of the well screen. A well seal consisting of hydrated bentonite chips will be installed above the sand pack. Up to three monitoring wells will be installed to a depth up to 150 feet bgs using the same construction parameters specified above. Wells will be completed with traffic-rated, flush-mount monuments.

Boring logs and well construction diagrams will be completed that include the driller’s license number and are signed by the licensed driller. The driller will upload these logs to Ecology’s database, as required. The Washington State Well ID for each installed well will be provided by the well drilling contractor, and the ID tags will be installed in each well monument.

17.10 WELL DEVELOPMENT

The newly installed monitoring wells will be developed to establish a hydraulic connection between the well and the surrounding saturated formation, settle the filter pack, and remove accumulated sediment/suspended solids that may enter the well during installation. The depth to the bottom of the well will be measured and recorded before and after well development. Standard methods for monitoring well development are described in NAVFAC Northwest SOP I-C-2 (Appendix E). Water quality instruments will be calibrated in accordance with NAVFAC Northwest SOP I-D-7 (Appendix E). The wells will be allowed to rest a minimum of 24 hours prior to well development, to allow time for the bentonite or grout seal to cure. Development will be performed by first using a surge block followed by a bailer (PVC or stainless steel) or pneumatic pump to remove sediments from the well and surrounding filter pack. Multiple iterations of surging and bailing will be required, depending on the aquifer characteristics.

Once the bailed water is visually free of sediment, development will continue using high-flow pumping techniques (greater than 0.5 liter per minute) until the water quality parameters (temperature, pH, specific conductance, and turbidity) stabilize to within 10 percent of the previous reading for three consecutive measurements, or until five borehole volumes (well casing plus annular space) have been removed. Because the monitoring wells may be screened in silty material, water quality parameters, and, notably, turbidity may not stabilize using high-flow pumping techniques. If water quality parameters do not stabilize to within 10 percent after five well volumes, low-flow pumping techniques (less than 0.5 liter per minute) will be performed for an additional well volume to better document groundwater conditions encountered during low-flow groundwater sampling. Water quality parameters will be recorded in the field logbook in accordance with NAVFAC Northwest SOP III-E (Appendix E). Well development water will be contained in labeled, DOT-approved containers and staged in a location specified by the Navy.

The following information will be recorded during the development of each well:

- Date, time, personnel, and well designation, general weather conditions
- Static groundwater levels
- Volume of water in well prior to development
- Volume of water removed
- Observations of water characteristics (e.g., color, odor, turbidity)
- Description of development technique

17.11 GROUNDWATER SAMPLING

Groundwater samples will be collected following well development using low-flow techniques in accordance with NAVFAC Northwest SOP I-C-3 and I-C-5 (Appendix E). Water quality instruments will be calibrated in accordance with NAVFAC Northwest SOP I-D-7 (Appendix E). Field measurements, including pH, specific conductance, turbidity, dissolved oxygen, temperature, salinity, and oxidation reduction potential, will be recorded during sampling in accordance with NAVFAC Northwest SOP I-D-7 (Appendix E). Groundwater samples collected at each location will be field screened using a shaker test. A small volume (approximately 10 to 25 milliliters) of groundwater will be collected and shaken by the sample collector on-site. If foaming is noted within the sample, it will be documented in the field logbook and on the laboratory ChoC when samples are submitted for analysis. This will alert the laboratory to the possible presence of elevated concentrations of PFAS/aqueous film-forming foam. IDW will be contained in labeled, DOT-approved containers and staged in a location specified by the Navy.

17.12 EQUIPMENT DECONTAMINATION

All non-disposable equipment will be decontaminated between samples to limit cross contamination in accordance with NAVFAC Northwest SOP III-I (Appendix E). Equipment will be rinsed with tap water to remove excess adhering soil, sediment, or plant material. Equipment will then be cleaned with an Alconox solution using a brush if necessary, then rinsed with PFAS-free DI water.

Decontamination fluids will be placed in labeled, DOT-approved containers for shipment of solid waste and stored in an area designated by Navy. Drums will be labeled with the following information:

- Contents/Media
- Beginning and end dates of accumulation
- Source location(s) (e.g., “Decon water from boring number[s] SB-62 through SB-72”)
- Navy contact information

Characterization and disposal of decontamination liquid will be performed in accordance with Navy and NBK Keyport base-specific requirements.

17.13 SAMPLING NAMING

17.13.1 Soil and Groundwater Samples

Soil and groundwater samples will be named in general accordance with NAVFAC Northwest SOP III-E. A descriptive ID number (for internal use only) will identify the sampling location, type, matrix, collection year, depth, and sample type. The descriptive ID number is used to provide sample-specific information (e.g., location, sequence, and matrix). The descriptive identifier is not revealed to the analytical laboratory. The descriptive ID number for all samples is assigned as follows:

AA-bbcc-D-e

Where:

AA = Location number (e.g., GP01, MW8, SB8-21)

bb = Sample type and matrix (e.g., Soil [SS]; Groundwater [GW]; Decontamination Water [DW]

cc = Collection year (e.g., 21 equals 2021)

D = Depth range (e.g., 0-2 equals 0 feet to 2 feet bgs)

e = Field QC sample type, if applicable (See Table 27-2)

For example, the sample number GP01-SS21-0-2 would indicate that the sample is a soil sample collected from boring location GP01, in 2021, at deep of 0 to 2 feet bgs. A more detailed procedure, including sample matrix type and field QC sample type, is provided in Worksheet #27.

As discussed in Section 17.7, field duplicates will be assigned a separate sample location ID than the parent sample and an alternate sample time to hide the location where the duplicate was collected from the laboratory. The correlating parent sample location for each duplicate sample will be recorded in the field logbook. All duplicate sample locations during Mobilization 2 will be designated as GP24. Therefore, a sample designation of GP24-01-SS21-2-6, would indicate a duplicate soil boring sample collected in 2021 from 2 to 6 feet bgs. The parent boring number and the actual time of collection will be specified in the field log book. All duplicate sample locations during Mobilization 3 will be designated as MW29. Therefore, a sample designation of MW29-01-GW21 would indicate a duplicate water sample collected in 2021. The parent well number and the actual time of collection will be specified in the field log book.

17.14 SAMPLE HANDLING

Each sample container submitted for analysis will be labeled with the location, date, and time the sample was collected and the analyses being requested, in general accordance with NAVFAC Northwest SOP III-E. The sample collection information will also be entered on a ChoC form. All samples will be placed on ice in coolers as soon as possible after collection, and then kept chilled in the field and during shipping or transport until they are delivered to the laboratory. A temperature blank will be included in each cooler before shipment. One trip blank will be included in each cooler containing samples that will be analyzed for VOCs and/or PFAS. If any samples are suspected of having a high concentration of VOCs (e.g., if product is observed in the sample or a sheen or odor is observed), these samples will not be shipped in the same coolers as sample containers designated for VOC analysis. The ChoC will be included in the cooler with the sample shipment. The samples will be relinquished on the ChoC by the field team before transfer to a third-party shipper or to the laboratory. Shipping containers/coolers will be custody sealed before they are relinquished to a third-party shipper, or any time the samples will not be in the custody of the field team, before they are transferred to the laboratory.

Worksheet #18: Location-Specific Sampling Methods/SOP Requirements Table

Sampling Location/ID Number	Depth (units)	Data Use	Matrix	Analyses	Number of Samples	Sampling SOP Reference [a]
Mobilization 2 – Direct-push Subsurface Investigation						
GP-1 through GP-3	50 feet bgs [e]	Assess soil and groundwater quality up- and down-gradient of slurry wall.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	9	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	3	I-C-4
GP-4 and GP-5, and GP-27 through GP-30	50 feet bgs [e]	Assess soil and groundwater quality within suspected cadmium and chromium hotspot.	Soil	VOCs, Metals including Cr^{+}6, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	18	I-B-1, I-F
			Groundwater	VOCs, Metals, Cr+6, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	6	I-C-4
GP-6 through GP-9	50 feet bgs [e]	Assess soil and groundwater quality within the footprint of the 1992 soil removal excavation associated with the former Building A Chrome Room.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	12	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	4	I-C-4
GP-10 through 12	50 feet bgs [e]	Assess soil and groundwater quality.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	9	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	3	I-C-4
GP-13, GP-14, and GP-31	50 feet bgs [e]	Assess soil and groundwater quality downgradient of former Buildings A and D.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	9	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	3	I-C-4

Sampling Location/ID Number	Depth (units)	Data Use	Matrix	Analyses	Number of Samples	Sampling SOP Reference [a]
GP-15 through GP-19	50 feet bgs [e]	Assess soil and groundwater quality around the perimeter of Building E.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	15	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	5	I-C-4
GP-20	50 feet bgs [e]	Assess soil and groundwater quality upgradient of former Building A. Assess soil and groundwater quality adjacent to utility corridor.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	3	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	1	I-C-4
GP-21	50 feet bgs [e]	Assess soil and groundwater quality upgradient of former Building A and downgradient of Building F.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	3	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	1	I-C-4
GP-22 and GP-24	50 feet bgs [e]	Assess soil and groundwater quality cross/up gradient of former Buildings A and D. Assess soil and groundwater quality upgradient of slurry wall.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	6	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	2	I-C-4
GP-23	50 feet bgs [e]	Assess soil and groundwater quality that may have been moved by tidal action to locations farther north between Buildings F and G.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	3	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	1	I-C-4

Sampling Location/ID Number	Depth (units)	Data Use	Matrix	Analyses	Number of Samples	Sampling SOP Reference [a]
GP-25 and GP-26	50 feet bgs [e]	Assess groundwater quality upgradient of the northeastern slurry wall.	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, TOC [c]	6	I-B-1, I-F
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide	2	I-C-4
Mobilization 3 - Deep Soil Boring and Monitoring Well Installation						
SB8-21-1, SB8-21-2, SB8-21-3	150 feet bgs	Collect soil to refine the understanding of deeper lithology at Area 8, and update the CSM that is based on the 1993 RI cross sections, and assess soil and deep groundwater quality	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Physical Parameters [b], TOC [c]	9	I-B-1, I-C-1, I-E
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Geochemical Parameters [d]	3	I-C-4, I-C-5
MW8-17 through MW8-26	50 feet bgs	Extend monitoring well network to assess shallow and/or intermediate soil and groundwater quality at Area 8	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Physical Parameters [b],	30	I-B-1, I-C-1, I-E
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Geochemical Parameters [d]	10	I-C-3, I-C-5

Sampling Location/ID Number	Depth (units)	Data Use	Matrix	Analyses	Number of Samples	Sampling SOP Reference [a]
MW8-27, MW8-28, MW8-29	150 feet bgs	Assess deep groundwater quality at Area 8	Soil	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Physical Parameters [b], TOC [c]	9	I-B-1, I-C-1, I-E
			Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Geochemical Parameters [d]	3	I-C-3, I-C-5
MW8-8, MW8-9, MW8-11, MW8-12, MW8-14, MW8-15, MW8-16	Varying depths [f]	Existing groundwater monitoring wells that will be used to assess groundwater quality throughout Area 8	Groundwater	VOCs, Metals, PAHs, 1,4-Dioxane, PFAS, SVOCs, Cyanide, Geochemical Parameters [d]	7	I-C-3, I-C-5

bgs	below ground surface
Cr+6	hexavalent chromium
ID	identification
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
SOP	standard operating procedure
SVOC	semivolatile organic compound
TOC	total organic carbon
VOC	volatile organic compound

[a] SOP or worksheet that describes the sample collection procedures.

[b] Physical parameters include Density – Grain and Bulk, Grain Size, Permeability (Intrinsic), and Porosity – Total and Air-Filled. Two samples collected per each 50-foot location and three samples collected per 150-foot location.

[c] TOC on soil samples only.

[d] Geochemical Parameters include Anions (Bromide, Chloride, Fluoride, Nitrate as N, Nitrite as N, Nitrate/Nitrite as N, and Sulfate), Chemical Characteristics (Dissolved Organic Carbon and Sulfide), and Dissolved Gases (Carbon Dioxide, Ethane, Ethene and Methane).

[e] Depths prescribed in this column reflect estimated total depth of boring. Soil and groundwater sample collection depths will be determined in the field using the criteria prescribed in WS#17, Section 17.8.

[f] New monitoring well screen intervals to be determined following Mobilization 2 data review.

Worksheet #19: Field Sampling Requirements Table

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Soil						
Soil [a]	Cyanide, Total	Preparation Method: EPA 9012B Preparation SOP: WI11621 Analysis Method: EPA 9012B Analysis SOP: WI11621	1 × 4-oz glass soil jar	100 g	Cool to ≤6°C	Maximum holding time is 14 days from collection to analysis.
Soil [a]	Total Organic Carbon	Preparation Method: Lloyd Kahn Method Preparation SOP: WI11627 Analysis Method: Lloyd Kahn Method Analysis SOP: WI11627	1 × 4-oz glass soil jar	20 g	Cool to ≤6°C	Maximum holding time is 28 days from collection to analysis.
Soil	Total Solids	Preparation Method: SM2540-G Preparation SOP: WI10697 Analysis Method: SM2540-GAnalysis SOP: WI10697	1 × 4-oz HDPE or glass soil jar	5 g	Cool to ≤6°C	Maximum holding time is 7 days.
Soil [a]	Metals [b]	Preparation Method: EPA 3050B Preparation SOP: WI8636 Analysis Method: EPA 6020B Analysis SOP: WI11933	1 × 4-oz glass soil jar	100 g	Cool to ≤6°C	Samples prepared within 6 months of collection and digestates analyzed within 6 months of sample preparation.
Soil [a]	Metals (mercury) [b]	Preparation Method: EPA 7471B Preparation SOP: WI11948 Analysis Method: EPA 7471B Analysis SOP: WI7965	1 × 4-oz glass soil jar	20 g	Cool to ≤6°C	Samples prepared and digestates analyzed within 28 days of sample collection.
Soil [a]	Hexavalent Chromium	Preparation Method: EPA 3060A Preparation SOP: WI10618 Analysis Method: EPA 7196A Analysis SOP: W11501	1 × 4-oz glass soil jar	100 g	Cool to ≤6°C	Samples prepared within 7 days of collection and digestates analyzed within 30 days of sample preparation.
Soil [a]	VOCs	Preparation Method: EPA 5035/5035A Preparation SOP: WI11170 Method: EPA 8260D Analysis SOP: WI8236	1 x TerraCore samplers plus 3 × 40-mL pre-tared glass VOA vials	5 g per vial	Methanol, DI water, and/or $NaHSO_4$; Cool to ≤6°C	Maximum holding time is 14 days from collection to analysis.
Soil [a]	1,4-Dioxane	Preparation Method: EPA 3546 Preparation SOP: EFGS-T-OP-SOP41432 Analysis Method: EPA 8270E SIM Analysis SOP: EFGS-T-MSS-SOP41389	1 × 8-oz glass soil jar with Teflon®-lined lid	30 g	Cool to ≤6°C	Samples extracted within 14 days of collection; extracts analyzed within 40 days following extraction.
Soil [a]	PAHs	Preparation Method: EPA 3546 Preparation SOP: WI10928 Analysis Method: EPA 8270E SIM Analysis SOP: WI9995	1 × 4-oz glass soil jar	100 g	Cool to ≤6°C	Samples extracted within 14 days of collection; extracts analyzed within 40 days following extraction.

