Washington

Final

Basewide Per- and Polyfluoroalkyl Substances (PFAS) Site Inspection Sampling and Analysis Plan

Naval Air Station Patuxent River
Webster Field Annex
St. Inigoes, Maryland

April 2020

SAP Worksheet #1—Title and Approval Page

Washington

Final

Basewide Per- and Polyfluoroalkyl Substances (PFAS) Site Inspection Sampling and Analysis Plan

Naval Air Station Patuxent River
Webster Field Annex
St. Inigoes, Maryland

April 2020

Prepared for NAVFAC Washington
by CH2M HILL, Inc.
Herndon, Virginia
Contract N62470-16-D-9000
CTO 4256

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Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

Approval Signatures:

Naval Facilities Engineering Command Atlantic Quality Assurance Officer	Date

Other Approval Signatures:

Naval Facilities Engineering Command Washington Remedial Project Manager	Date

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Executive Summary

This Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) presents the technical approach for the Site Inspection (SI) for per- and polyfluoroalkyl substances (PFAS) in environmental media to be conducted at Webster Field Annex in St. Inigoes, Maryland, under the command of Naval Air Station (NAS) Patuxent River. A total of 2 sites at Webster Field Annex will be included in the SI activities. This SI is being conducted for the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), under the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) 9000 Program.

This SI SAP has been completed under Contract N62470-16-D-9000, Contract Task Order (CTO) 4256, in accordance with the Navy's SAP policy to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses. The objectives and technical approach included in this SAP were jointly scoped by the NAS Patuxent River Tier 1 Partnering Team, which includes representatives from the Navy, U.S. Environmental Protection Agency (USEPA) Region 3, and Maryland Department of the Environment (MDE).

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

Webster Field Annex, under the command of NAS Patuxent River, was identified as an installation where aqueous film-forming foam (AFFF) was likely used in fire-fighting activities, resulting in potential releases of PFAS to groundwater. The Navy is committed to identifying, evaluating, and where appropriate, remediating contamination resulting from its activities, including those relative to chemicals of emerging concern, such as PFAS. In October 2014, the Assistant Secretary of the Navy, Energy, Installations and Environment issued a policy requiring evaluation of sites with the potential for PFAS contamination under the Defense Environmental Restoration Program. The primary Navy releases of PFAS were through the use of AFFF for fire and emergency responses and during testing and training activities; however, PFAS may be released to the environment from other activities, including industrial operations (specifically chrome plating) and the storage, handling, or disposal of PFAS-containing materials or wastes. Interviews with fire department and base personnel completed for the Preliminary Assessment (PA) report for PFAS (CH2M HILL, Inc. [CH2M], 2019) (**Appendix A**) identified two areas at Webster Field Annex where AFFF was reportedly or potentially released. The focus of the PA was on releases of AFFF. A subsequent change in Navy policy requires assessment of other potential releases of PFAS in addition to AFFF. These potential releases are currently being evaluated by the Navy; if other areas at Webster Field Annex not identified in the PA are identified during a more thorough source area assessment, they will be evaluated as part of subsequent mobilizations in accordance with procedures outlined in this SAP.

Potential PFAS source areas included in this SI SAP are:

- Fire Station 3, Building 8076
- AFFF Crash Truck Maintenance Check Area

The following objectives have been identified for this SI:

- Determine whether PFAS (if present) exhibit concentrations that exceed the project action limits (PALs) for soil and groundwater at the suspected source areas identified in the April 2019 PA.
- Determine the potential for PFAS (if present) to migrate offsite.

This SAP outlines the following approach to evaluate PFAS in site media:

- Co-located surface and subsurface soil samples will be collected from each site and analyzed for the 18 PFAS compounds included in USEPA Drinking Water Method 537.1. Analytical laboratory procedures will be in compliance with Table B-15 from the Department of Defense (DoD) Quality Systems Manual (QSM) v5.3 or the most current version of the QSM for which the laboratory is accredited at the time of sample analysis.
- Groundwater grab samples will be collected from newly-installed temporary piezometers at each site and analyzed for the 18 PFAS compounds described previously.
- Results of this investigation will be used to determine if further investigation is warranted at either site.

This SAP includes 37 worksheets specific to the Navy's SAP guidance. All tables are embedded within the worksheets. All figures are included at the end of the document. The PA for PFAS at Webster Field Annex is included in **Appendix A**. The Health and Safety Plan (HASP) for the investigation is included in **Appendix B**. Field standard operating procedures (SOPs) are included in **Appendix C**. The laboratory DoD Environmental Laboratory Accreditation Program (ELAP) accreditation letter for Battelle (Norwell, Massachusetts) is included in **Appendix D**. Laboratory-specific SOPs are included in **Appendix E**. Slides from the December 2018 Partnering Scoping Session Presentation specific to the SI for PFAS in environmental media to be conducted at Webster Field Annex are included in **Appendix F**.

SAP Worksheets

Appendixes

Tables

Figures

Acronyms and Abbreviations

°C	degree(s) Celsius
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
AFFF	aqueous film-forming foam
AM	Activity Manager
AQM	Activity Quality Manager
bgs	below ground surface
CA	corrective action
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	chain-of-custody
CSM	conceptual site model
CTO	Contract Task Order
DoD	Department of Defense
DPT	direct-push technology
DQI	data quality indicator
EB	equipment blank
ELAP	Environmental Laboratory Accreditation Program
ERA	ecological risk assessment
ERP	Environmental Restoration Program
ESV	ecological screening value
FB	field blank
FD	field duplicate
FTL	Field Team Leader
g	gram(s)
GPS	Global Positioning System
HASP	Health and Safety Plan
HHRA	human health risk assessment
HQ	hazard quotient
IDW	investigation-derived waste
IS	internal standards
LC	liquid chromatograph
LCS	laboratory control sample
LIMS	Laboratory Information Management Systems
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
MDE	Maryland Department of the Environment

mL	milliliter(s)
MPC	measurement performance criteria
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NC	no criteria
ng/L	nanogram(s) per liter
ORP	oxidation-reduction potential
PA	Preliminary Assessment
PAL	project action limit
PC	Project Chemist
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutane sulfonate
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PID	photoionization detector
PM	Project Manager
PQL	project quantitation limit
PQO	project quality objective
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SI	Site Inspection
SME	Subject Matter Expert
SOP	standard operating procedure
STC	Senior Technical Consultant
TBD	to be determined
UCMR3	Third Unregulated Contaminant Monitoring Rule
UFP	Uniform Federal Policy
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
WQP	water quality parameter