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Soil [a]	PFAS	Preparation Method: QSM V5.3-Table B-15 Preparation SOP: WI36459 Analysis Method: QSM V5.3-Table B-15 Analysis SOP: WI36459	1 × 4.5-oz HDPE bottle	10 g	Cool to ≤6°C	Samples extracted within 28 days of collection; extracts analyzed within 28 days following extraction.
Soil [a]	SVOCs	Preparation Method: EPA 3546 Preparation SOP: WI10928 Analysis Method: EPA 8270E Analysis SOP: WI9617	1 × 4-oz glass soil jar	100 g	Cool to ≤6°C	Samples extracted within 14 days of collection; extracts analyzed within 40 days following extraction.
Soil	Density – Grain and Bulk	Analysis Method: API RP40 and ASTM D2937 Analysis SOP: IGS 001	One 2-inch by 6-inch length of undisturbed soil [c]	N/A	N/A	N/A.
Soil	Grain Size	Analysis Method: ASTM D422 Analysis SOP: EFGS-T-WC-SOP40944	1 x 16-oz glass soil jar	500 g	N/A	N/A.
Soil	Permeability (Intrinsic)	Analysis Method: API RP40 Analysis SOP: IGSL 003	One 2-inch by 6-inch length of undisturbed soil [c]	N/A	N/A	N/A.
Soil	Porosity – Total and Air-Filled	Analysis Method: API RP40 Analysis SOP: IGSL 004	One 2-inch by 6-inch length of undisturbed soil [c]	N/A	N/A	N/A.
Water (Groundwater)						
Water	Anions	Preparation Method: EPA 300.0 Preparation SOP: WI11626 Analysis Method: EPA 300.0 Analysis SOP: WI11626	1 × 50-mL HDPE bottle	50 mL	Cool to ≤6°C	Maximum holding time is 28 days to analysis with exception of nitrate and nitrite which is 48 hours to analysis.
Water	Cyanide, Total	Preparation Method: EPA 9012B Preparation SOP: WI11621 Analysis Method: EPA 9012B Analysis SOP: WI11621	1 × 250-mL HDPE bottle	250 mL	Cool to ≤6°C and adjust pH to >12 with NaOH, ascorbic acid	Maximum holding time is 14 days from collection to analysis.
Water	Dissolved Organic Carbon	Preparation Method: SM5310C Preparation SOP: WI11637 Analysis Method: SM5310C Analysis SOP: WI11637	2 × 40-mL amber glass vial	40 mL	Cool to ≤6°C	Maximum holding time is 28 days to analysis.
Water	Sulfide	Preparation Method: SM4500 S2D Preparation SOP: WI11483 Analysis Method: SM4500 S2D Analysis SOP: WI11483	1 × 250-mL glass bottle	250 mL	Cool to ≤6°C, no headspace, NaOH, ZnAc	Maximum holding time is 7 days from collection to analysis.
Water	Dissolved Gases	Preparation Method: RSK_175 Preparation SOP: WI9796 Analysis Method: RSK_175 Analysis SOP: WI9796	2 × 40-mL vials, Teflon-lined septum caps	40 mL	Cool to ≤6°C, no headspace, adjust to pH <2 with HCl	Maximum holding time is 14 days from collection to analysis.

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Water	Metals, Total [b]	Preparation Method: EPA 3005A Preparation SOP: WI8639 Analysis Method: EPA 6010D/6020B Analysis SOP: WI11931/WI11933	1 × 250-mL HDPE	250 mL	Cool to ≤6°C and adjust to pH <2 with HNO_3	Samples prepared within 6 months of collection and digestates analyzed within 6 months of sample preparation.
Water	Hexavalent Chromium	Preparation Method: EPA 7196A Analysis Method: EPA 7196A Analysis SOP: WI11501	1 × 500-mL HDPE	250 mL	Cool to ≤6°C	Maximum holding time is 24 hours from collection to analysis.
Water	Metals, Dissolved [b]	Preparation Method: EPA 3005A Preparation SOP: WI8639 Analysis Method: EPA 6010D/6020B Analysis SOP: WI11931/WI11933	1 × 250-mL HDPE	250 mL	Cool to ≤6°C and adjust to pH <2 with HNO_3 after field filtration	Samples prepared within 6 months of collection and digestates analyzed within 6 months of sample preparation.
Water	Low-level mercury, Total	Preparation Method: EPA 1631E Preparation SOP: EFGS-T-AFS-SOP 2822 Analysis Method: EPA 1631E Analysis SOP: EFGS-T-AFS-SOP 2822	1x 125-mL glass or Teflon jar	125 mL	Cool to ≤6°C, and adjust to pH <2 with HCl	Maximum holding time is 90 days - calculated from the time the sample is collected to the time the sample is prepared/extracted.
Water	Low-level mercury, Dissolved	Preparation Method: EPA 1631E Preparation SOP: EFGS-T-AFS-SOP 2822 Analysis Method: EPA 1631E Analysis SOP: EFGS-T-AFS-SOP 2822	1x 125-mL glass or Teflon jar	125 mL	Cool to ≤6°C, and adjust to pH <2 with HCl after field filtration	Maximum holding time is 90 days - calculated from the time the sample is collected to the time the sample is prepared/extracted.
Water	VOCs	Preparation Method: EPA 8260D Preparation SOP: WI8194 Analysis Method: EPA 8260D Analysis SOP: WI8194	3 × 40-mL vials, Teflon-lined septum caps	40 mL	Cool to ≤6°C and adjust to pH <2 with HCl	Maximum holding time is 7 days to analysis if pH >2 or 14 days if pH <2.
Water	Low-level vinyl chloride	Preparation Method: EPA 8260D SIM Preparation SOP: ARI 703S Analysis Method: EPA 8260D SIM Analysis SOP: ARI 703S	3 × 40-mL vials, Teflon-lined septum caps	40 mL	Cool to ≤6°C and adjust to pH <2 with HCl	Maximum holding time is 7 days to analysis if pH >2 or 14 days if pH <2.
Water	1,4-Dioxane	Preparation Method: EPA 3510C Preparation SOP: EFGS-T-OP-SOP41411 Analysis Method: EPA 8270E SIM Analysis SOP: EFGS-T-MSS_SOP41389	2 × 250-mL amber glass, Teflon-lined lid	500 mL	Cool to ≤6°C	Samples extracted within 7 days of collection; extracts analyzed within 40 days following extraction.
Water	PAHs	Preparation Method: EPA 3510C Preparation SOP: ARI 3311S Analysis Method: EPA 8270E SIM Analysis SOP: ARI 801S	2 × 1L amber glass, Teflon-lined lid	1 L	Cool to ≤6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Water	PFAS	Preparation Method: QSM V5.3-Table B-15 Preparation SOP: WI36458 Analysis Method: QSM V5.3-Table B-15 Analysis SOP: WI36458	2 × 250-mL HDPE bottle	250 mL	Cool to ≤6°C	Samples extracted within 14 days of collection; extracts analyzed within 28 days following extraction.
Water	SVOCs	Preparation Method: EPA 3546 Preparation SOP: WI10928 Analysis Method: EPA 8270E Analysis SOP: WI9617	2 x 250-mL amber glass	250 mL	Cool to ≤6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.

°C	degrees Celsius
ASTM	American Society for Testing and Materials
DI	deionized
g	gram
HCl	hydrogen chloride
HDPE	high-density polyethylene
HNO_3	nitric acid
IGS	Integrated Geosciences
L	liter
mL	milliliter
N/A	not applicable
$NaHSO_4$	sodium bisulfate
NaOH	sodium hydroxide
oz	ounce
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
SOP	standard operating procedure
TCLP	Toxicity Characteristic Leaching Procedure
VOA	volatile organic analyte
VOC	volatile organic compound
ZnAc	zinc acetate

[a] Sample results will be reported on a dry weight basis.

[b] Metals for soil include arsenic, cadmium, chromium, cobalt, copper, lead, nickel, mercury, silver, and zinc. Metals for groundwater samples include arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury (low-level), nickel, selenium, silver, thallium, vanadium, and zinc. Calcium and magnesium are included with dissolved metals analysis for groundwater.

[c] The 2-inch diameter x 6-inch length of soil is adequate to complete testing for density, grain size, permeability, and porosity.

Worksheet #20: Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations [a]	No. of Field Duplicates [a]	No. of MS/MSD Pairs [a]	No. of Field Blanks [a]	No. of Equipment Blanks [a]	No. of Trip Blanks [a]	Total Sample Count
Soil	Cyanide, Total	93/48	5/3	5/3	0	12/22	0	115/76
Soil	TOC	141/0	8/0	8/0	0	0	0	157/0
Soil	Total Solids	93/48	5/3	0/0	0	0	0	98/51
Soil	Metals	93/48	5/3	5/3	0	12/22	0	115/76
Soil	Hexavalent Chromium	18/0	1/0	1/0	0	12/0	0	32/0
Soil	VOCs	93/48	5/3	5/3	0	12/22	4/5	119/81
Soil	1,4-Dioxane	93/48	5/3	5/3	0	12/22	0	115/76
Soil	PAHs	93/48	5/3	5/3	0	12/22	0	115/76
Soil	PFAS	93/48	5/3	5/3	1/1	12/22	12/22	128/99
Soil	SVOCs	93/48	5/3	5/3	0	12/22	0	115/76
Soil	Density – Grain and Bulk	0/38	0	0	0	0	0	0/38
Soil	Grain Size	0/38	0	0	0	0	0	0/38
Soil	Permeability (Intrinsic)	0/38	0	0	0	0	0	0/38
Soil	Porosity – Total and Air-Filled	0/38	0	0	0	0	0	0/38
Groundwater	Anions	0/23	0/2	0/2	0	0	0	0/27
Groundwater	Cyanide, Total	31/23	2/2	2/2	0	Note [b]/8	0	35/35
Groundwater	Dissolved Organic Carbon	0/23	0/2	0/2	0/1 (filter blank only)	0	0	0/28
Groundwater	Sulfide	0/23	0/2	0/2	0	0	0	0/27
Groundwater	Dissolved Gases	0/23	0/2	0/2	0	0	0	0/27
Groundwater	Metals, Total	31/23	2/2	2/2	0	Note [b]/8	0	35/35
Groundwater	Metals, Dissolved	31/23	2/2	2/2	0/1 (filter blank only)	0	0	35/28
Groundwater	Hexavalent Chromium	6/0	1/0	1/0	0	0	0	8/0
Groundwater	VOCs	31/23	2/2	2/2	0	Note [b]/8	8/8	43/43
Groundwater	Low-level vinyl chloride	31/23	2/2	2/2	0	Note [b]/8	8/8	43/43
Groundwater	1,4-Dioxane	31/23	2/2	2/2	0	Note [b]/8	0	35/35

Matrix	Analytical Group	No. of Sampling Locations [a]	No. of Field Duplicates [a]	No. of MS/MSD Pairs [a]	No. of Field Blanks [a]	No. of Equipment Blanks [a]	No. of Trip Blanks [a]	Total Sample Count
Groundwater	PAHs	31/23	2/2	2/2	0	Note [b]/8	0	35/35
Groundwater	PFAS	31/23	2/2	2/2	1/1	Note [b]/8	Note [b]/8	36/44
Groundwater	SVOCs	31/23	2/2	2/2	0	Note [b]/8	0	35/35

Hg	mercury
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
no.	number
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
SOP	standard operating procedure
SVOC	semivolatile organic compound
TOC	total organic carbon
VOC	volatile organic compound

[a] Represents Mobilization 2/Mobilization 3.

[b] Equipment blanks and trip blanks for direct-push drilling are common for soil and grab groundwater samples shown above for soil. The numbers of equipment blanks and trip blanks shown for Mobilization 3 are based on sampling of groundwater from monitoring wells.

Worksheet #21: Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number [a]	Originating Organization of Sampling SOP	Equipment Type	Comments
I-A-6	Utility Clearance	NAVFAC NW	N/A	N/A
I-A-10	Monitoring/Sampling Location Recording	NAVFAC NW	N/A	N/A
I-B-1	Soil Sampling	NAVFAC NW	N/A	No
I-B-2	Geophysical Testing Procedures	NAVFAC NW	N/A	No
I-B-4	Borehole Abandonment	NAVFAC NW	N/A	Yes [b]
I-B-15	Field Test Kits	NAVFAC NW	Refer to SOP for sample type	No
I-C-1	Monitoring Well and Piezometer Installation	NAVFAC NW	N/A	No
I-C-2	Monitoring Well Development	NAVFAC NW	N/A	No
I-C-3	Monitoring Well Sampling	NAVFAC NW	GPS	No
I-C-4	Groundwater Sampling from Temporary Wells (Piezometers)	NAVFAC NW	N/A	No
I-C-5	Low-Flow Groundwater Purging and Sampling	NAVFAC NW	N/A	No
I-C-6	Monitoring Well and Piezometer Abandonment	NAVFAC NW	N/A	No
I-D-1	Drum Sampling Procedures	NAVFAC NW	N/A	N/A
I-D-5	Water Level Measurements	NAVFAC NW	N/A	N/A
I-D-7	Field Parameter Measurements	NAVFAC NW	N/A	N/A
I-D-8	Headspace Analysis	NAVFAC NW	N/A	N/A
I-E	Soil and Rock Classification	NAVFAC NW	N/A	No
I-F	Direct Push Sampling Techniques	NAVFAC NW	Drill rods and core sleeves	No
III-E	Record Keeping, Sample Labeling, and Chain-of-Custody Procedures	NAVFAC NW	N/A	N/A
III-I	Equipment Decontamination	NAVFAC NW	N/A	N/A

GPS	global positioning system
N/A	not applicable
NAVFAC	Naval Facilities Engineering Systems Command
NW	Northwest
SOP	standard operating procedure

[a] Applicable procedures from the Project Procedures Manual (DON 2015).
[b] SOP will be applied to collection of perched groundwater.