SAP Worksheet #2—SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name:	Webster Field Annex, St. Inigoes, Maryland, under the command of Naval Air Station (NAS) Patuxent River
Operable Unit:	Not Applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-16-D-9000
Contract Title:	Comprehensive Long-term Environmental Action Navy (CLEAN) 9000 Program
Work Assignment Number (optional):	Contract Task Order (CTO) 4256

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the following guidance documents:
   - *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
   - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
   - *Draft Interim Recommendations to Address Groundwater Contaminated with Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS)* (USEPA, 2019a)
   - *Interim Per-and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)* (Navy, 2017)
   - *Environmental Restoration Program Manual* (Navy, 2018)
2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site management process
3. This document is a project-specific SAP.
4. List dates of scoping sessions that were held:

Scoping Session	Date
NAS Patuxent River PFAS Conference Call	February 9, 2017
NAS Patuxent River Tier 1 Partnering Team Meeting	January 23-24, 2018
NAS Patuxent River Tier 1 Partnering Team Meeting[a]	December 11-12, 2018

Notes:
[a] PFAS Partnering Scoping Session Presentation is included in **Appendix F**.

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

Title	Date
None	

SAP Worksheet #2—SAP Identifying Information (continued)

6. List organizational partners (stakeholders) and connection with lead organization:

Organization Partners/Stakeholders	Connection
U.S. Environmental Protection Agency (USEPA)[a]	Federal Regulatory Agency
Maryland Department of the Environment (MDE)	State Regulatory Agency
NAS Patuxent River	Base Stakeholder
Naval Facilities Engineering Command (NAVFAC) Atlantic	Technical Representative
NAVFAC Washington	Remedial Project Manager

Notes:
[a] non-regulatory partner for Webster Field Annex

7. If any required SAP elements or required information are N/A to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion as follows:
    - All required information is included in this SAP; therefore, the crosswalk table is not necessary for this project.

SAP Worksheet #3—Distribution List

SAP Recipients	Title	Organization	Telephone Number (optional)	E-mail Address or Mailing Address
David Steckler	Navy Remedial Project Manager (RPM)	NAVFAC Washington	202-685-3275	david.steckler@navy.mil
Heidi Morgan	Base Environmental Restoration Program (ERP) Manager	NAS Patuxent River	301-757-4897	heidi.a.morgan@navy.mil
To Be Determined (TBD)	Navy Chemist – Quality Assurance Officer (QAO)	NAVFAC Atlantic	TBD	TBD
Andy Sochanski	USEPA Tier 1 Representative	USEPA Region 3	215-814-3370	sochanski.andy@epa.gov
Jenny Herman	MDE Tier 1 Representative	MDE	410-537-3319	jenny.herman@maryland.gov
John Ledbetter	Activity Manager (AM)/Project Manager (PM)	CH2M	703-376-5172	john.ledbetter1@jacobs.com
John Tomik	Activity Quality Manager (AQM)	CH2M	757-671-6259	john.tomik@jacobs.com
Laura Cook	Senior Technical Consultant (STC)/ Subject Matter Expert (SME)	CH2M	757-671-6214	laura.cook1@jacobs.com
Anita Dodson	Navy Program Chemist	CH2M	757-671-6218	anita.dodson@jacobs.com
Juan Acaron	Project Chemist (PC)	CH2M	352-384-7002	juan.acaron@jacobs.com
Roni Warren	Human Health Risk Assessor	CH2M	814-364-2454	roni.warren@jacobs.com
Dan Lavoie	Ecological Risk Assessor	CH2M	202-265-2906	daniel.lavoie@jacobs.com
Carl Woods	Health and Safety Manager	CH2M	513-889-5771	carl.woods@jacobs.com
TBD	Field Team Lead (FTL)	CH2M	TBD	TBD
Jonathan Thorn	Laboratory PM	Battelle	781-681-5565	thorn@battelle.org
TBD	Data Validation Subcontractor	TBD	TBD	TBD

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

The personnel listed below acknowledge their receipt, acceptance, and approval for the listed sections of this UFP-SAP for the field activities at Webster Field Annex, under the command of NAS Patuxent River. The signed version of this document becomes a part of the administrative record for NAS Patuxent River, and a copy will be maintained in CH2M's project file.

Name	Organization/Title/Role	Telephone Number	Signature/ E-mail Receipt	Date SAP Read	SAP Section Revised
John Tomik	CH2M – AQM	757-671-6259			
John Ledbetter	CH2M – AM/PM	703-376-5172			
Laura Cook	CH2M – STC/SME	757-671-6214			
Katie Tippin	CH2M – Navy Program UFP-SAP Quality Reviewer	757-671-6258			
Anita Dodson	CH2M – Navy Program Chemist	757-671-6218			
Juan Acaron	CH2M – PC	352-384-7002			
Roni Warren	CH2M – Human Health Risk Assessor	814-364-2454			
Dan Lavoie	CH2M – Ecological Risk Assessor	202-265-2906			
Carl Woods	CH2M – Health and Safety Manager	513-889-5771			
TBD	CH2M – FTL	TBD			
TBD	CH2M – Field Team Members	TBD			
David Steckler	Navy RPM	202-685-3275			
Heidi Morgan	Base ERP Manager	301-757-4897			
TBD	Navy Chemist – QAO	TBD			
Jenny Herman	MDE Tier 1 Representative	410-537-3319			
Jonathan Thorn	Battelle/Laboratory PM	781-681-5565			
TBD	TBD/Data Validator	TBD			