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
PID meter	Calibrate with ambient air and a calibration span gas (100 ppm isobutylene).	Keep batteries charged.	Calibrate with calibration gas.	Visually inspect meter for wear or damage before calibration.	Daily	Stable and acceptable readings achieved per manufacturer's instructions	If readings do not stabilize, do not use device.	Field Manager	Manufacturer's specifications for all inspection, testing, maintenance, and calibrations.
XRF Analyzer	Calibrate with metal standards provided by manufacturer.	Keep batteries charged.	Calibrate with metals standard.	Visually inspect meter for wear or damage before calibration.	Daily	Stable and acceptable readings achieved per manufacturer's instructions	If readings do not stabilize, do not use device.	Field Manager	Manufacturer's specifications for all inspection, testing, maintenance, and calibrations.
Horiba Water Quality Parameter Probe [b]	Calibrate with calibration solutions (pH buffers and conductivity and turbidity solutions).	Decontaminate after every use. Keep batteries charged.	Calibrate with calibration solutions.	Visually inspect probes for wear or damage. Run a calibration.	Daily	Stable readings achieved (three or more successive readings within 10% of each other)	If readings do not stabilize, do not use device.	Field Manager	Procedure I-C-3: Monitoring Well Sampling (DON 2015) and manufacturer's specifications for all inspection, testing, maintenance, and calibrations.
Battery-operated electronic balance	Initial calibration and every 10 samples, calibration verification with 100 gram weight.	According to the manufacturer's recommendations.	Accuracy and precision per manufacturer's specifications.	Visually inspect balance for wear or damage before calibration.	Daily	≤2 grams	Recalibrate balance.	Field Manager	Manufacturer's specifications for all inspection, testing, maintenance, and calibrations.

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
Bladder or submersible pumps	N/A.	Decontaminate pumps between wells and dispose of tubing.	Determine if pumps are working correctly. Adjust flow rate (purge rate) to yield 100–300 mL/minute. Operate at low flow for several minutes.	Visually inspect for damage.	Daily	Pump is not creating significant draw-down (i.e., ≤0.2 feet)	Reduce pumping rate and continue to monitor draw-down with water level meter until acceptance criterion is met.	Field Manager	Procedure I-C-3: Monitoring Well Sampling (DON 2015) and manufacturer's specifications for all inspection, testing, maintenance, and calibrations.
Trimble dGPS	Prior to survey, verify vs. previously surveyed location (e.g., benchmark).	Visual inspection.	Check daily vs. position established during field sampling or previously surveyed location.	Check daily.	Daily	≤1.0 meter	Return to manufacturer for recalibration.	Field Manager	No SOP.

%	percent
dGPS	differential global positioning system
mL	milliliter
N/A	not applicable
PID	photoionization detector
ppm	part per million
SOP	standard operating procedure
XRF	X-ray fluorescence

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

[b] Used for monitoring temperature, pH, specific conductivity, turbidity, and dissolved oxygen.

Worksheet #23: Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
WI11621	Determination of Total Cyanide in Water, Wastewater, and Soils (Department of Defense) SW-846 9012B, SW-846 9012A, Rev 4, effective 090/8/2014.	Definitive	Soil, Aqueous/Cyanide	Flow Analyzer	ELLE	No
WI11627	Total Organic Carbon and Total Carbon in Solids and Sludges by Combustion by SM 5310B, EPA 415.1, SW-846 9060/9060A, Lloyd Kahn, Rev 17, effective 7/9/19.	Definitive	Soil/Total Organic Carbon	TOC Analyzer	ELLE	No
WI10697	% Moisture Calculation and % Solids Calculation (Gravimetric) by SM 2540 G-1997 and SM 2540 G-2011, Rev 17; effective 3/21/19.	Definitive	Soil, Solids/Total Solids	Oven/Balance	ELLE	No
639S	Solids Determination SOP 639S Version 008.1 Rev 03/23/2015.	Definitive	Soil, Solids/Total Solids	Oven/Balance	ARI	No
WI11933	Metals by Inductively Coupled Plasma Mass Spectrometry for SW846 Methods 6020/6020A/6020B (aqueous/solid/tissue) and EPA 200.8 (aqueous).	Definitive	Soil, aqueous/Metals	ICP MS	ELLE	No
EFGS-T-AFS-SOP2822	Determination of Total Mercury in Various Matrices by FI-AFS.	Definitive	Water, Low-level Mercury	FI-AFS	Eurofins Frontier Global Sciences, LLC (Eurofins Seattle)	No
WI7965	Mercury in Aqueous, Solid, and Tissue Samples by EPA 7471A, 7471B, 7470A, and 245.3 rev 3 by Cold Vapor AA, Rev 19, effective 11/30/2020.	Definitive	Solids, Aqueous/Mercury	CVAA	ELLE	No
WI11501	Hexavalent Chromium in Waters and Soils (Colorimetric) by SW-846 7196A, Rev 13, effective 10/08/2021.	Definitive	Solids, Aqueous Hexavalent Chromium	UV Spec	ELLE	No
WI8236	VOCs and GRO by GC/MS in Soils by Method 8260C/D, Rev 6, effective 4/12/19.	Definitive	Soil, Solids/VOCs	GC/MS	ELLE	No
EFGS-T-MSS-SOP41389	Semivolatile Organic Compound (Base/Neutrals and Acids) Analysis by GC/MS [Method 8270E].	Definitive	Soil/1,4-dioxane	GC/MS	Eurofins Seattle	No
WI9995	Semivolatiles in Waters and Soils by Methods 8270C/D/E SIM and 625.1 SIM by GC/MS, Version 19, effective 06/03/2022.	Definitive	Water, solid, tissue GC/MS SVOCs SIM	GC/MS	ELLE	No
WI9617	Semivolatile Organic Compounds by Method 8270D/E in Aqueous and Non-Aqueous Matrices using GC-MS, Rev 12.1, effective 04/26/2021.	Definitive	Soil/PAHs, SVOCs	GC/MS	ELLE	No

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
WI36459	Polyfluorinated Alkyl Substances (PFASs) in Solids by Method 537 Version 1.1 Modified QSM 5.3 Table B-15 Using LC/MS/MS Rev. 1, effective 01/29/2021.	Definitive	Soil, Solids/PFAS	LC/MS/MS	ELLE	No
IGS 001	Determination of Dry or Native Bulk Density, IGSL/SOP#001, effective 9/1/2019.	Definitive	Soil/Physical Characteristics	Drying Oven - Precision Scientific, Cat #1250	IGS	No
EFGS-T-WC-SOP40944	Particle Size Analysis of Soils [Method ASTM D422, D7928, D6913], V 1.1, Approved 11-12-2022.	Definitive	Soil/Physical Characteristics	Drying Oven Temperature Range 110110°C +/- 5°C	Eurofins Seattle	No
IGS 003	Hydraulic Conductivity and Fluid Intrinsic Permeability, IGSL/SOP#003, effective 9/1/2019.	Definitive	Soil/Physical Characteristics	IGS P-101 Flexible wall Permeameter	IGS	No
IGS 004	Determination of Total Porosity Procedure (Method API RP 40), IGSL/SOP#004, effective 9/1/2019.	Definitive	Soil/Physical Characteristics	Ohaus EP6102	IGS	No
WI11626	Determination of Inorganic Anions by Ion Chromatography in Waters and Soil by EPA 300.0, SW 846 9056, and SW 846 9056A, Rev 22, effective 12/24/2018.	Definitive	Water/Anions	IC	ELLE	No
WI11637	Total Organic Carbon, Dissolved Organic Carbon, and Inorganic Carbon by SM 5310C or EPA 415.1 in Waters, Rev 16, effective 9/25/18.	Definitive	Water/Dissolved Organic Carbon	TOC Analyzer	ELLE	No
WI11483	Colorimetric Sulfide in Waters (#0230), Sulfide as H2S (#10293 Calculation), Dissolved Sulfide in Water (#10499) by 4500-S2 D-2011, 4500-S2 F-2011, or EPA 376.2, Rev 17, effective 03/15/2018.	Definitive	Water/Total Sulfide	UV Spec	ELLE	No
WI9796	Volatile Hydrocarbons in Water by Method RSK-175 Modified and SW-846 8015 Using Headspace Sampling Techniques and GC-FID, Rev 18, effective 12/5/18.	Definitive	Water/Dissolved Gases	GC/FID	ELLE	No
WI8194	VOCs and GRO by GC/MS in Waters and Wastewaters by Method 8260C/D, Rev 8, effective 7/18/19.	Definitive	Water/VOCs	GC/MS	ELLE	No
703S	Volatile Organic Analysis Selected Ion Mass Spectrometry SOP 703S Version 13 Rev 2/12/2020.	Definitive	Water/Low-level vinyl chloride	GC/MS	ARI	No
EFGS-T-MSS-SOP41389	Semivolatile Organic Compound (Base/Neutrals and Acids) Analysis by GC/MS [Method 8270E].	Definitive	Water/1,4-dioxane	GC/MS	Eurofins Seattle	No

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
801S	GC-MS Analysis of PAH/PCP, Method 8270E – Selective Ion Monitoring (SIM), Revision 012, 6/25/19.	Definitive	Water/PAHs	GC-MS	ARI	No
WI36458	Polyfluorinated Alkyl Substances (PFAS) in Aqueous Samples by Method 537 Revision 1.1 Modified QSM 5.3 Table B-15 Using/LC/MS/MS, Rev 1, effective 01/28/2021.	N/A	Water/PFAS	LC/MS/MS	ELLE	No

Note: The laboratory SOPs listed in Worksheet #23 are the most current revisions at the time of publication of this QAPP. AECOM will review the laboratory SOPs immediately prior to sample submittal to ensure that the laboratory uses SOPs that are in compliance with the DoD QSM annual review requirement.

%	percent
API	American Petroleum Institute
ARI	Analytical Resources, Inc.
CVAA	cold vapor atomic absorption
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
GC/FID	gas chromatography-flame ionization detector
GC/MS	gas chromatography-mass spectrometry
GRO	gasoline range organic
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma–mass spectroscopy
IGS	Integrated Geosciences
LC/MS/MS	liquid chromatography with tandem mass spectrometry
N/A	not applicable
PAH	polynuclear aromatic hydrocarbon
SOP	standard operating procedure
Spec	spectrophotometer
TCLP	Toxicity Characteristic Leaching Procedure
UV	ultraviolet
VOC	volatile organic compound

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Worksheet #24: Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
IC (Anions 300.0)	Initial calibration with a minimum of 5 points with a concentration span of 15x or 30x depending on the analyte	Every 60 days or when CCV fails	r >0.995; Level 1 standard must recover ≥50% of the true value.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11626 (EPA 300, water)
	ICB	After each initial calibration	No analytes detected > MDL.	Correct problem and reanalyze the ICB. Recalibrate if needed.	ELLE Analyst	WI11626 (EPA 300, water)
	ICV	After each initial calibration	Within +/- 10% of the nominal concentration.	If ICV fails again do system maintenance and recalibrate.	ELLE Analyst	WI11626 (EPA 300, water)
	CCV	Every 10 injections	Within +/- 10% of the nominal concentration.	Recalibrate; reanalyze affected samples.	ELLE Analyst	WI11626 (EPA 300, water)
	CCB	Every 10 injections	No analytes detected > MDL.	Recalibrate; reanalyze affected samples.	ELLE Analyst	WI11626 (EPA 300, water)
	LOD	Quarterly	Detect the compound.	Reanalyze the LOD.	ELLE Analyst	WI11626 (EPA 300, water)
TOC Analyzer: TOC in Soil	Initial calibration with a minimum 4 points ranging from 0.3 mg C to 6 mg C	Monthly or after continuing calibration fails	r^2 ≥0.995.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)
	ICB Standard	After each initial calibration	No analytes detected > LOQ.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)
	ICV Standard	After each initial calibration	Within +/- 10% of the nominal concentration.	Reanalyze the ICV. If ICV fails again, do system maintenance and recalibrate.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)
	MDL Standard	Yearly	All compounds must be detected.	Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)
	CCV Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration.	All affected samples are reanalyzed.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)
	CCB Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	No analytes detected > LOQ.	All affected samples are reanalyzed.	ELLE Analyst	WI11627 (Lloyd Kahn, soil)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
TOC Analyzer: TOC, DOC, and TIC in Water	Initial calibration with a minimum 6 points ranging from 1.0 ppm to 100 ppm	Monthly or after continuing calibration fails	r^2 ≥0.995.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11637 (SM5310C, water)
	ICB Standard	After each initial calibration	No analytes detected > LOQ.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11637 (SM5310C, water)
	ICV Standard	After each initial calibration	Within +/- 10% of the nominal concentration.	Reanalyze the ICV. If ICV fails again, do system maintenance and recalibrate.	ELLE Analyst	WI11637 (SM5310C, water)
	Total Inorganic Check Standard	Daily	Within +/- 20% of the nominal concentration.	All affected samples are reanalyzed.	ELLE Analyst	WI11637 (SM5310C, water)
	CCV Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration.	All affected samples are reanalyzed.	ELLE Analyst	WI11637 (SM5310C, water)
	CCB Standard	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	No analytes detected > LOQ.	All affected samples are reanalyzed.	ELLE Analyst	WI11637 (SM5310C, water)
% Moisture	Use at least two Class 1 weights that bracket expected mass typically ranging from 0.01-50.0g	Daily	+/- 0.5 g.	Perform balance internal calibration, tag out of operation and contact outside support.	ELLE Analyst	WI10697
Total Solids	Internal Balance Calibration	Daily	N/A.	N/A.	N/A	639S
	Balance Verification against traceable standards	Beginning of each weighing cycle	Return weight within 1 mg or 10% of known weight, whichever is less.	Take balance out of service until maintenance completed.	ARI Laboratory Supervisor/QA Manager	639S

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
ICP/MS: 6020B	Tuning	Daily	No amu diff. of >0.1 P.W. ≥0.64 and ≥0.66; %RSD <5 for masses used for tuning.	Perform mass calibration for amu. Adjust mass calibration for P.W.	ELLE Analyst	WI11933
	Initial Calibration consists of Blank and 1 point: 0 and 10,000 ppb for Al, Ca, Fe, Mg, K, Na; 0 and 1,000 ppb for As, Ba, Cr, Co, Cu, Mn, Ni, Ti, V, Zn; 0 and 100 ppb for Sb, Be, Cd, Pb. Mo, Se, Ag, Sr, Tl, Sn	Each new run	Passing ICV and ICB.	Recalibrate, perform instrument maintenance if calibration cannot conform to criteria, recalibrate.	ELLE Analyst	WI11933
	ICV	After each calibration	±10% of true value.	Reanalyze.	ELLE Analyst	WI11933
	ICB	Immediately after the ICV	No analytes > LOD.	Reanalyze.	ELLE Analyst	WI11933
	LOD	Quarterly	Analytes detected.	Reprep and reanalyze LOD.	ELLE Analyst	WI11933
	CCV	Immediately after the ICSAB and every 10 samples	±10% of true value.	Reanalyze.	ELLE Analyst	WI11933
	CCB	Immediately after the CCV and every 10 samples	No analytes > LOD.	Reanalyze.	ELLE Analyst	WI11933
	Interference Check Sample-A	At the beginning of each run immediately following the LLC	Absolute value of concentration for all non-spiked project analytes <1/2 LOQ.	Recalibrate.	ELLE Analyst	WI11933
	Interference Check Sample-AB	At the beginning of each run immediately following the LLC	± 20% of the true value for each analyte.	Recalibrate.	ELLE Analyst	WI11933
	Low Level Check (LLC)	Beginning of each sequence and before the interference check samples	± 20% True Value.	Reanalyze the sample.	ELLE Analyst	WI11933
	Linear Dynamic Range (LDR) Check	Quarterly	±10% of true value.	Samples > 90% of the linear range must be reanalyzed as a dilution.	ELLE Analyst	WI11933