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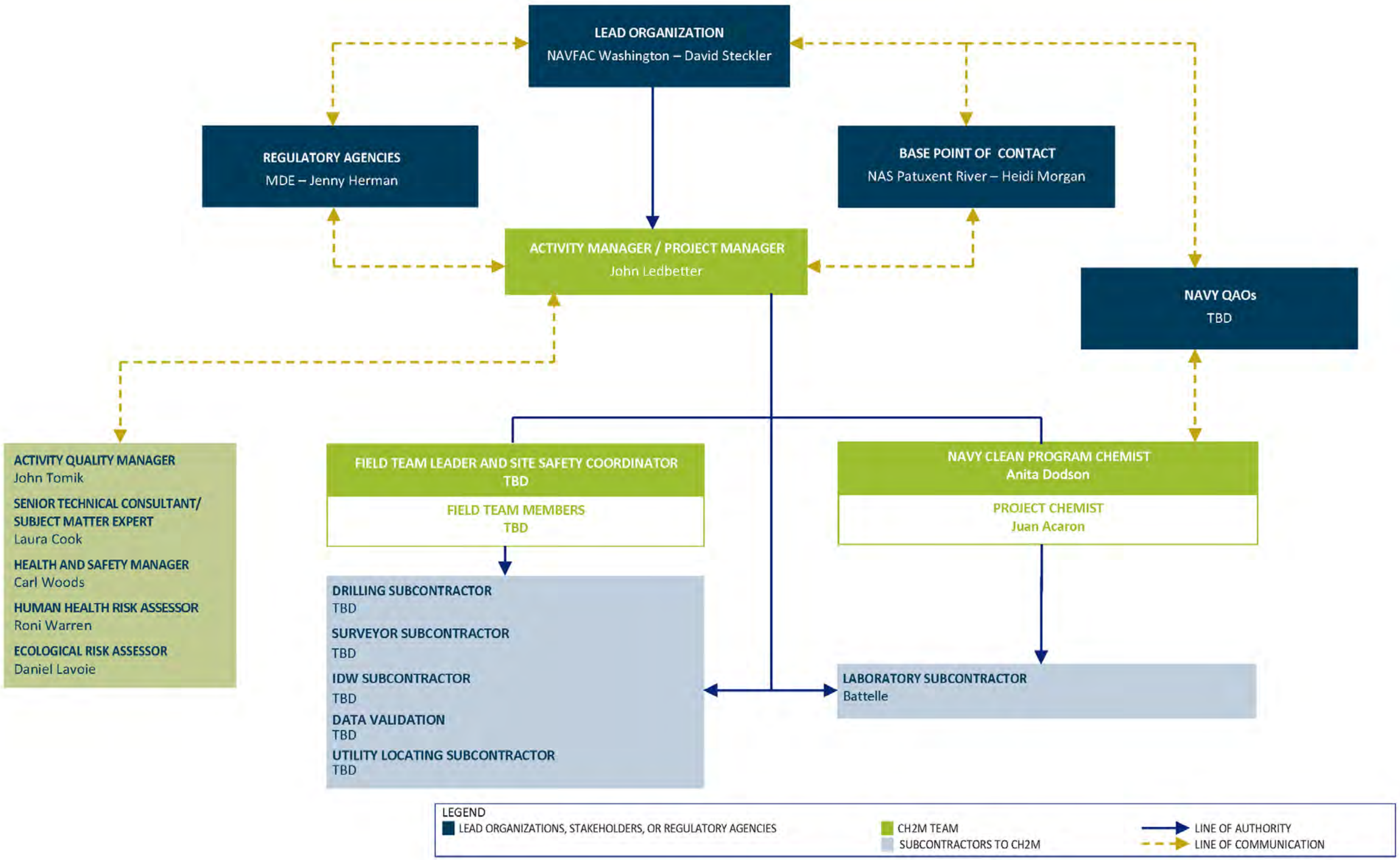
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Entity	Name	Telephone Number and/or E-mail Address	Procedure (Timing, Pathway To/From, etc.)
Communication with NAVFAC (lead agency)	Navy RPM	David Steckler	david.steckler@navy.mil	• Primary contact for Navy; can delegate communication to other internal or external points of contact • Primary contact to stakeholder agency managers • Has 30 days for UFP-SAP review
Communication with MDE	MDE Tier 1 Representative	Jenny Herman	jenny.herman@maryland.gov Alternatve Contacts: ira.may@maryland.gov curtis.detore@maryland.gov peggy.williams@maryland.gov	• Primary contact for MDE; can delegate communication to other internal or external points of contact • Has 60 days for UFP-SAP review • Navy RPM will notify MDE via e-mail within 24 hours for field changes affecting the scope or implementation of the UFP-SAP • Upon notification, MDE has 24 hours to approve or comment on field changes
Stop Work due to Safety Issues	Anyone onsite	TBD	TBD	• Has the ability to stop work due to any health and safety reason
Communication regarding overall project status and implementation	CH2M AM/PM	John Ledbetter	john.ledbetter1@jacobs.com	• Primary contact for CH2M to Navy and MDE RPMs for all project activities; can delegate communication to other internal or external points of contact • Forwards information and materials about the project to Navy RPM and MDE • Oversees the overall project status • Will be informed of project status by CH2M project staff • Manages subcontractors • If field changes occur, works with Navy RPM to communicate changes to MDE within 24 hours • Communicates field results to the NAS Patuxent River Tier 1 Partnering Team during Partnering Meetings

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Telephone Number and/or E-mail Address	Procedure (Timing, Pathway To/From, etc.)
SAP implementation in the field	CH2M FTL	TBD	TBD	• Secondary contact for CH2M to Navy for all Webster Field Annex activities • Facilitates CH2M's internal communication (AM/PM to field team members) • Coordinates schedules and field activities with field subcontractors • Communicates with subcontractors by phone, followed with e-mail to document any decisions and actions • Implements project health and safety requirements • Reports health and safety near misses and incidents to the CH2M AM/PM immediately by telephone • Provides daily reports and pertinent updates to the CH2M AM/PM by telephone or e-mail
SAP/Work Plan changes in the field	CH2M FTL	TBD	TBD	• Documents field activities and work plan deviations (made with approval of CH2M AM/PM) with loose-leaf paper • Communicates any field/project deviations to CH2M AM/PM on a daily basis and prior to conducting any action that may be affected by such communications
Communication regarding SAP changes	CH2M Program Chemist	Anita Dodson	anita.dodson@jacobs.com	• Changes to the project that would prompt a SAP change that would require Navy QAO approval include: - The addition of an analytical suite and/or environmental matrix not previously included in the SAP - Laboratory accreditation to a new DoD QSM version - Inclusion of a new lab into the SAP for any reason - Updates to the Conceptual Site Model (CSM) that prompt new data quality objectives • Updated laboratory LOQ, LOD, DL values will not prompt a SAP update for Navy QAO approval unless those updates negatively impact the ability to meet the PALs
	CH2M PC	Juan Acaron	juan.acaron@jacobs.com	• If necessary, discusses concerns with the Navy QAO

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Telephone Number and/or E-mail Address	Procedure (Timing, Pathway To/From, etc.)
Field Corrective Actions (CAs)	CH2M FTL	TBD	TBD	• Field and analytical issues requiring CA will be identified by the CH2M FTL and brought to the attention of the CH2M AM/PM before any decisions on action and necessary corrections are made • Communications and decisions should be made on a daily basis and prior to conducting any actions that may be affected by such communications and decisions • Communications with CH2M AM/PM will be in-person or by telephone, followed with e-mail to document any decisions and actions
	CH2M AM/PM	John Ledbetter	john.ledbetter1@jacobs.com	
Field staff discussions and inquiry regarding human health risk assessment (HHRA) and ecological risk assessment (ERA)	CH2M Human Health Risk Assessor	Roni Warren	roni.warren@jacobs.com	• Primary point of contact for field team before, during, and after investigation for HHRA and ERA concerns • Communicates back to CH2M AM/PM and PC, as needed • Primary contact for CH2M PC during post-investigation data process
	CH2M Ecological Risk Assessor	Daniel Lavoie	daniel.lavoie@jacobs.com	
Management of analytical laboratory and data validation subcontractors; oversight of analytical CAs and release of analytical data	CH2M PC	Juan Acaron	juan.acaron@jacobs.com	• Analytical laboratory CAs will be identified or brought to the attention of the CH2M PC on a daily basis • Facilitates resolution on a same-day basis after consulting with the CH2M AM/PM, Quality Assurance Officer (QAO), and Navy chemist (if changes in the UFP-SAP are warranted) to ensure UFP-SAP requirements are met by the laboratory • Approves release of analytical data after validation is completed and approved by the CH2M PC • Communicates with subcontractors by telephone, followed with e-mail to document any decisions and actions • Tracks data from sample collection through data upload • Primary contact for Laboratory PM • Reports laboratory issues to the CH2M AM/PM by telephone or e-mail within 4 business hours • Notifies the Navy RPM of any significant data quality issues from the laboratory, allowing NAVFAC Atlantic to ensure concerns would not affect other Navy work

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Telephone Number and/or E-mail Address	Procedure (Timing, Pathway To/From, etc.)
Reporting laboratory quality issues concerning PFAS	Laboratory PM	Jonathan Thorn	thorn@battelle.org	• Reports analytical laboratory CAs to the CH2M PC on a same-day basis • CH2M PC facilitates resolution after consulting with the CH2M AM/PM and the Navy Chemist (if changes to the UFP-SAP are warranted) to ensure UFP-SAP requirements are met by the laboratory • Communications will be by telephone, followed with e-mail to document any decisions and actions

SAP Worksheet #7—Personnel Responsibilities Table

(UFP-QAPP Manual Section 2.4.3)

Title/Role	Organizational Affiliation	Responsibilities
David Steckler	Navy RPM	Manages all NAS Patuxent River Program activities, including those at Webster Field Annex
Jenny Herman	MDE Tier 1 Representative	Reviews and provides input for MDE on the Webster Field Annex PFAS SI
John Tomik	CH2M – AQM	Provides overall technical quality control (QC) of the field investigation design and implementation; responsible for audits, CAs, and quality assurance (QA) performance checks
John Ledbetter	CH2M – AM/PM	Manages and oversees all project activities, and is responsible for all aspects of the work performed under this SAP; oversees overall project status for all CH2M projects implemented at Webster Field Annex
Laura Cook	CH2M – STC/SME	Oversight of all technical aspects of the project, including PFAS-related items
Katie Tippin	CH2M – Navy Program UFP-SAP Quality Reviewer	Provides UFP-SAP delivery support and QA oversight
Anita Dodson	CH2M – Navy Program Chemist	Provides UFP-SAP delivery support and QA oversight
Juan Acaron	CH2M – PC	Assists the development of the UFP-SAP, coordinates laboratory subcontracts, and oversees performance of laboratory services and data validation
Roni Warren	CH2M – Human Health Risk Assessor	Oversight of all activities associated with HHRA efforts
Dan Lavoie	CH2M – Ecological Risk Assessor	Oversight of all activities associated with ERA efforts
Carl Woods	CH2M – Health and Safety Manager	Develops and approves project health and safety plan (Appendix B)
TBD	CH2M – FTL	Supervises field implementation of the UFP-SAP
Jonathan Thorn	Battelle/Laboratory PM	Responsible for audits, CAs, and checks of QA performance within the laboratory
TBD	TBD/Data Validator	Provides data validation of analytical laboratory data
TBD	TBD/Utility Locator	Performs utility location to facilitate sample collection in areas of subsurface utilities
TBD	TBD/Survey Subcontractor	Surveys the elevations and horizontal locations of newly-installed temporary piezometers; horizontal locations of sample locations will also be obtained via hand-held GPS unit
TBD	TBD/Drilling Subcontractor	Performs temporary piezometer installation activities
TBD	TBD/IDW Subcontractor	Responsible for manifesting, transporting, and disposing of IDW

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SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training beyond standard health and safety training is required for this project. The field team will be briefed during the kick-off meeting on PFAS SOPs listed in **Worksheet #21** and provided in **Appendix C**.

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

Project Name: Webster Field Annex PFAS SI Scoping Session **Projected Date(s) of Sampling:** TBD **AM/PM:** John Ledbetter	**Site Name:** Webster Field Annex **Site Location:** St. Inigoes, Maryland

Date of Session: February 9, 2017 (NAS Patuxent River PFAS Conference Call)

Scoping Session Purpose: Update Navy stakeholders regarding the status of the NAS Patuxent River aqueous film-forming foam (AFFF) review, conduct a kick-off meeting for a 'mini Tiger-Team' for those at NAVFAC interested with the PFAS investigation effort at NAS Patuxent River, and obtain input and buy-in on the proposed priority list of PFAS sites, reporting, and sharing with regulatory stakeholders, including information specific to Webster Field.