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
Hexavalent Chromium 7196A	Initial calibration with a minimum of 7 points plus a reagent blank ranging from 0.01 ppm to 1.25 ppm	Daily	r >0.995.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11501
	LOD	Quarterly	Detect the compound.	Reanalyze the LOD.	ELLE Analyst	WI11501
	ICV	After each initial calibration	Within +/- 10% of the nominal concentration.	If ICV fails again do system maintenance and recalibrate.	ELLE Analyst	WI11501
	Reagent Blank	After each ICV and CCV	No analytes detected > 1/2 LOQ.	Correct problem and reanalyze the blank. Recalibrate if needed.	ELLE Analyst	WI11501
	CCV	Prior to sample analysis, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration.	Reanalyze the CCV in duplicate. If both pass continue with analysis. If either fails again take corrective action and recalibrate.	ELLE Analyst	WI11501
	Reagent Blank	After each CCV	No analytes detected > 1/2 LOQ.	Reanalyze affected samples.	ELLE Analyst	WI11501
FI-AFS: 1631E	Minimum of 5 calibration standards	Daily Initial calibration prior to sample analysis	RSD of response factors Correlation coefficient ≤15%.	The validity of the calibration is determined by the subsequent calibration verifications. If invalid, identify and correct problem, then repeat ICAL.	Lab Manager / Analyst [b]	EFGS-T-AFS-SOP2822
	Initial Calibration Verification (ICV)	Once after each ICAL, prior to beginning analytical run	Within 79-121% of the true value for all target analytes.	Evaluate standards and instrument response. If standard issue, repeat or remake then repeat standard as appropriate. If still fails, repeat initial calibration.	Lab Manager/Analyst [b]	EFGS-T-AFS-SOP2822

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
FI-AFS: 1631E (cont'd)	Continuing calibration verification (CCV), same source as IC	Following IC, after every 10 samples and the end of the sequence	Within 77-123% of the true value for all target analytes.	Evaluate standard and instrument response. If problem with instrument (autosampler failure, response poor, etc.) or standards, correct as appropriate, then repeat. If still fails, repeat initial calibration. Re-analyze all samples not bracketed by successful calibration verification. 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.	Lab Manager/Analyst [b]	EFGS-T-AFS-SOP2822
	Initial and Continuation Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at the end of the analysis sequence	No analytes detected >LOD.	Reanalyze once. If acceptable, continue. If unacceptable, terminate analysis; correct the problem, recalibrate the instrument, verify calibration and rerun all samples since the last acceptable CCB.	Lab Manager/Analyst [b]	EFGS-T-AFS-SOP2822
GC/MS Volatiles 8260D	GC/MS Tuning	Tune with BFB before an ICAL and every 12 hours	Per ion abundance criteria in SW-846 method.	Retune, injection port maintenance, clean the source, and/or change the column.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	Initial Calibration with minimum 5 points; Solid and 5 mL waters 1 ppb through 300 ppb; 25 mL waters 0.2 ppb through 25 ppb; 5 mL UST waters 0.5 ppb through 200 ppb	After continuing calibration fails	%RSD of ≤15% is required for all analytes using an average relative response factor. 10% of the analytes may fail this criteria. For any analytes with a %RSD >15%, a first-degree linear regression can be used providing that the correlation coefficient (CC) is ≥ 0.99 and a minimum of five levels are used. A quadratic curve fit may be used provided that the coefficient of determination is ≥ 0.99 and a minimum of six levels are used. If >10% of the analytes fail, the calibration is not valid and must be repeated. Minimum response factor criteria must be met for select compounds.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI8194 (water) and WI8236 (soil)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS Volatiles 8260D (cont'd)	Retention Time Window Establishment	Once per ICAL and at the beginning of the analytical sequence	Position is set using the midpoint standard of the ICAL curve when ICAL is performed. On days with no ICAL, use the initial CCV.	N/A.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ±0.06 RRT units.	Correct problem, then recalibrate.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	MDL Standard	After each calibration	All compounds must be detected.	Repeat tuning and ICAL procedure prior to analyzing samples. Repeat maintenance if needed.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	ICV Standard	After each calibration	All target analytes ≤20% drift.	Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	LOD standard	Quarterly	All compounds must be detected.	Reprep and reanalyze LOD.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
	CCV standard	Every 12 hours and at the end of analytical run	All target analytes ≤20% drift. Ending CCV – All reported analytes and surrogates within ± 50%.	Reanalyze CCV in duplicate immediately. If both pass, samples can be reported. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed, all samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported.	ELLE Analyst	WI8194 (water) and WI8236 (soil)
GC/MS-SIM (Vinyl chloride) 8260D	Tune Check Mass Spectrometer Tuning; BFB	Prior to ICAL.	Specific ion abundance criteria of BFB from method 8260. Tune check can be acquired as a full scan.	Retune instrument and verify.	ARI Analyst and ARI Data Reviewer	703S
	ICAL.	At instrument set-up, prior to sample analysis	RSD for each analyte ≤20% or Linear least squares regression for each analyte: $r^2 \geq 0.99$.	Correct problem then repeat ICAL.	ARI Analyst and ARI Data Reviewer	703S
	Retention Time Window Position Establishment	Once per ICAL and at the beginning of the analytical sequence	Position shall be set using the midpoint standard of the calibration curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	Retention time window position establishment.	ARI Analyst and ARI Data Reviewer	703S
	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ± 0.06 RRT units of the mean RRT of the calibration standards. RRTs may be updated based on the daily CCV.	Correct problem, then rerun ICAL.	ARI Analyst and ARI Data Reviewer	703S

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS-SIM (Vinyl chloride) 8260D (cont'd)	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis	All reported analytes within ± 20% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	ARI Analyst and ARI Data Reviewer	703S
GC/MS (1,4-Dioxane) 8270E SIM	Check of mass spectral ion intensities (tuning procedure) using DFTPP (8270C)	Prior to ICAL and at the beginning of each 12-hour period	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389
	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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit. (ICAL)	At instrument set-up, 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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389
	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.	Analyst	EFGS-T-MSS-SOP41389
	Initial 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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS (1,4-Dioxane) 8270E SIM (cont'd)	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. 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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389
	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. *[7MS]* 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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389
	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.	Analyst/Lab Manager	EFGS-T-MSS-SOP41389

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS SIM (PAH) 8270E	GC/MS Tuning and Performance Check	Tune with DFTPP before an ICAL or CCV	Per ion abundance criteria in SW-846 method; DDT breakdown ≤20%; tailing factors: benzidine ≤2; pentachlorophenol ≤2.	Retune instrument and verify.	Analyst/Lab Manager	WI9995
GC/MS SIM (PAH)	Initial calibration with a minimum of 5 points: Solid, tissue and water 1000 mL= 0.05 ppm through 10 ppm; Water 250 mL= 0.01 ppm through 2.5 ppm	After continuing calibration fails	Avg RRF is used if %RSD ≤20%, If >20%, a linear fit can be used if $r^2 \geq 0.99$. A linear curve fit is a suitable alternative when only 5 calibration standards are analyzed. When calculating the calibration curves using the linear regression model, a minimum quantitation check on the viability of the lowest calibration point should be performed by re-fitting the response from the low concentration calibration standard back into the curve. The recalculated concentration of the low calibration point should be within ±30% of the standard's true concentration.	Perform more aggressive instrument maintenance and recalibrate.	Analyst/Lab Manager	WI9995
	Retention Time Window Establishment	Once per ICAL and at the beginning of the analytical sequence	Position is set using the midpoint standard of the ICAL curve when ICAL is performed. On days with no ICAL use the initial CCV.	N/A.	Analyst/Lab Manager	WI9995
	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ± 0.06 RRT units of the mean RRT of the calibration standards. RRTs may be updated based on the daily CCV.	Correct problem, then rerun ICAL.	Analyst/Lab Manager	WI9995
	ICV standard	After each initial calibration	All target compounds ≤20% drift.	Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again do system maintenance, recalibrate, and reanalyze samples.	Analyst/Lab Manager	WI9995
	CCV standard	Every 12 hours	Target compounds ≤20% drift.	Reanalyze CCV in duplicate immediately. If both pass, samples can be report. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed all samples since acceptable CCV must be reanalyzed. If the CCV fails high any associated samples that are ND can be reported.	Analyst/Lab Manager	WI9995
	SECC standard	End of analytical run	Run within 12 hour tune time; ±50% drift.	Reanalyze the SECC if within the 12-hour tune period. If not or if the reanalyzed SECC fails do system maintenance, retune, recalibrate, and reanalyze samples.	Analyst/Lab Manager	WI9995

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS SIM (PAH) 8270E	Tune Check Mass Spectrometer Tuning; PFTBA.	Prior to ICAL	Specific ion abundance criteria of DFTPP from method 8270. Tune check can be acquired as a full scan.	Retune instrument and verify.	ARI Analyst and ARI Data Reviewer	801S
	Performance Checks	At the beginning of each 12-hour period, prior to analysis of samples	Degradation ≤ 20% for DDT.	Correct problem, then repeat performance checks.	ARI Analyst and ARI Data Reviewer	801S
	ICAL	At instrument set-up, prior to sample analysis	Each analyte must meet one of the following options: RSD for each analyte ≤20% (If pentachlorophenol is a target analyte, an RSDof ≤ 40% allowed). or Linear least squares regression for each analyte: $r^2 \geq 0.99$. A maximum of 10% of the total target analyte list (including surrogates) will be allowed to fail any or all the listed options for acceptance criteria. Q-Flags are applied to all reported target analytes failing ICAL criteria.	Correct problem, then repeat ICAL.	ARI Analyst and ARI Data Reviewer	801S
	Retention Time Window Position Establishment	Once per ICAL and at the beginning of the analytical sequence	Position shall be set using the midpoint standard of the calibration curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	Retention time window position establishment.	ARI Analyst and ARI Data Reviewer	801S
	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ± 0.06 RRT units of the mean RRT of the calibration standards. RRTs may be updated based on the daily CCV.	Correct problem, then rerun ICAL.	ARI Analyst and ARI Data Reviewer	801S
	Initial Calibration Verification (ICV)	Once after each ICAL, and analysis of a second source standard prior to sample analysis	All reported analytes within ± 20% of true value. Up to 10% of analytes may exceed the SCV criteria if they are recovered in the 50 – 150% range. All SCV that exceed ± 20% of true value will be documented in the case narrative.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	ARI Analyst and ARI Data Reviewer	801S

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
GC/MS Semivolatiles 8270E	GC/MS Tuning and Performance Check	Tune with DFTPP before an ICAL or CCV	Per ion abundance criteria in SW-846 method; DDT breakdown ≤20%; tailing factors: benzidine ≤2; pentachlorophenol ≤2.	Retune, injection port maintenance, clean the source, and/or change the column.	ELLE Analyst	WI9617
	Initial calibration with a minimum 5 points: Solid, tissue and water 1000 mL= 0.5 ppm through 120 ppm; water 250 mL= 0.125 ppm through 30 ppm	After continuing calibration fails	Average RRF is used if %RSD ≤15%; if >15% a linear fit can be used if r^2 ≥0.99. Minimum 5 levels for average RRF or linear fit and 6 levels for quadratic.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI9617
	MDL standard	After each initial calibration	All compounds must be detected.	Repeat tuning and ICAL procedure prior to analyzing samples. Repeat maintenance if needed.	ELLE Analyst	WI9617
	Retention Time Window Establishment	Once per ICAL and at the beginning of the analytical sequence	Position is set using the midpoint standard of the ICAL curve when ICAL is performed. On days with no ICAL use, the initial CCV.	N/A.	ELLE Analyst	WI9617
	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ±0.06 RRT units.	Correct problem, then recalibrate.	ELLE Analyst	WI9617
	ICV standard	After each initial calibration	Target compounds ≤20% drift.	Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples.	ELLE Analyst	WI9617
	LOD standard	Quarterly	All compounds must be detected.	Reprep and reanalyze LOD.	ELLE Analyst	WI9617
	CCV standard	Every 12 hours	RF for SPCC ≥0.050, target compounds ≤20% drift. Ending CCV – All reported analytes and surrogates within ± 50%.	Reanalyze CCV in duplicate immediately. If both pass, samples can be reported. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed, all samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported.	ELLE Analyst	WI9617
	SECC standard	End of analytical run	Run within 12 hour tune time; ±50% drift.	Reanalyze the SECC if within the 12 hour tune period. If not, or if the reanalyzed SECC fails, do system maintenance, retune, recalibrate, and reanalyze samples.	ELLE Analyst	WI9617

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
LC/MS/MS PFAS for QSM 5.3 Table B-15	Mass Calibration	Initially, annually, and after performing major maintenance	Per manufacturer's specifications.	N/A.	ELLE Analyst	W36458 and WI36459
	Tuning of LC/MS/MS	When masses fall outside of ± 0.5 amu of true masses	Within 0.5 amu of true value.	Retune and verify. If tuning fails acceptance criteria, perform a mass calibration and repeat the tune check.	ELLE Analyst	W36458 and WI36459
	Mass Spectral Acquisition Rate	Each analyte, labeled analyte, and injection internal standard	A minimum of 10 spectra scans are acquired across each chromatographic peak.	N/A.	ELLE Analyst	W36458 and WI36459
	Initial calibration with a minimum 5 points	After continuing calibration fails	S/N ratio ≥10:1 for all ions used for quantification. %RSD of the RFs for all analytes must be <20%. Linear or non-linear calibrations must have a r^2 ≥0.99. Must use at least 6 points for a quadratic. Analytes must be within 70-130% of their true values for each calibration standard.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	W36458 and WI36459
	MDL standard	After each initial calibration	All compounds must be detected.	Repeat ICAL procedure prior to analyzing samples. Repeat maintenance if needed.	ELLE Analyst	W36458 and WI36459
	Instrument Sensitivity Check	Prior to analysis and every 12 hours using a standard with analyte concentrations at the LOQ	Recover within ±30% of their true value.	Correct problem and rerun ISC. If problem persist, repeat ICAL.	ELLE Analyst	W36458 and WI36459
	ICV Standard	Once with every ICAL	Within ±30% of their true value.	Reanalyze the ICV and samples associated with the non-compliant ICV. If ICV fails again, do system maintenance, recalibrate, and reanalyze samples.	ELLE Analyst	W36458 and WI36459
	LOD standard	Quarterly	All compounds must be detected.	Reprep and reanalyze LOD.	ELLE Analyst	W36458 and WI36459
	LOQ Verification	Quarterly	Within 50% of true value.	Reprep and reanalyze LOQ.	ELLE Analyst	W36458 and WI36459
	CCV Standard	Every 10 samples and at the end of a sequence	Alternate analyte concentrations range from the LOQ to the mid-level of the calibration curve. Recover within ±30% of their true value.	Reanalyze CCV in duplicate immediately. If both pass, samples can be reported. If either fails or if immediate reanalysis of CCV in duplicate cannot be performed, all samples since acceptable CCV must be reanalyzed. If the CCV fails high, any associated samples that are ND can be reported.	ELLE Analyst	W36458 and WI36459