Name	Title/Project Role	Affiliation	Telephone Number	E-mail Address
David Barclift	Technical Representative	NAVFAC Washington	215-897-4913	david.barclift@navy.mil
Byron Brant	Environmental Restoration	NAVFAC Atlantic	757-322-4786	byron.brant@navy.mil
Kim Brown	Headquarters Point of Contact	NAVFAC Washington	202-685-0096	kim.brown@navy.mil
Gunarti Coghlan	Environmental Engineer	NAVFAC Washington	202-685-9299	gunarti.coghlan@navy.mil
Jennifer Corack	Technical Representative	NAVFAC Atlantic	757-322-4335	jennifer.corack@navy.mil
Paula Gilbertson	Tier 2 Representative	NAVFAC Washington	202-685-3305	paula.gilbertson@navy.mil
Heidi Morgan	NAS Patuxent River ERP Manager	NAS Patuxent River	301-757-4897	heidi.a.morgan@navy.mil
Tim Reisch	Technical Representative	NAVFAC Atlantic	757-322-4130	timothy.reisch@navy.mil
David Steckler	Navy RPM	NAVFAC Washington	202-685-3275	david.steckler@navy.mil
Carrie Saunders	CH2M Scientist	CH2M	512-249-3344	carrie.saunders@jacobs.com
John Ledbetter	CH2M AM/PM	CH2M	703-376-5172	john.ledbetter1@jacobs.com
Quinn Philiposian	CH2M Geologist	CH2M	703-376-5212	quinn.philiposian@jacobs.com.com

Comments

NAS Patuxent River is a Priority Level 3 facility according to the initial "Defense Environmental Restoration Program Sites and Areas of Concern" list. Currently, no at-risk drinking water supply wells have been identified and no detections of PFAS constituents were identified during the UCMR3 sampling performed in December 2014, which was conducted at the drinking water supply wells within the boundary of NAS Patuxent River. PFAS is generally an installation-level concern at Navy facilities. The Team went over the PA for PFAS at NAS Patuxent River and at Webster Field Annex, which identified several "sites" recommended to be investigated in the future; no gathered information calls into question the facility's prioritization. The Team agreed that initial investigations should focus on sites which are both on the Navy's identified list of sites and were identified as "high priority" in the PA document.

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

Interviews conducted as part of the PA revealed AFFF use at Webster Field Annex. NRC Solomons has one building with an AFFF fire suppression system. These two facilities are not on the National Priorities List and will not be included in the NAS Patuxent River PFAS investigation.

Action Items

- Continue to assess the "high and medium priority sites" at NAS Patuxent River per the list provided for the call through site visits to get details on various media pathways and receptors, consolidate all the information, and prepare the draft assessment report
- If possible, close out suggested "no action" and "low priority" sites via desktop evaluations or through the assessment report
- PA report should document if ERP sites are adjacent or on top of PFAS sites and have a description of the base as it fits into the PFAS Defense Environmental Restoration Program Site and Area of Concern Identification and Prioritization Framework (i.e., explain why NAS Patuxent River is a Priority Level 3 facility and not Priority Level 1, etc.)
- After PA report is finalized, conduct SI sampling efforts from high priority sites
- CH2M to continue to work on the Draft PA Report for NAS Patuxent River with a due date of late spring/early summer
- Tim Reisch to provide the Navy policy and PFAS Defense Environmental Restoration Program Site and Area of Concern Identification information to CH2M
- Tim Reisch to be the point of contact for distributing the Draft PA Report for Navy vetting and review
- Gunarti Coghlan to follow up with Heidi Morgan on contacts at NAVSEA for ongoing efforts to replace AFFF legacy stocks

Consensus Decisions

- The Team agreed that initial investigations should focus on sites which are both on the Navy's identified list of sites and were identified as "high priority" in the PA document.
- The Team agreed that if existing monitoring wells were identified, they would be sampled as part of the SI investigations.
- The Team agreed that the Webster Field Annex PFAS investigation would not be included in the NAS Patuxent River PFAS investigation.

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

Project Name: Webster Field Annex PFAS SI Scoping Session **Projected Date(s) of Sampling:** TBD **AM/PM:** John Ledbetter			**Site Name:** Webster Field Annex **Site Location:** St. Inigoes, Maryland	
Date of Session: January 23-24, 2018 (NAS Patuxent River Tier 1 Partnering Team Meeting) **Scoping Session Purpose:** Update the NAS Patuxent River Tier 1 Partnering Team on the status of the PA PFAS Report and obtain input and buy-in on UFP-SAP development for the upcoming PFAS SI efforts, including information specific to Webster Field.				
Name	**Title/Project Role**	**Affiliation**	**Telephone Number**	**E-mail Address**
Andy Sochanski	USEPA Tier 1 Representative	USEPA Region 3	215-814-3370	sochanski.andy@epa.gov
Jenny Herman	MDE Tier 1 Representative	MDE	410-537-3319	jenny.herman@maryland.gov
Heidi Morgan	NAS Patuxent River ERP Manager	NAS Patuxent River	301-757-4897	heidi.a.morgan@navy.mil
David Steckler	Navy RPM	NAVFAC Washington	202-685-3275	david.steckler@navy.mil
John Ledbetter	CH2M AM/PM	CH2M	703-376-5172	john.ledbetter1@jacobs.com
Joe Kenderdine	CH2M Engineer	CH2M	703-376-5156	joseph.kenderdine@jacobs.com

Comments

The Team discussed the Basewide Draft PA Report for PFAS and initial regulatory comments. David Steckler stated that the Navy has funding for the SIs for all PFAS sites at NAS Patuxent River and Webster Field Annex. The Team agreed that one UFP-SAP will cover all of the NAS Patuxent River sites to be investigated as SIs; Webster Field Annex sites will be addressed in a separate UFP-SAP.

Action Items

- After PA report is finalized, initiate development of the UFP-SAP for PFAS SIs at NAS Patuxent River, with a similar process for Webster Field Annex (*the Final Preliminary Assessment Report for PFAS at Webster Field Annex was finalized in April 2019 and is included in* ***Appendix A***)
- USEPA and MDE to review the Draft PA Report for NAS Patuxent River

Consensus Decisions

- The Team agreed that one UFP-SAP will cover all of the NAS Patuxent River sites to be investigated as SIs (includes all 16 sites identified in the Basewide Draft PA Report for PFAS at NAS Patuxent River); Webster Field Annex sites will be addressed in a separate UFP-SAP.

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

Project Name: Webster Field Annex PFAS SI Scoping Session **Projected Date(s) of Sampling:** TBD **AM/PM:** John Ledbetter		**Site Name:** Webster Field Annex **Site Location:** St. Inigoes, Maryland		
Date of Session: December 11-12, 2018 (NAS Patuxent River Tier 1 Partnering Team Meeting) **Scoping Session Purpose:** Update the NAS Patuxent River Tier 1 Partnering Team on the status of the UFP-SAP for PFAS SI efforts and determine proposed SI sampling locations for each site at NAS Patuxent River and Webster Field Annex based on a review of site descriptions, operational histories, and CSMs (see **Appendix F**).				
Name	**Title/Project Role**	**Affiliation**	**Telephone Number**	**E-mail Address**
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Comments

The Team revisited an overview of the PFAS SIs for NAS Patuxent River and Webster Field Annex. There are 16 sites at NAS Patuxent River and 1 site at Webster Field Annex, with 18 samples budgeted per site (approximately 8 grab groundwater, 5 surface soil, and 5 subsurface soil). The intention is to retain approximately the same overall number of samples (288 samples at NAS Patuxent River and 18 samples at Webster Field Annex), with adjustments possible per site. Soil (surface and subsurface), groundwater, surface water, and sediment samples are possible. The Webster Field Annex site will not be included in the NAS Patuxent River PFAS investigation and will consequently not be included in the UFP-SAP for NAS Patuxent River.

The following objectives were identified for each site at Webster Field Annex:

- Determine whether PFAS (if present) exhibit concentrations that exceed the PALs for soil and groundwater at the suspected source areas identified in the April 2019 PA.
- Determine the potential for PFAS (if present) to migrate offsite.

When conducting the SIs, field observations and groundwater flow could influence the proposed sample locations. MDE asked if USEPA would accept piezometer data; USEPA confirmed that such data are acceptable. Throughout the discussion, the Team reviewed detailed site-specific information (site descriptions, operational histories, and CSMs) prior to finalizing proposed sample locations. It was decided that sample depths would include 0-0.5’ bgs (surface soil), down to 4’ bgs (subsurface soil), and at the water table (groundwater). The Team agreed to the proposed sampling effort at each site.

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

Action Items

- Separate UFP-SAP documents are being generated for the PFAS SIs at NAS Patuxent River and Webster Field Annex. Likewise, separate SI Reports for the two facilities will ultimately be generated.
- Based on the site-by-site discussions, there will be 291 samples collected at NAS Patuxent River and 21 samples collected at Webster Field Annex (sample counts at the time of the meeting).
- USEPA requested the following copies for each of the UFP-SAP deliverables:
  - 1 CD and 1 hard copy for Andy Sochanski (USEPA Tier 1 Representative)
  - 1 CD and 1 hard copy for chemists at Fort Meade (USEPA Region 3 Office of Analytical Services and Quality Assurance)

Consensus Decisions

- The Team agreed to the proposed sampling effort at each site.

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SAP Worksheet #10—Conceptual Site Model

Webster Field Annex is located in St. Inigoes, Maryland (**Figure 1**). **Figure 2** presents the locations of the potential source areas for PFAS at the facility. **Table 10-1** presents a summary of the site descriptions and background. Site-specific physical characteristics and histories are outlined in detail in **Appendix A**.

Table 10-1. Site Descriptions and Background
NAS Patuxent River Webster Field Annex, St. Inigoes, Maryland

Installation Name	Webster Field Annex
Potential PFAS Source Areas	Fire Station 3, Building 8076 (**Figure 2**) is located in the northwestern portion of Webster Field Annex, approximately 200 feet east of St. Mary's River. Constructed in 1968, Building 8076 is a one-story permanent structure encompassing approximately 2,600 square feet. The building currently serves as the Webster Field Fire Station and holds approximately 310 gallons of 3 percent AFFF. The start date for AFFF storage is unknown; although AFFF is stored in the building, there are no known releases of AFFF. This site was added to the planned SI activities after the scoping sessions based on a regulatory comment made by MDE on the Draft PA Report for Webster Field Annex. The comment (dated January 10, 2019) noted MDE concerns regarding AFFF storage tanks at Fire Station 3 (Building 8076) and the potential for a release to occur when filling the crash trucks with AFFF. Soil and groundwater samples were agreed upon by the NAS Patuxent River Tier 1 Partnering Team. AFFF Crash Truck Maintenance Check Area (**Figure 2**) is the location where the Webster Field Fire Department conducted daily and monthly checks of the AFFF spray equipment. Daily checks confirmed proper foam consistency, and monthly checks verified correct AFFF spray pattern setup using the crash truck equipment from Fire Station 3, Building 8076. The spray of AFFF would occur approximately 100 feet to 150 feet to the right and left from the "T" on the taxiway adjacent to the northwest runway at Webster Field Annex. The time period over which equipment functioning testing was conducted is unknown. During the monthly checks, AFFF was allowed to infiltrate into the ground and discharge to surrounding stormwater ditches and drains. An unknown amount of AFFF was released overall. Guidance for using NoFoam Kits in lieu of the AFFF spray checks has been available since the mid-2000s, and the crash truck at Webster Field Annex is currently tested monthly with water only at the Crash Truck Maintenance Check Area.
Installation Location	Webster Field Annex is an 850-acre Navy facility located in St. Inigoes, approximately 15 miles southwest of NAS Patuxent River in St. Mary's County, Maryland (**Figure 1**). The facility was originally used as a dispersal field in the event of aerial attacks during World War II and as an auxiliary landing field for NAS Patuxent River.
Current Use	Webster Field Annex, under the command of NAS Patuxent River, is currently used principally for the Naval Air Reserve Training program and for some test activities such as Unmanned Aerial Vehicle operations.
Site Conditions – Physical Characteristics	St. Inigoes Creek borders Webster Field Annex to the northeast and St. Mary's River borders Webster Field Annex to the north and west. The topography of Webster Field Annex varies from gently rolling to flat. In general, the topography of the site tends to slope gently from the northeast to the southwest towards St. Mary's River, which empties into the Potomac River. The elevation at the east end of the northeast/southwest trending runway is 21 feet above mean sea level and the elevation at the west end of the runway near St. Mary's River is approximately 12 feet above mean sea level.
Site Conditions – Geology and Hydrogeology	Webster Field Annex is in the Coastal Plain physiographic province, approximately 50 miles southeast of the Piedmont physiographic province. The Coastal Plain sediments consist of a thick sequence of unconsolidated sand, clay, and gravel that dips gently (less than 1 degree) to the east and southeast (Fred C. Hart and Associates, Inc., 1984). The thickness of the sedimentary units varies from approximately 2,000 feet in the northwestern part of St. Mary's County to 3,000 feet in the southeastern area of the county. Near Webster Field Annex, the unconsolidated Coastal Plain sediments overlie crystalline rocks. The regional hydrogeological system of the Coastal Plain near Webster Field Annex consists of several aquifers within the geologic units discussed above. From shallowest to deepest, the aquifers of primary interest with respect to Webster Field Annex are the surficial aquifer, the Piney Point-Nanjemoy aquifer, the Aquia aquifer, and the Patapsco aquifer.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Descriptions and Background (continued)
NAS Patuxent River Webster Field Annex, St. Inigoes, Maryland