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
LC/MS/MS PFAS for QSM 5.3 Table B-15 (cont'd)	Instrument Blanks	Immediately following the highest standard analyzed and daily at start of a sequence	Concentration of each analyte must be ≤1/2 LOQ.	If criteria not met after highest calibration standard, that standard's concentration must be decreased until criteria are met. If criteria are not met for sample, run additional instrument blanks until criteria are met.	ELLE Analyst	W36458 and WI36459
Total Cyanide: 9012B	Initial calibration with a minimum of 6 points ranging from 0.010 mg/L to 0.350 mg/L	Daily	r >0.995.	Perform more aggressive instrument maintenance and recalibrate.	ELLE Analyst	WI11621
	Initial Calibration Blank	With each initial calibration	No analytes detected > 1/2 LOQ.	Reanalyze or recalibrate.	ELLE Analyst	WI11621
	LOD	Quarterly	Detect the compound.	Reanalyze the LOD.	ELLE Analyst	WI11621
	ICV	After each initial calibration	Within +/- 10% of the nominal concentration.	If ICV fails again, do system maintenance and recalibrate.	ELLE Analyst	WI11621
	CCV	Prior to sample analysis, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration.	Reanalyze the CCV in duplicate. If both pass, continue with analysis. If either fails again, take corrective action and recalibrate.	ELLE Analyst	WI11621
	CCB	Prior to sample analysis, after every 10 field samples, and at the end of the sequence	No analytes detected > 1/2 LOQ.	Correct problem and reanalyze associated samples.	ELLE Analyst	WI11621
	Distillation verification	With each initial calibration	Within +/- 10% of the nominal concentration.	Correct problem and reanalyze associated samples or repeat ICAL.	ELLE Analyst	WI11621

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference [a]
Sulfide	Calibration using at least 5 points ranging from 0.10 to 2.0 mg/L	Every 3 months or when a new reagent is prepared	Correlation coefficient must be ≥0.995.	Correct the problem and recalibrate.	ELLE Analyst	WI11483
	CCV Standard	Beginning of each batch, every 10 samples, and end of batch	±10% D.	Correct the problem, recalibrate, and reanalyze affected samples.	ELLE Analyst	WI11483
Distillation -- iodometric titration	Standardization of titrant	Initial daily standardization prior to sample analysis	See method SOP for standardization procedure.	N/A.	Eurofins TestAmerica Denver Analyst/Section Supervisor	DV-WC-0042

%D	percent difference
µg/L	microgram per liter
amu	atomic mass unit
ARI	Analytical Resources, Inc.
BFB	bromofluorobenzene
CA	corrective action
CCB	continued calibration blank
CCV	continued calibration verification
D	difference
DDT	dichlorodiphenyltrichloroethane
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
GC/MS	gas chromatography-mass spectrometry
IC	initial calibration
ICAL	initial calibration
ICB	initial calibration blank
ICP-MS	inductively coupled plasma–mass spectroscopy
ICSAB	interference check solution A and B
ICV	initial calibration verification
IS	internal standard
ISC	initial site characterization
LC/MS/MS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
m/z	mass-to-charge ration
MDL	method detection limit
mg/L	milligram per liter
mL	milliliter
N/A	not applicable
PAH	polynuclear aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
PFTBA	perfluorotributylamine
ppb	parts per billion
ppm	parts per million
QC	quality control
QSM	Quality Systems Manual
RF	response factor
RL	reporting limit
RRF	relative response factor
RRT	relative retention time
RSD	relative standard deviation
RT	retention time
SCV	Secondary Chronic Value
S/N	signal-to-noise ratio
SPCC	system performance check compounds
TIC	tentatively identified compound
TOC	total organic carbon

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

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
TOC Analyzer	As needed replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90–110% for calibration checks.	Recalibration.	ELLE Analyst	WI11637 (5310C waters); WI11627 (soil)
Analytical balance	Assure the balance is in a vibration-free area, is level, and the interior housing is clean. Annual calibration and maintenance.	Verification with ASTM certified weights Annual calibration and maintenance	Visual inspection and weight verification Annual calibration and maintenance	Each day of use Annual	The reading must be ±0.1% or ±0.5mg, whichever is greater. Per vendor specification in compliance with ISO certification.	1) Verify cleanliness of weights 2) remove balance from service and place a call to service firm 3) management must evaluate data generated since last acceptable reading to determine any potential impacts to data quality. Per vendor specification in compliance with ISO certification.	ELLE analyst Professional calibration vendor (ISO 17025 certified)	WI11880
Analytical Balance	Annual calibration verification of traceable weights.	Daily calibration check with traceable weight	Visual inspection	Annual calibration, daily check.	1 mg or 10% of weight, whichever is less.	Out of service until maintenance performed.	ARI Lab Supervisor or QA Officer	639S
Thermo 6000 Series ICP-AES	As needed replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90–110% for the calibration checks.	Recalibration.	ELLE Analyst	WI11931
Leeman Labs Hydra II Mercury Analyzer	As needed, replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90-110% for the calibration checks.	Recalibration.	ELLE Analyst	WI7965
Agilent 7500 CE	As needed, replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90-110% for the calibration checks.	Recalibration.	ELLE Analyst	WI11933
Agilent 7700X	As needed, replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90-110% for the calibration checks.	Recalibration.	ELLE Analyst	WI11933

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
FI-AFS	N/A.	Calibration	Check pump tubing, lamp voltage, flow rates	Each day before use	Passing calibration.	Identify the problem, fix the issue and re-calibrate.	Lab Manager / Analyst [b]	EFGS-T-AFS-SOP2822
	Change soda lime.	Calibration	N/A	Every 3 days	Passing calibration.	Identify the problem, fix the issue and re-calibrate.	Lab Manager / Analyst [b]	EFGS-T-AFS-SOP2822
	Clean top deck and autosampler.	Calibration	Check fittings	Monthly	Passing calibration.	Identify the problem, fix the issue and re-calibrate.	Lab Manager / Analyst [b]	EFGS-T-AFS-SOP2822
HP5890, HP6890, or Agilent 7890 Gas Chromatograph with Flame Ionization Detector	Injection port maintenance; Column; FID maintenance.	Continuing calibration check	Visual Inspection	As needed maintenance/ calibration checks every 10 injections	Initial calibration or continuing calibration verification passes method criteria.	Perform Maintenance again; re- calibrate if necessary.	ELLE analyst	WI9689
UV Spectrophotometer	As needed replacement of components.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90-110% for calibration checks.	Recalibration.	ELLE Analyst	WI11483 and WI11501
Agilent 6890 GC/5973 MSD (or equivalent)	As needed, replacement of components.	CCV	Visual inspection of components	As needed	Initial calibration or continuing calibration verification passes method criteria.	Perform additional maintenance prior to instrument calibration or CCV.	Analysts or group leaders	WI7619 and WI9598
NT16 Agilent 7890B/5977A MSD (SIM Vinyl Chloride)	Check gas supply daily, bake or change trap as needed, check tune, cut or change column, change septa as needed.	ICAL, daily calibration, system monitoring throughout analytical run	Visual inspection of components, ion source, gas supply, septum seal, vacuum, trap	As needed	Tune, initial calibration, continuing calibration, RT windows pass criteria.	Perform additional maintenance prior to new calibration or CCV.	ARI Analyst or Lab Supervisor	703S
NT12 Agilent 6890/5972N MSD (SIM PAHs)	Check gas supply daily, check tune, cut or change column, change septa as needed.	ICAL, daily calibration, system monitoring throughout analytical run	Visual inspection of components, ion source, gas supply, septum seal, vacuum, trap	As needed	Tune, initial calibration, continuing calibration, RT windows pass criteria.	Perform additional maintenance prior to new calibration or CCV.	ARI Analyst or Lab Supervisor	801S
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.	Eurofins Chemist	EFGS-T-MSS-SOP41389

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
GC/MS	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.	Eurofins Chemist	EFGS-T-MSS-SOP41389
8270 Agilent 6890 or 7890 GC/5973, 5975, or 5977 MSD (or equivalent)	As needed, replacement of components (injection port; column, ion source; other).	Continuing calibration verification (CCV) and DFTPP per 12-hour tune period	Visual inspection of components	Daily routine maintenance (injection port); as needed for other components	Initial calibration or continuing calibration verification passes method criteria.	Perform maintenance again; recalibration if necessary.	Analysts or group leaders	WI9598
LC/MS/MS	Backflush of column, injection port and pre-columns, cleaning of ion spray cone, adjustment of collision energies, others as needed.	Calibration check	Visual	As needed	Initial calibration or calibration verification passes method specifications.	Perform additional maintenance prior to instrument calibration or calibration verification.	ELLE Analysts	WI23588
Flow Analyzer	As needed replacement of components and/or tubing.	Calibration checks	Visual inspection of components	As needed maintenance/ calibration checks every 10 injections	90-110% for calibration checks.	Recalibration.	ELLE Analyst	WI11621
Analytical Balance	Annual calibration/ Verification.	Daily Check with Class 1 weights	Visual inspection	Annual calibration/ Daily check	The reading must be ±0.1% or ±0.5 mg, whichever is greater. Weight must be 1000× heavier than sensitivity of balance.	1) Verify cleanliness of weights. 2) Remove balance from service and place a call to service firm. 3) Management must evaluate data generated since last acceptable reading to determine any potential impacts to data quality.	Outside vendor for calibration/ analyst for daily checks	SOP11880
Agilent 6890 or 7890 GC w/ HP 5973, 5975, or 5977 MSD	As needed, replacement of components.	CCV	Visual inspection of components	As needed	Initial calibration or continuing calibration verification passes method criteria.	Perform additional maintenance prior to instrument calibration or CCV.	Analysts or group leaders	WI7619
Agilent 6890 GC/PID and/or FID (or equivalent)	As needed, replacement of components.	CCV	Visual inspection of components	As needed	Initial calibration or continuing calibration verification passes method criteria.	Perform additional maintenance prior to instrument calibration or CCV.	Analysts or group leaders	WI7619

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference [a]
HP5890, HP6890, or Agilent 7890 Gas Chromatograph with Flame Ionization Detector	Injection port maintenance; column; FID maintenance.	Continuing Calibration Check	Visual inspection	As needed	Initial calibration within specifications.	Perform maintenance again; recalibrate if necessary.	ELLE Analyst	WI9689
Analytical balance	Assure the balance is in a vibration-free area, is level, and the interior housing is clean.	Verification with ASTM certified weights	Visual inspection and weight verification	Each day of use	The reading must be ±0.1% or ±0.5mg, whichever is greater.	1) Verify cleanliness of weights. 2) Remove balance from service and place a call to service firm. 3) Management must evaluate data generated since last acceptable reading to determine any potential impacts to data quality.	ELLE analyst	SOP11880
Analytical balance	Annual calibration and maintenance.	Annual calibration and maintenance	Annual calibration and maintenance	Annual	As per vendor's specifications in compliance with ISO certification.	As per vendor's specifications in compliance with ISO certification.	Professional calibration vendor (ISO 17025 certified)	SOP11880

ARI	Analytical Resources Inc.
ASTM	American Society for Testing and Materials
CCV	continuing calibration verification
DFTPP	decafluorotriphenylphosphine
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
FID	flame ionization detector
GC	gas chromatograph
ICAL	initial calibration
ICP-AES	inductively coupled plasma-atomic emission spectroscopy
ISO	International Organization for Standardization
LC/MS/MS	liquid chromatography with tandem mass spectrometry
MSD	matrix spike duplicate
N/A	not applicable
PAH	polynuclear aromatic hydrocarbon
PID	photoionization detector
QA	quality assurance
TOC	total organic carbon
UV	ultraviolet

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

Worksheet #26: Sample Handling System

Item	Personnel/Organization/Time Limit
Sample Collection, Packaging, and Shipment	
Sample Collection	Field manager, field QC coordinator, field geologist/AECOM
Sample Packaging	Field manager, field QC coordinator, field geologist/AECOM
Coordination of Shipment	Field QC coordinator, field geologist/AECOM
Type of Shipment/Carrier	Insulated cooler/FedEx Corporation
Sample Receipt and Analysis	
Sample Receipt	Sample custodian/designated analytical laboratory
Sample Custody and Storage	Sample custodian/designated analytical laboratory
Sample Preparation	Laboratory analyst/designated analytical laboratory
Sample Determinative Analysis	Laboratory analyst/designated analytical laboratory
Sample Archiving	
Laboratory Sample Storage	90 days from sample receipt
Sample Extract/Digestate Storage	90 days from extraction/digestion
Biological Sample Storage	Not applicable
Sample Disposal	
Personnel/Organization	Sample custodian/designated analytical laboratory
Number of Days from Analysis	6 months with approval from AECOM

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Worksheet #27: Sample Custody Requirements

Each sample will be assigned a ChoC sample ID number and a descriptive ID number in accordance with NAVFAC Northwest SOP I-A-11. All sample ID numbers will be recorded in the field logbook in accordance with NAVFAC Northwest SOP III-D. The ChoC sample ID number (the only ID number submitted to the analytical laboratory) is used to facilitate data tracking and storage. The ChoC sample ID number allows all samples to be submitted to the laboratory without providing information on the sample type or source. The descriptive ID number is linked to the ChoC sample ID number, which provides information regarding sample type, origin, and source.

27.1 DESCRIPTIVE IDENTIFICATION NUMBER

A descriptive ID number (for internal use only) will identify the sampling location, type, matrix, collection year, depth, and sample type. The descriptive ID number is used to provide sample-specific information (e.g., location, sequence, and matrix). The descriptive identifier is not revealed to the analytical laboratory. The descriptive ID number for all samples is assigned as follows:

AA-bbcc-D-e

Where:

AA = Location ID (e.g., GP01, MW8, SB8-21)

bb = Sample type and matrix (Table 27-1)

cc = Collection year (e.g., 21 equals 2021)

D = depth range (e.g., 0-2 equals 0 feet to 2 feet bgs)

e = Field QC sample type (Table 27-2)

For example, the sample number GP01-SS21-10-12 would indicate that the sample is a soil sample collected from boring location GP01, in 2021, at deep of 10 to 12 feet bgs. These characters will establish a unique descriptive identifier that will be used during data evaluation.

Field duplicates will be assigned a separate sample location ID than the parent sample and an alternate sample time to hide the location where the duplicate was collected from the laboratory. The correlating parent sample location for each duplicate sample will be recorded in the field logbook. All duplicate sample locations during Mobilization 2 will be designated as GP24. Therefore, a sample designation of GP24-01-SS21-2-6, would indicate a duplicate soil boring sample collected in 2021 from 2 to 6 feet bgs. The parent boring number and the actual time of collection will be specified in the field log book. All duplicate sample locations during Mobilization 3 will be designated as MW29.

Table 27-1: Sample Type and Matrix Identifiers

Identifier	Sample Type	Matrix
SS	Soil	Soil
GW	Groundwater	Water
DW	Decontamination water	Water
WQ	Water Blanks	Water

Table 27-2: Field QC Sample Type Identifiers

Identifier	Field or QC Sample Type	Description
MSD	Matrix Spike/Matrix Spike Duplicate	Co-located for soil (adjacent liners)/replicate for water
E	Equipment Blank	Water
B	Field Blank	Water
T	Trip Blank	Water

27.2 HANDLING, SHIPPING, AND CUSTODY

All samples collected for analysis will be recorded in the field logbook in accordance with NAVFAC Northwest SOP III-E. All samples will be labeled and recorded on ChoC forms. Samples will be handled, stored, and shipped in accordance with NAVFAC Northwest SOP III-G All samples collected during this project will be shipped to the analytical laboratory via overnight airfreight.

All samples received at the analytical laboratory will be managed in accordance with laboratory SOPs for receiving samples, archiving data, and sample disposal and waste collection, as well as storage and disposal per Section 5.8, “Handling Samples and Test Items” of the DoD DOE QSM, Version 5.3 (DoD and DOE 2019).

Worksheet #28: Laboratory QC Samples Table

Matrix:	Soil
Analytical Group:	Total Organic Carbon
Analytical Method/SOP Reference:	Analytical Methods: Lloyd Kahn Preparation Methods: Lloyd Kahn Laboratory SOPs: WI11627
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
MB	1 per prep batch of up to 20 samples	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze blank to confirm detections. If detects confirm, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS	1 per 10 samples	Laboratory statistical limits.	Flag outliers.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Laboratory statistical limits.	Correct problem, reprepare and reanalyze the LCS and all sample associated.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
Duplicate	1 per 10 samples	Laboratory statistical RPD.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LOQ	limit of quantitation
MB	method blank
MS	matrix spike
ND	non-detect
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Soil/Solids
Analytical Group:	Total Solids
Analytical Method/SOP Reference:	Analytical Methods: SM 2540-G Preparation Methods: SM 2540-G Laboratory SOPs: WI10697
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Duplicate	1 per 10 samples	Laboratory statistical RPD	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Laboratory statistical limits	Correct problem, reprepare and reanalyze the LCS and all sample associated.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.

LCS	laboratory control sample
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Soil
Analytical Group:	Metals
Analytical Method/SOP Reference:	Analytical Methods: EPA 6020B Preparation Methods: EPA 3050B Laboratory SOPs:WI8636, WI11933
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample.	Reanalyze blank to confirm detections. If detections confirmed, redigest samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3 ±25% for elements not in QSM 5.1.1; RPD ≤20%.	Analyze post digestion spike and serial dilution.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3 ±20% for elements not in QSM 5.1.1; RPD ≤20%.	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per prep batch of up to 20 samples	RPD must be ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Serial Dilutions	Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ	The percent difference must be ≤10%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Post Digestion Spike (PDS)	Prepare with each background sample	± 20% True Value.	No specific action needed unless required by the project. PDS is reported in data package.	ELLE Analyst	Accuracy/Bias	Results within acceptance criteria.
Internal Standard	Every sample and QC	Must be 50%–130% of the calibration blank.	Reanalyze at a dilution.	ELLE Analyst	Precision	Results within acceptance criteria.

DoD	Department of Defense
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	not detected
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RL	reporting limit
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Soil\Solids
Analytical Group:	Mercury
Analytical Method/SOP Reference:	Analytical Methods: EPA 7470A, EPA 7471B Preparation Methods: TCLP 1311, EPA 7470A, EPA 7471B Laboratory SOPs: WI7965
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
MS/MSD pair	One per analytical method for each batch of at most 20 samples.	Per DoD QSM Appendix C Limits, Methods SW-846 6010C/7471B and Lab SOPs MSD or Matrix Duplicate: RPD of all analytes ≤20%.	Examine the PQOs. Notify Lab QA officer and project chemist about additional measures to be taken.	Analyst Lab QA Officer Project Chemist	Accuracy/Precision	For matrix evaluation, use QC acceptance criteria at least as stringent as specified by DoD QSM 5.3 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.2] as applicable).
Dilution test	One per preparatory batch if MS or MSD fails. Only applicable to samples with concentrations >50× the LOQ prior to dilution.	Five-fold dilution must agree within ±10% of the original measurement.	Perform PDS addition.	Analyst Lab QA Officer Project Chemist	Accuracy/ Representativeness	QC acceptance criteria specified by DoD QSM 5.2 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.3] as applicable). Diluted result is within ±10% of the original measurement.
PDS (ICP only)	One per preparatory batch when dilution test fails or analyte concentration in all samples <50 × LOQ prior to dilution. Use the same sample as used for the MS/MSD, if possible.	Recovery within 80–120%.	Run all associate samples in the preparatory batch by MSA.	Analyst Lab QA Officer Project Chemist	Accuracy/ Representativeness	QC acceptance criteria specified by DoD QSM 5.2 (DoD and DOE 2019) (update to lab's most recent accreditation [e.g., QSM 5.2] as applicable). Recovery within 80–120%.
MSA	When dilution test or post digestion spike fails.	N/A.	N/A.	Analyst Lab QA Officer Project Chemist	Confirmation	N/A.

DoD	Department of Defense
DOE	Department of Energy
ICP	inductively coupled plasma
LOQ	limit of quantitation
MS	matrix spike
MSA	method of standard addition
MSD	matrix spike duplicate
N/A	not applicable
PDS	post digestion spike
PQO	project quality objective
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Soil
Analytical Group:	Hexavalent Chromium
Analytical Method/SOP Reference:	Analytical Methods: EPA 7196A Preparation Methods: EPA 3060A Laboratory SOPs: WI11501
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
MB	1 per prep batch of up to 10 samples	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze blank to confirm detections. If detects confirm, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Sample Blank	1 per sample	Use for background correction.	NA.	ELLE Analyst	Background contribution	NA.
MS soluble	1 per prep batch of up to 10 samples	Laboratory statistical limits.	Dilute sample and reanalyze.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
MS insoluble	1 per prep batch of up to 10 samples	Laboratory statistical limits.	Dilute sample and reanalyze.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS soluble	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.3; RPD ≤ 20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS insoluble	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.3; RPD ≤ 20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per prep batch of up to 10 samples	RPD ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LOQ	limit of quantitation
MB	method blank
MS	matrix spike
ND	non-detect
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Soil
Analytical Group:	VOCs
Analytical Method/SOP Reference:	Analytical Methods: EPA 8260D Preparation Methods: EPA 5035/5035A Laboratory SOPs: WI11170/WI8236
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.3.	If obvious matrix interference report data with a comment. Otherwise, re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits.
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detects confirm reanalyze samples that are not ND or not >10x the blank value or regulatory limit.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3.; RPD ≤20%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3.; RPD ≤20%.	Analytes in the LCS that fail high and are ND in the samples can be reported. For all others reanalyze LCS and samples. If it still fails, perform instrument maintenance, restart the tune period and reanalyze all QC and samples.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to + 100% of internal standard area of 12 hour STD. RT change.	Check the instrument for possible problems and then reanalyze samples. If reinject confirms, report with a comment.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure
STD	standard
VOC	volatile organic compound

Matrix:	Soil and Water
Analytical Group:	1,4-Dioxane
Analytical Method/SOP Reference:	Analytical Methods: EPA 8270E SIM Preparation Methods: EPA 3546, EPA 3510C Laboratory SOPs: EFGS-T-MSS-SOP41389
Analytical Organization:	Eurofins Seattle

QC Sample	Frequency and Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per each preparation batch of at most 20 samples	No target analytes ≥ ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).	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/Lab Manager	Sensitivity/Bias	No analytes detected >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is higher.
LCS	One per preparation batch of at most 20 samples	QSM limits (if available) or current in-housel limits if no QSM limits published.	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.	Analyst/Lab Manager	Precision/Accuracy	QSM or laboratory statistically derived control limits.

Matrix:	Soil and Water
Analytical Group:	1,4-Dioxane
Analytical Method/SOP Reference:	Analytical Methods: EPA 8270E SIM Preparation Methods: EPA 3546, EPA 3510C Laboratory SOPs: EFGS-T-MSS-SOP41389
Analytical Organization:	Eurofins Seattle

QC Sample	Frequency and Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Internal Standards	Every standard, sample, and laboratory QC sample	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 in accordance with DoD QSM requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst/Lab Manager	Precision	Results within acceptance criteria.
MS/MSD	Per preparation batch as required by project with sufficient volume	Recovery: QSM limits (if available) or current in-housel limits if no QSM limits published. RPD: RPD of all analytes ≤ 20% (between MS and MSD).	If not related to matrix interference, re-extract and reanalyze MS/MSD.	Analyst/Lab Manager	Bias	QSM or laboratory statistically derived control limits.

CCV	continuing calibration verification
LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
QC	quality control
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

Matrix:	Soil
Analytical Group:	PAHs/SVOCs
Analytical Method/SOP Reference:	Analytical Methods: EPA 8270E SIM Preparation Methods: EPA 3546 Laboratory SOPs: WI10928/WI9995, WI19617
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	QSM 5.4 or above limits for those listed, otherwise use laboratory statistical limits.	If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits.
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detects, confirm reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.4 or above. Laboratory statistical limits for compounds not in QSM 5.4; RPD ≤20%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.4 and above. Laboratory statistical limits for compounds not in QSM 5.4; RPD ≤20%.	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to +100% of internal standard area of 12-hour STD. RT within ±10 sec. of midpoint standard in the ICAL.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

ICAL	initial calibration standard
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
PAH	polynuclear aromatic hydrocarbon
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure
STD	standard

Matrix:	Soil
Analytical Group:	PFAS
Analytical Method/SOP Reference:	Analytical Methods: DoD QSM v5.3, Table B-15 Preparation Methods: DoD QSM v5.3, Table B-15 Laboratory SOPs: WI36459
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Laboratory statistical limits, if in-house limits do not exist use 70-130%; RPD ≤30%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Laboratory statistical limits, if in-house limits do not exist use 70-130%; RPD ≤30%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Isotopically Labeled Extraction Standards	Per sample (including MS/MSD, LCS, and blanks) prior to preparation	Within 50% of true value.	If fails for QC sample, but the native compounds are within specification, report data. If fails for sample, reextract and reanalyze and/or consult a supervisor for course of action.	ELLE Analyst	Accuracy	Results within acceptance limits.
Post Spike Sample	Aqueous samples prepared by serial dilution instead of SPE that have reported values <LOQ	70-130% recovery.	Reanalyze sample, sample duplicate and post spike sample at higher dilutions until criteria is met.	ELLE Analyst	Accuracy	Results within acceptance limits.

EIS	environmental impact statement
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
PFAS	per- and polyfluoroalkyl substances
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure
SPE	solid phase extraction

Matrix:	Soil/Solids/Water
Analytical Group:	Total Cyanide
Analytical Method/SOP Reference:	Analytical Methods: EPA 9012B Preparation Methods: EPA 9012B Laboratory SOPs: WI11621
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.	Reanalyze blank to confirm detections. If detects confirm, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.
MS	1 per 10 samples	Recovery limits per QSM 5.3; RPD ≤20%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3; RPD ≤20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per 10 samples	RPD ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Post Digestions Spike (PDS)	When MS fails	Recovery limits per QSM 5.3; RPD ≤20%.	Perform MSA.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Method of Standard Addition (MSA)	When MS &PDS fails	N/A.	Include MSA information with data.	ELLE Analyst	Accuracy/Bias/Precision	N/A.

LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSA	method of standard addition
N/A	not applicable
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Anions
Analytical Method/SOP Reference:	Analytical Methods: EPA 300 Preparation Methods: EPA 300 Laboratory SOPs: WI11626
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per prep batch of up to 20 samples	No analytes detected >MDL or <1/10 the amount measure in any sample.	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.
MS	1 per 10 samples	Method limits.	Flag outliers.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Method limits.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
Duplicate	1 per 10 samples	Laboratory statistical.	Flag outliers.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LOQ	limit of quantitation
MDL	method detection limit
MS	matrix spike
ND	non-detect
QC	quality control
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Dissolved Organic Carbon
Analytical Method/SOP Reference:	Analytical Methods: SM 5310C Preparation Methods: SM 5310C Laboratory SOPs: WI11637
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per prep batch of up to 20 samples	No analytes detected > MDL or >1/10 the amount measured in any sample.	Reanalyze blank to confirm detections. If detections confirmed, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > MDL or >1/10 the amount measured in any sample.
MS	1 per 10 samples	Laboratory statistical limits.	Flag outliers.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Laboratory statistical limits.	Correct problem, reprepare and reanalyze the LCS and all samples associated.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits.
Duplicate	1 per 10 samples	Laboratory statistical RPD.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
MDL	method detection limit
MS	matrix spike
ND	non-detect
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Sulfide
Analytical Method/SOP Reference:	Analytical Methods: SM4500 S2D Preparation Methods: SM4500 S2D Laboratory SOPs: WI11483
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.	Reanalyze blank to confirm detections. If detections confirmed, reanalyze samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.
MS/MSD	1 per 20 samples	Laboratory statistical window and RPD.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Method specified window.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-analyzed.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per 20 samples	Laboratory statistical RPD.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Dissolved Gases
Analytical Method/SOP Reference:	Analytical Methods: RSK_175 Preparation Methods: RSK_175 Laboratory SOPs: WI9796
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Laboratory statistical limits.	Reanalyze if outside limits, if confirmed, report data with comment. If not confirmed, re-extract.	ELLE Analyst	Accuracy	Results within acceptance limits.
Method blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤30%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤30%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.

LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Metals (Total and Dissolved Fraction)
Analytical Method/SOP Reference:	Analytical Methods: EPA 6020B Preparation Methods: EPA 3005A Laboratory SOPs: WI8639, WI11933
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample.	Reanalyze blank to confirm detections. If detections confirmed, redigest samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3 ±25% for elements not in QSM 5.1.1; RPD ≤20%.	Analyze post digestion spike and serial dilution.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3 ±20% for elements not in QSM 5.1.1; RPD ≤20%.	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per prep batch of up to 20 samples	RPD must be ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Serial Dilutions	Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ	The percent difference must be ≤10%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Post Digestion Spike	Prepare with each background sample	± 20% True Value.	No specific action needed unless required by the project. PDS is reported in data package.	ELLE Analyst	Accuracy/Bias	Results within acceptance criteria.
Internal Standard	Every sample and QC	Must be 50%–130% of the calibration blank.	Reanalyze at a dilution.	ELLE Analyst	Precision	Results within acceptance criteria.