Site Conditions – Geology and Hydrogeology (continued)	The surficial (water table) aquifer, the shallowest aquifer beneath Webster Field Annex, occurs in the Lowland deposits (i.e., clay, silt, sand, and gravel), is unconfined, and ranges in thickness from 10 to 100 feet (USGS, 2007). The St. Mary's Formation, as one formation of the low-permeability Chesapeake Group, functions primarily as a confining unit underlying the surficial aquifer. This confining unit is approximately 210 to 250 feet thick (USGS, 2007). The Piney Point-Nanjemoy, Aquia, and Upper Patapsco aquifers are deeper, confined aquifers below the St. Mary's Formation (Fred C. Hart and Associates, Inc., 1984). Groundwater from the surficial aquifer discharges to surface water bodies at Webster Field Annex, including ponds, streams, and the St. Mary's River. The groundwater flow direction for the surficial aquifer across the installation is predominately towards the St. Mary's River. The surficial aquifer is recharged by precipitation and infiltration. The groundwater flow direction for the Piney Point-Nanjemoy and Aquia aquifers is predominately towards the north and northwest at Webster Field Annex.
Drinking Water Source Evaluation	The Piney Point-Nanjemoy, Aquia, and Patapsco aquifers are the primary sources of potable water for NAS Patuxent River and surrounding areas (Klohe and Feehley, 2001), including Webster Field Annex. Drinking water receptors are located within one mile of the facility boundary. The closest residential area to the facility is the St. Inigoes Shores community, near the facility entrance off Villa Road. This community and other properties within one mile of Webster Field Annex are not serviced by municipal water and are on private water wells, which are installed in the Piney Point-Nanjemoy and Aquia aquifers at depths greater than 325 feet (St. Mary's County, 2018). All known properties with private drinking water wells are located upgradient of potential PFAS source areas at the facility. There are three community supply wells at Webster Field Annex. Well 2 is located at Building 8130 (Coast Guard Building), and Wells 4 and 5 are located at Building 8195 (**Figure 2**). Wells 2 and 4 are screened in the Aquia aquifer at 537 feet and 539 feet, respectively; however, Well 4 is not functioning and is expected to be replaced in the future (date to be determined). Well 5 is screened in the deeper Upper Patapsco aquifer at 884 feet. These wells connect to the main water supply for Webster Field Annex. Wells 2 and 5 were tested for PFAS in October 2016 under the Navy's policy regarding sampling for PFOA and PFOS at all Navy installations where such sampling was not previously completed under the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) study; none of the six PFAS compounds (PFOS, PFOA, PFBS, perfluorononanoic acid, perfluorohexane sulfonic acid, and perfluoroheptanoic acid) were detected during the sampling effort, as indicated in the Final PA Report for Webster Field Annex (**Appendix A**).
Contaminants of Potential Concern	18 PFAS Compounds: • N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) • N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) • Perfluorobutanesulfonic acid (PFBS) • Perfluorodecanoic acid (PFDA) • Perfluorododecanoic acid (PFDoA) • Perfluoroheptanoic acid (PFHpA) • Perfluorohexanesulfonic acid (PFHxS) • Perfluorohexanoic acid (PFHxA) • Perfluorononanoic acid (PFNA) • Perfluorooctanesulfonic acid (PFOS) • Perfluorooctanoic acid (PFOA) • Perfluorotetradecanoic acid (PFTA) • Perfluorotridecanoic acid (PFTrDA) • Perfluoroundecanoic acid (PFUnA) • 4,8-dioxa-3H-perfluorononanoic acid (ADONA) • 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS) • 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS) • Hexafluoropropylene oxide dimer acid (HFPO-DA)

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Site Descriptions and Background (continued)
NAS Patuxent River Webster Field Annex, St. Inigoes, Maryland

Nature and Extent	Unknown; no PFAS investigations have been conducted at the potential PFAS source areas
Migration Pathways	• Direct release of PFAS to soil and groundwater • Leaching of PFAS currently and/or historically present from soil to groundwater • Direct discharge to stormwater ditches and drains • Groundwater discharge to surface water • Overland flow of stormwater containing PFAS
Potential Receptors/ Exposure Routes	Current receptors (workers and trespassers/visitors) and future receptors (residents, workers, and trespassers/visitors) may be exposed to PFAS in soil and groundwater through incidental ingestion and dermal contact. Receptors may also be exposed to PFAS through inhalation of dust. PFAS are known to bioaccumulate and human receptors may be exposed through consumption of biota (such as fish) which may be contaminated with PFAS. Groundwater is not typically an exposure medium for ecological receptors, but ecological exposures may occur if groundwater discharges to a surface water body. In addition, ecological receptors (such as terrestrial and aquatic plants; soil, aquatic, and benthic invertebrates; fish; amphibians; and reptiles) may be directly exposed to PFAS compounds present in surface and shallow subsurface soil, surface water, and/or sediment, although surface water and sediment samples are not planned during the SI at Webster Field Annex. Surface water and sediment samples may be collected during an additional phase of the SI if any PFAS compounds are detected in the planned soil and groundwater samples. There is evidence that PFAS compounds entering food webs and thus ecological receptors (such as birds and mammals) may be exposed to these constituents via this pathway. However, no ecological screening values (ESVs) have been promulgated by USEPA at this time.