LCS	laboratory control sample	MSD	matrix spike duplicate	QSM	Quality Systems Manual
LCSD	laboratory control sample duplicate	ND	non-detect	RL	reporting limit
LOQ	limit of quantitation	PDS	post digestion spike	RPD	relative percent difference
MS	matrix spike	QC	quality control	SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Metals (Low Level Mercury, Total and Dissolved Fraction)
Analytical Method/SOP Reference:	Analytical Methods: EPA 1631E Preparation Methods: EPA 1631E Laboratory SOPs: EFGS-T-AFS-SOP2822
Analytical Organization:	Eurofins Frontier Global Sciences, LLC (Eurofins Seattle)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	3 per preparation batch of up to 20 samples	No analyte detected > ½ the RL or 1/10 the amount measured in any sample.	Reprep and reanalyze the method blanks and all samples processed with the contaminated blank. If problem persists, notify PM and Technical Director.	Lab Manager / Analyst	Accuracy/Laboratory Contamination	No target analytes ≥ ½ LOQ in accordance with DoD QSM requirements.
LCS/LCSD	One set per preparatory batch of up to 20 samples	75-125% Recovery; RPD ≤ 24.	Correct problem, reprep and reanalyze LCS and all samples in associated batch for failed analyte. If problem persists, Notify PM and Technical Director.	Lab Manager / Analyst	Accuracy/Bias/ Precision	Recovery within laboratory statistically derived control limits.
Duplicate	One per preparatory batch of up to 20 samples	RPD ≤ 24%.	Correct problem, reprep and reanalyze LCS and all samples in associated batch for failed analyte. If problem persists, Notify PM and Technical Director.	Lab Manager / Analyst	Precision	Results within acceptance limits.
Matrix Spike/Matrix Spike Duplicate	One set per 10 samples	71-125% Recovery; RPD ≤ 24%.	Analyze an AS/ASD to determine if there is matrix interference. If there isn't any interference, correct problem, reprep and reanalyze LCS and all samples in associated batch for failed analyte. If problem persists, Notify PM and Technical Director.	Lab Manager / Analyst	Accuracy/Bias/ Precision	Recovery within laboratory statistically derived control limits.

AS/ASD	analytical spike/analytical spike duplicate
DoD	Department of Defense
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
PM	project manager
QSM	Quality Systems Manual
RL	reporting limit
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Hexavalent Chromium
Analytical Method/SOP Reference:	Analytical Methods: EPA 7196A Preparation Methods: EPA 7196A Laboratory SOPs: WI11501
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
MB	1 per prep batch of up to 10 samples	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze blank to confirm detections. If detects confirm, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
Sample Blank	1 per sample	Use for background correction.	N/A.	ELLE Analyst	Background contribution	NA.
MS soluble	1 per prep batch of up to 10 samples	Laboratory statistical limits.	Dilute sample and reanalyze.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
MS insoluble	1 per prep batch of up to 10 samples	Laboratory statistical limits.	Dilute sample and reanalyze.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS soluble	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.3; RPD ≤ 20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS insoluble	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.3; RPD ≤ 20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per prep batch of up to 10 samples	RPD ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LOQ	limit of quantitation
MB	method blank
MS	matrix spike
ND	non-detect
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

Matrix: Water

Analytical Group: VOCs

Analytical Method/SOP Reference: Analytical Methods: EPA 8260D
Preparation Methods: EPA 8260D
Laboratory SOPs: WI8194

Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3.	If obvious matrix interference report data with a comment. Otherwise, re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits.
Method blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detections confirmed, reanalyze samples that are not ND or not >10x the blank value or regulatory limit.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤20%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3; RPD ≤20%.	Analytes in the LCS that fail high and are ND in the samples can be reported. For all others, reanalyze LCS and samples. If it still fails, perform instrument maintenance, restart the tune period and reanalyze all QC and samples.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to + 100% of internal standard area of 12 hour STD. RT change.	Check the instrument for possible problems and then reanalyze samples. If reinject confirms, report with a comment.	ELLE Analyst	Precision	Results within acceptance limits.

LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure
STD	standard
VOC	volatile organic compound

Matrix:	Water
Analytical Group:	VOCs - Low-level vinyl chloride
Analytical Method/SOP Reference:	Analytical Methods: EPA 8260D SIM Preparation Methods: EPA 8260D SIM Laboratory SOPs: 703S
Analytical Organization:	Analytical Resources, Inc. (ARI)

QC Sample	Frequency and Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per matrix per analytical method for each batch of 20 samples	No analytes detected >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is higher.	Correct problem. If required, re-prep and reanalyze method blank and all samples processed with the contaminated blank. Flag sample data as appropriate.	ARI Analyst	Sensitivity/Bias	No analytes detected >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is higher.
LCS/LCSD	One pair per analytical bracket	Laboratory statistical limits.	Correct problem. If required, re-prep and reanalyze method blank and all samples processed with the failing LCS/LCSD. Apply Q flag to analytes in the batch.	ARI Analyst	Precision/Accuracy	Results may not be reported without a valid LCS. Flagging only appropriate where samples cannot be reanalyzed.
Internal Standards	Every standard, sample, and laboratory QC sample	-50% to +100% of area in CCV. RT drift <30 seconds.	Reanalyze or reanalyze at dilution to mitigate matrix interference.	ARI Analyst	Precision	Results within acceptance criteria.
Surrogate Spikes	Per sample including laboratory QC	Laboratory statistical limits.	Reanalyze if outside limits. If confirmed, report.	ARI Analyst	Precision	% Recovery within acceptance limits.
MS/MSD	Per batch as required by project with sufficient volume	Advisory only (compare to LCS limits).	Review for errors. Indication of sample characteristics, no other corrective action required.	ARI Analyst	Bias	RPD<30%.

ARI	Analytical Resources Inc.
CCV	continuing calibration verification
LCS	laboratory control sample
LCSD	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
QC	quality control
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure
VOC	volatile organic compound

Matrix:	Water
Analytical Group:	PAHs
Analytical Method/SOP Reference:	Analytical Methods: EPA 8270E – SIM Preparation Methods: EPA 3510C Laboratory SOPs: 3311S, 801S
Analytical Organization:	Analytical Resources, Inc. (ARI)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per each preparation batch up to 20 samples	No analytes detected >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is higher.	Correct problem. If required, re-prep and reanalyze method blank and all samples processed with the contaminated blank. Flag sample data as appropriate.	ARI Analyst/Prep Supervisor	Sensitivity/Bias	No analytes detected >1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is higher.
LCS	One per preparation batch	Laboratory statistical limits.	Correct problem. If required, re-prep and reanalyze method blank and all samples processed with the failing LCS. Apply Q flag to analytes in the batch.	ARI Analyst	Precision/Accuracy	Results may not be reported without a valid LCS. Flagging only appropriate where samples cannot be reanalyzed.
Internal Standards	Every standard, sample, and laboratory QC sample	-50% to +100% of area in CCV. RT drift <30 seconds.	Reanalyze or reanalyze at dilution to mitigate matrix interference.	ARI Analyst	Precision	Results within acceptance criteria.
Surrogate Spikes	Per sample including laboratory QC	Laboratory statistical limits.	Reanalyze if outside limits. If confirmed, report.	ARI Analyst	Precision	% Recovery within acceptance limits.
MS/MSD	Per preparation batch as required by project with sufficient volume	Advisory only (compare to LCS limits).	Review for errors. Indication of sample characteristics, no other corrective action required.	ARI Analyst and Data Reviewer	Bias	RPD<30%.

CCV	continuing calibration verification
LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
PAH	polynuclear aromatic hydrocarbon
QC	quality control
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	PFAS
Analytical Method/SOP Reference:	Analytical Methods: DoD QSM v5.3, Table B-15 Preparation Methods: DoD QSM v5.3, Table B-15 Laboratory SOPs: WI36458
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detections confirmed, reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Appendix C QSM 5.3. If analytes aren't listed use in-house limits; RPD 30%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Appendix C QSM 5.3. If analytes aren't listed use in-house limits; RPD 30%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Isotopically Labeled Extraction Standards	Per sample (including MS/MSD, LCS, and blanks) prior to preparation	Within 50% of true value.	If fails for QC sample, but the native compounds are within specification, report data. If fails for sample, reextract and reanalyze and/or consult a supervisor for course of action.	ELLE Analyst	Accuracy	Results within acceptance limits.
Post Spike Sample	Aqueous samples prepared by serial dilution instead of SPE that have reported values <LOQ	70–130% recovery.	Reanalyze sample, sample duplicate and post spike sample at higher dilutions until criteria is met.	ELLE Analyst	Accuracy	Results within acceptance limits.

EIS	environmental impact statement
HFPODA	Hexafluoropropylene oxide dimer acid
LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
PFAS	per- and polyfluoroalkyl substances
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure
SPE	Solid Phase Extraction

Matrix: Water

Analytical Group: SVOCs

Analytical Method/SOP Reference: Analytical Methods: EPA 8270E
Preparation Methods: EPA 3510C
Laboratory SOPs: WI11432/WI19617

Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze to confirm detections. If detections confirmed, reextract samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤20%.	Flag outliers.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to +100% of internal standard area of 12 hour STD. RT within ±10 sec. of midpoint standard in the ICAL.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3.	If obvious matrix interference, report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits.

LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

Matrix:	Water
Analytical Group:	Total Cyanide
Analytical Method/SOP Reference:	Analytical Methods: EPA 9012B Preparation Methods: EPA 9012B Laboratory SOPs: WI11621
Analytical Organization:	Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.	Reanalyze blank to confirm detections. If detections confirmed, reprep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample.
MS	1 per 10 samples	Recovery limits per QSM 5.3; RPD ≤20%.	Perform PDS and/or MSA.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
LCS	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3; RPD ≤20%.	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Duplicate	1 per 10 samples	RPD ≤20%.	Flag data.	ELLE Analyst	Precision	Results within acceptance limits.
Post Digestions Spike (PDS)	When MS fails	Recovery limits per QSM 5.3; RPD ≤20%.	Perform MSA.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits.
Method of Standard Addition (MSA)	When MS &PDS fails	NA.	Include MSA information with data.	ELLE Analyst	Accuracy/Bias/Precision	N/A.

LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSA	method of standard addition
N/A	not applicable
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

Worksheet #29: Project Documents and Records Table

Document [a]	Storage/Archive Location
Sample Collection Documents and Records	Storage: AECOM Technical Services, Inc. 1111 3rd Avenue, Suite 1600 Seattle, WA 98101 Phone: 206-438-2700 Archive: Seattle Federal Records Center 6125 Sand Point Way, NE Seattle, WA 98115-7999 Phone: 206-336-5115
Field logbook (and sampling notes)	
Field sample forms (e.g., boring logs, sample log sheets, drilling logs)	
Chain-of-Custody records	
Air bills	
Photographs	
Field task modification forms	
Field sampling SOPs	
Laboratory documents and records	
Sample collection logs	
Health and safety sign in sheets	
Accident prevention plan acknowledgement	
Surveyed locations	
Communication logs	
Documentation of deviation from methods	
Excavation permits	
Explosive safety submission determination request	
Corrective action forms/documentation of the audits	
Documentation of internal QA review	
Identification of QC samples	
Meteorological data from field	
Sampling instrument calibration logs	
Sampling location and sampling plan	
Sampling report	
Analytical Records	
Chain-of-Custody records	
Sample receipt forms and sample tracking forms	
Preparation and analysis forms and/or logbooks	
Tabulated data summary forms and raw data for field samples, standards, QC checks, and QC samples	
Case narrative	
Sample chronology (time of receipt, extraction, and analysis)	
Identification of QC samples	
Communication logs	
Corrective action reports	
Definitions of laboratory qualifiers	
Documentation of corrective action results	
Documentation of laboratory method deviations	

Document [a]	Storage/Archive Location
Electronic data deliverables	Storage: AECOM Technical Services, Inc. 1111 3rd Avenue, Suite 1600 Seattle, WA 98101 Phone: 206-438-2700 Archive: Seattle Federal Records Center 6125 Sand Point Way, NE Seattle, WA 98115-7999 Phone: 206-336-5115
Instrument calibration reports	
Laboratory sample identification numbers	
Reporting forms, completed with actual results	
Signatures for laboratory sign-off (e.g., laboratory QA manager)	
Standards traceability records	
Project Data Assessment Records	
Field sampling audit checklists	
Analytical audit checklists	
Data review reports	
Telephone logs	
Corrective action reports	
Laboratory assessment	
Laboratory QA plan	
LOD study information	
DoD ELAP accreditation	
Off-site Analysis Documents and Records	
Chain-of-Custody documents	
Laboratory data reports	
Third-party data validation reports	

DoD	Department of Defense
ELAP	Environmental Laboratory Accreditation Program
LOD	limit of detection
QA	quality assurance
QC	quality control
SOP	standard operating procedure

[a] All documents produced for the project will be kept in a secured facility for the life of the project. Upon closure of the project, laboratory data will be archived at the Federal Records Center in Seattle, Washington, and AECOM Technical Services, Inc. will retain copies of the project documentation for 10 years.

Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Sampling Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization [a] (name and address, contact person, and phone number)	Backup Laboratory/Organization (name and address, contact person, and phone number)
Soil	Cyanide, Total	See Worksheet 18	WI11621	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Total Organic Carbon	See Worksheet 18	WI11627	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Metals	See Worksheet 18	WI11931/WI11933/WI17965	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Hexavalent Chromium	See Worksheet 18	WI11501	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	VOCs	See Worksheet 18	WI8236	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	1,4-Dioxane	See Worksheet 18	EFGS-T-MSS-SOP41389	30 calendar days	Eurofins Seattle, 5755 8th St. E., Tacoma, WA, 253-922-2310, Amanda Barnhart, 717-556-3860	N/A
	PAHs/SVOCs	See Worksheet 18	WI9995/WI9617	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	PFAS	See Worksheet 18	WI36459	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Total Solids	See Worksheet 18	WI10697	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Density (Grain and Bulk)	See Worksheet 18	IGS 001	30 calendar days	Integrated Geosciences Laboratories, LLC, 6016 Centralcrest Street, Houston, TX, 77092, Emeko Anazodo, 713-373-7180	N/A
	Grain Size	See Worksheet 18	EFGS-T-WC-SOP40944	30 calendar days	Eurofins Seattle, 5755 8th St. E., Tacoma, WA, 253-922-2310, Amanda Barnhart, 717-556-3860	N/A
	Permeability	See Worksheet 18	IGS 003	30 calendar days	Integrated Geosciences Laboratories, LLC, 6016 Centralcrest Street, Houston, TX, 77092, Emeko Anazodo, 713-373-7180	N/A
	Porosity (Total and Air-Filled)	See Worksheet 18	IGS 004	30 calendar days	Integrated Geosciences Laboratories, LLC, 6016 Centralcrest Street, Houston, TX, 77092, Emeko Anazodo, 713-373-7180	N/A

Matrix	Analytical Group	Sampling Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization [a] (name and address, contact person, and phone number)	Backup Laboratory/Organization (name and address, contact person, and phone number)
Groundwater	Anions	See Worksheet 18	WI11626	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Cyanide, Total	All IDW Aqueous Samples	WI11621	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Dissolved Organic Carbon	See Worksheet 18	WI11637	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Sulfide	See Worksheet 18	WI11483	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Dissolved Gases	See Worksheet 18	WI9796	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Metals, total and dissolved fractions	See Worksheet 18	WI11931/WI11933	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Low-level mercury	See Worksheet 18	EFGS-T-AFS-SOP2822	30 calendar days	Eurofins Frontier Global Sciences, LLC, 5755 8th St. E., Tacoma, WA, 253-922-2310 [b]	N/A
	Hexavalent Chromium	See Worksheet 18	WI11501	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	VOCs	See Worksheet 18	WI8194	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	Low-level vinyl chloride	See Worksheet 18	703S	30 calendar days	Analytical Resources, Inc., 4611 S. 134th Place, Suite 100, Tukwila, WA 98168, Kelly Bottem, 206-695-6211	N/A
	1,4-Dioxane	See Worksheet 18	EFGS-T-MSS-SOP41389	30 calendar days	Eurofins Seattle, 5755 8th St. E., Tacoma, WA, 253-922-2310, Amanda Barnhart, 717-556-3860	N/A
	PAHs	See Worksheet 18	801S	30 calendar days	Analytical Resources, Inc., 4611 S. 134th Place, Suite 100, Tukwila, WA 98168, Kelly Bottem, 206-695-6211	N/A

Matrix	Analytical Group	Sampling Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization [a] (name and address, contact person, and phone number)	Backup Laboratory/Organization (name and address, contact person, and phone number)
Groundwater (cont'd)	PFAS	See Worksheet 18	WI36458	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A
	SVOCs	See Worksheet 18	WI19617	30 calendar days	Eurofins Lancaster Laboratories Env. LLC, 2425 New Holland Pike, Lancaster, PA, Amanda Barnhart, 717-556-3860	N/A

[a] Laboratory meets accreditation requirements to support project needs.
[b] Eurofins Frontier Global Sciences, LLC is part of Eurofins Seattle and is included in the current accreditation by Washington State Department of Ecology for Eurofins Seattle.

Data packages will be due 30 days after samples are received at the laboratory.

Data packages will be prepared according to Procedure I-A-7, *Analytical Data Validation Planning and Coordination* (DON 2015). Data packages must include, at a minimum, the following sections:

1. Cover sheet
2. Table of contents
3. Case narrative
4. Analytical results
5. Sample management records
6. QA/QC information
7. Information for third-party review

For complete details of hard copy and EDD data package requirements, see Appendix G.

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Worksheet #31: Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Review of field procedures	Daily	Internal	AECOM	Field Manager	Field Team Members	Field Manager	CTO Manager
Review of field notes/logbook	Weekly	Internal	AECOM	Field Manager/ Field QC Coordinator	Field Team Members	Field Manager	CTO Manager
Review of field instrument calibration sheets	Daily	Internal	AECOM	Field Manager	Field Team Members	Field Manager	CTO Manager
Review of ChoC forms	Daily	Internal	AECOM	Project Chemist	Field QC Coordinator	Field Manager/Field QC Coordinator	CTO Manager
Field audit	Once	Internal	AECOM	Quality Assurance Manager	CTO Manager/ Field Manager	Field Manager	CTO Manager/Field Manager
Laboratory data assessment	Once per SDG	External/ Internal	LDC/AECOM	Third-Party Data Validator/Project Chemist	Laboratory Project Manager	Laboratory Project Manager	Third-Party Data Validator/Project Chemist

ChoC	chain of custody
CTO	contract task order
LDC	Laboratory Data Consultants
QC	quality control
SDG	sample delivery group

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Worksheet #32: Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response [a]	Timeframe for Response
Review of field procedures	Verbal communication/ logbook record	CTO Manager	Immediate	Logbook entry	CTO Manager	24 hours after notification
Review of field notes/logbook	Logbook record	CTO Manager	Immediate	Logbook entry	CTO Manager	24 hours after notification
Review of field instrument calibration sheets	Logbook record	CTO Manager	Immediate	Logbook entry	CTO Manager	24 hours after notification
Review of ChoC forms	Logbook record	Field Manager	Immediate	E-mail	QC Coordinator/ Field Manager, AECOM	24 hours after notification
Field audit	Written audit report	CTO Manager/ Field Manager	72 hours after audit	Letter	Quality Assurance Manager	24 hours after notification
Laboratory data assessment	Verbal communication or e-mail	CTO Manager/Laboratory Project Manager	24 hours after notification	Letter or e-mail	Third-Party Data Validator/Project Chemist	24 hours after notification

ChoC	chain of custody
CTO	contract task order
QC	quality control

[a] Copies of all assessment findings and corrective action responses will be provided to the Navy remedial project manager.

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Worksheet #33: Quality Assurance Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Third-Party Data Validation Report	Once, after submission of each sampling delivery group from the analytical laboratory	TBD	Mingta Lin, Pyron Environmental Inc.	CTO Manager (AECOM) and RPM (Navy)
Third-Party DQAR	Once, after all data are generated	TBD	Mingta Lin, Pyron Environmental Inc.	CTO Manager (AECOM) and RPM (Navy)
Field Audit Report	Once, during the initial 3 weeks of the field work	TBD	Quality Assurance Manager, AECOM	CTO Manager (AECOM), CTO Field Manager (AECOM), and QA Manager (Navy)

CTO	contract task order
DQAR	data quality assessment report
LDC	Laboratory Data Consultants
RPM	remedial project manager
TBD	to be determined

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Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIa/IIb [a]	Internal/External
Laboratory system audits	Determine whether the laboratory holds a current DoD ELAP certification for all analyses to be performed for the project. Include copy of certification information in Appendix I.	Project Chemist (Jen Garner, AECOM)	Step I	Internal
Field procedures	Determine whether field procedures are performed in accordance with this WP/QAPP and prescribed procedures. Document with Project QC checklist.	QA Program Manager (Scott Lewis, AECOM)	Step I	Internal
Field logbook and notes	Review the field logbook and any field notes on a weekly basis and place them in the project file. Copies of the field logbook and field notes will be provided to the CTO manager and included in the Field Audit Report. Document with Project QC checklist.	Field Manager (Sarah Welter, AECOM)	Step I	Internal
Instrument calibration sheets	Determine whether instruments are calibrated and used in accordance with manufacturer's' requirements. For field instruments, document with Project QC checklist and include calibration sheets with field documents in the project file. Laboratory calibrations will be included in laboratory reports and discussed in data validation reports.	Project Chemist (Jen Garner, AECOM) & Data Validator (Mingta Lin, Pyron)	Step I	Internal & External
ChoC forms	Review ChoC completed forms and verify them against the corresponding packed sample coolers. A copy of each ChoC will be placed in the project file. The original ChoC will be taped inside the cooler for shipment to the analytical laboratory. Document with Project QC Checklist.	Project Chemist (Jen Garner, AECOM)	Step I	Internal
Sampling analytical data package	Verify all analytical data packages for completeness prior to submittal of the data to the project chemist and data validator. Document with laboratory checklist.	Project Manager (Mandy Barnhart, Eurofins Kelly Bottem, ARI)	Step I	External
Analytes	Determine whether all analytes specified in Worksheet #15 were analyzed and reported by the laboratory. Document with Project QC Checklist.	Project Chemist (Jen Garner, AECOM)	Step IIa	Internal
ChoC and field QC logbook	Examine data traceability from sample collection to project data generation. Document with Project QC checklist.	Project Chemist (Jen Garner, AECOM)	Step IIa	Internal

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIa/IIb [a]	Internal/External
Laboratory data and WP/QAPP requirements	Assess and document the performance of the analytical process. A Stage 4 Validation will be performed on 10% of the soil and groundwater and associated field QC data by a third-party validation firm. The remaining data will undergo Stage 2B validation by a third-party data validation firm. All IDW data will undergo Stage 2A validation by AECOM. Data will be validated as described in *DoD General Data Validation Guidelines* dated November 4, 2019 and supported by associated Modules 1 through 4. Document with data validation report.	Data Validator (Mingta Lin, Pyron & Project Chemist (Jen Garner, AECOM)	Steps IIa & IIb	Internal & External
Sampling plan	Determine whether the number and type of soil and groundwater samples specified in Worksheet #20 were collected and analyzed. Document with Project QC checklist completed during review of field documentation and with data validation report.	Project Chemist (Jen Garner, AECOM) & Field Manager (Sarah Welter, AECOM)	Step IIb	Internal
Field QC samples	Establish that the number of QC samples specified in Worksheet #20 were collected and analyzed. Document with Project QC checklist completed during review of field documentation and with data validation report.	Project Chemist (Jen Garner, AECOM)	Step Iib	Internal
Project quantitation limits and data qualifiers	Establish that sample results met the project quantitation limits, field QA data is evaluated for data usability as described in Worksheet 37, below, and qualify the data in accordance with *General Data Validation Guidelines* dated November 4, 2019 and associated Modules 1 through 4. *Document with data validation report, Project QC checklist(s), and data usability writeup for SRI report.*	Data Validator (Mingta Lin, Pyron.) & Project Chemist (Jen Garner, AECOM)	Step Iib	Internal & External
Validation report	Summarize outcome of data comparison to MPC in the WP/QAPP. Include qualified data and an explanation of all data qualifiers. *Document with data validation report and data usability writeup for SRI report.*	Data Validator (Mingta Lin, Pyron)	Step IIa	External

ARI	Analytical Resources Inc.
ChoC	chain of custody
CTO	contract task order
DoD	Department of Defense
ELAP	Environmental Laboratory Accreditation Program
IDW	investigation derived waste
LDC	Laboratory Data Consultants
MPC	measurement performance criteria
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
WP	work plan

[a] IIa Compliance with methods, procedures, and contracts. See Table 10, page 117, UFP-QAPP manual, V.1 (DoD 2005).
IIb Comparison with measurement performance criteria in the WP/QAPP. See Table 11, page 118, UFP-QAPP manual, V.1 (DoD 2005).

Worksheet #37: Usability Assessment

37.1 SUMMARY OF THE DATA USABILITY ASSESSMENT PROCESS

A systematic data quality assessment process involving data verification steps and third-party data validation, as specified in Worksheets #34-36, will be implemented to assess the usability of environmental sample data generated for this QAPP. The evaluation will consider any deviations from proposed field activities or sampling and handling procedures. The analytical results of the soil and groundwater sampling will be compared to the project quality objectives (PQOs) described in Worksheet #11 to determine whether the measurement performance criteria (MPC) were met. Upon completion of the verification and validation processes, the data quality indicators will be evaluated for each analytical group in terms of meeting MPC goals as expressed by the precision, accuracy, representativeness, comparability, and completeness criteria. Variances in QC parameters will be assessed in relation to the potential impacts on the usability of the affected data and interpretation of field sampling results. The SRI Report will include discussions of any limitations on the use of project data from this assessment and potential impacts on the project decision statement process described in Worksheet #11.

37.2 FIELD ACTIVITY AND DATA VERIFICATION SUMMARY

The AECOM field manager will be responsible for periodic internal reviews to verify that field sampling procedures, instrument calibrations, and other relevant activities are performed in accordance with the QAPP. A bound field logbook will be used to document deviations in the proposed field activities, changes in sampling locations, sample types, duplicate pair identities and other relevant data/issues.

The data verification process will include an on-site data review against the QAPP requirements for completeness and accuracy per Worksheet #22 (SOP requirements for field equipment calibration, maintenance, and testing). In addition, the review process will verify SOPs for field sampling and analysis were followed.

The ChoC records and field QC logbook will be examined for traceability of data from sample collection to planned and requested analyses for environmental field and field QC samples (as specified in Worksheets #18, #19, and #20).

Upon its receipt from the designated analytical laboratory, electronic data will be assessed for proper reporting format with respect to data fields and content.

37.3 DATA VALIDATION AND DATA QUALITY ASSESSMENT PROCESS

All analytical laboratory data results will be validated in accordance with *DoD General Data Validation Guidelines* dated November 4, 2019 and associated modules as described in WS #14 (Section 14.5.5). The analytical data will be evaluated based on the validation guidance, project requirements as indicated in this document and *DoD QSM*, Version 5.3 (DoD and DOE 2019).

Sample data not meeting the project and *DoD QSM*, Version 5.3 (DoD and DOE 2019) acceptance criteria will be qualified with an abbreviation, or flag, to indicate a deficiency with the data. These qualifier flags are identified in Section 4.8 of the *DoD General Data Validation Guidelines.*

The documentation generated during data validation by the independent data validator will include a report that describes the information reviewed, the results of this review (including assigned qualifier flags), and a recommendation on data usability and limitations of specific data points. The report will provide information on the samples included in the review and the date(s) collected; the condition of samples when received at the laboratory and any discrepancies noted during the receiving process; verification of sample preparation and analysis within the method specified holding time; and review of associated QC analyses including blanks, laboratory control samples, MSs, and field and/or laboratory duplicates. The documentation generated by AECOM for validation of IDW data will include a report with similar content as the independent validator but the content will align with Stage 2A validation requirements.

Following completion of data validation, the AECOM Project Chemist will summarize impacts to data quality based on the information provided in the data validation reports. The Keyport project team will determine ultimate data usability based on this summary assessment, field information, and data purpose. The final validated chemical data will be loaded into NIRIS as an electronic data deliverable so that data users can readily identify any limitations associated with a specific data point.

With regard to PFAS, for NMePFOSA, NMePFOSAE, NEtPFOSA, NEtPFOSAE, and HFPODA (Hexafluoropropylene oxide dimer acid), an exception will be made to the QSM 5.3 Table B-15 criteria as typically recover for these compounds is <50%. For all other PFAS compounds, if environmental impact statement (EIS) recovery is <50%, the laboratory will check for laboratory error and correct if identified. If no laboratory error is identified, additional corrective action will be performed if EIS recovery is <10%. If EIS recovery is >10% and samples have detections above the reporting limit, no additional corrective action will be performed. If EIS recovery is >10% and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be proportionately increased as necessary and appropriate to ensure that reported values accurately reflect the sensitivity of the analysis. For all PFAS compounds, if EIS recovery is >150%, the laboratory will check for error and correct if identified. If no laboratory error is identified, additional corrective action will be performed only when field samples have detections above the reporting limits for the associated native target analytes and EIS recovery is >200%.

Ninety percent completeness for acceptable analytical data is required. The project team will determine the impact to the project objectives if 90 percent completeness is not achieved. Generally, data that do not meet the established acceptance criteria are cause for resampling and reanalysis. However, in some cases, data that do not meet acceptance criteria are usable with specified limitations. Data that are indicated as usable with limitations are included in the project reports but are clearly indicated as having limited usability. Indicators of data limitations include data qualifiers, quantitative evaluations, and narrative statements regarding potential bias.