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

Problem Statements and Objectives

The objectives, environmental questions, investigation approach, and project quality objectives (PQOs) for this SI are presented in **Table 11-1**.

Table 11-1. Problem Statements and Objectives
NAS Patuxent River Webster Field Annex, St. Inigoes, Maryland

Problem Definition/Objective	Environmental Questions	General Investigation Approach	PQOs
Determine whether PFAS (if present) exhibit concentrations that exceed the PALs for soil and groundwater at the suspected source areas[1] identified in the April 2019 PA.	Are PFAS compounds detected in environmental samples collected at each site? If present, do PFAS concentrations exceed the PALs at each site?	**<u>Groundwater (Surficial Aquifer)</u>** Temporary piezometers will be installed/sampled at the proposed locations at each site shown on **Figure 3** and **Figure 4.** **<u>Soil</u>**[2] Co-located surface soil samples (0-6 inches bgs) and subsurface soil samples (36-48 inches bgs) will be collected from the proposed locations at each site shown on **Figure 3** and **Figure 4**.	If PFOA, PFOS, or PFBS concentrations exceed the PALs (see **Worksheet #15**) in any given site media, additional environmental sampling, including surface water and/or sediment, based on the results at that site will be considered by the NAS Patuxent River Tier 1 Partnering Team. Any additional sampling will be conducted as part of an addendum to this SAP. If PFOA, PFOS, or PFBS concentrations do not exceed the PALs in any given site media, no further action will be taken at that site at that time. PFAS data for the remaining 15 PFAS compounds will be archived for possible future use and evaluation, including screening of possible ecological risk[3].
Determine the potential for PFAS (if present) to migrate offsite.	What is the groundwater flow direction at each site?	To refine the understanding of groundwater flow at each site, newly-installed temporary piezometers (see **Figure 3** and **Figure 4**) will be gauged for the depth to groundwater, and contour maps will be created.	This information will be used to assess the potential migration of PFAS contamination and, in conjunction with a comparison of analytical results to the PALs, will be used to scope additional environmental sampling, as warranted.

Notes:

1 Other potential sources of PFAS in addition to AFFF (i.e., paints/pesticides, chrome plating shops, etc.) are currently being evaluated by the Navy; if other areas at Webster Field Annex not identified in the PA due to a subsequent change in Navy policy are identified during a more thorough source area assessment, they will be evaluated as part of subsequent mobilizations in accordance with procedures outlined in an addendum to this SAP.

2 Some surface soil samples will be collected in the drainage ditches around the AFFF Crash Truck Maintenance Check Area. These soil samples are not considered sediment samples because the ditches are typically dry except for rain events. As such, surface water is not typically present.

3 Screening values for ecological receptors have not yet been promulgated by USEPA. A risk screening will not be completed until these values are promulgated, at which time the groundwater to surface water interface will be evaluated.

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

What are the Project Action Limits (PALs)?

The PALs for data collected are provided in **Worksheet #15** and summarized below:

- **Groundwater** data will be screened against the following PALs:
  - **Human Health** – PFBS results will be compared to the current USEPA tap water RSL (based on a hazard quotient [HQ] of 0.1). The USEPA RSL calculator was used to calculate tap water RSLs for PFOS and PFOA (based on a HQ of 0.1). Although not a PAL, the USEPA lifetime health advisory for PFOA and PFOS is listed in **Worksheet #15** to ensure maximum usability of the data. There are no PALs for any other analytes.
  - **Ecological** – No promulgated ESVs have been issued by the USEPA for PFAS at this time. The analytical data will be evaluated for potentially unacceptable risk to ecological receptors once ESVs are issued.
- **Surface and Subsurface Soil** data will be screened against the following PALs:
  - **Human Health** - PFBS results will be compared to the current USEPA residential soil RSL (based on a HQ of 0.1). The USEPA RSL calculator was used to calculate residential soil RSLs for PFOS and PFOA (based on a HQ of 0.1). There are no PALs for any other analytes.
  - **Ecological** – No formal ESVs have been issued by the USEPA for PFAS. The analytical data will be evaluated for potentially unacceptable risk to ecological receptors once ESVs are issued. Once available, ESVs will only be applied to samples collected within 24 inches of the ground surface. However, the literature-based ESVs provided in **Worksheet #15-2** (soil) are included to ensure adequate analytical sensitivity and will be used to conduct an ecological risk screening.

What will the data be used for?

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

What types of data are needed?

Worksheets #14, #15, #17, and **#18** contain detailed information on the types of data needed for this project.

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

- All environmental sample locations (soil and groundwater) are shown on **Figure 3** and **Figure 4**. These locations are based on the rationale presented in **Worksheet #17**; sampling will be conducted in accordance with the project schedule outlined in **Worksheet #16**.
- The data will be collected as outlined in **Worksheet #14** and following the SOPs presented in **Worksheet #21**.

Are there special data quality needs to support environmental decisions?

Offsite laboratory analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments with respect to the aforementioned project objectives. Additionally, laboratory-specific Limits of Detection (LODs) will be less than the USEPA lifetime health advisory for PFOA and PFOS of 70 nanograms per liter (ng/L) or 0.07 micrograms per liter (µg/L) for the sum of the two chemicals. While there is no drinking water exposure potential downgradient of potential PFAS sites identified at Webster Field Annex and the USEPA lifetime health advisory is not a PAL for the site, this data quality requirement is intended to be conservative for maximum flexibility in future use of site data. QC sample requirements are detailed in **Worksheet #20**. For action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheets #24** and **#28** for laboratory QC samples**.** These MPC are consistent with the latest version of the Department of Defense (DoD) Quality Systems Manual (QSM), as applicable, and laboratory in-house limits where the QSM does not apply.

SAP Worksheet #12-1—Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

Matrix: GW
Analytical Group: PFAS
Analytical Method: LC-MS/MS Compliant with QSM v5.3[1] Table B-15

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

Notes:
[1] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

SAP Worksheet #12-2—Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

Matrix: SS, SB
Analytical Group: PFAS
Analytical Method: LC-MS/MS Compliant with QSM v5.3[1] Table B-15

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

Notes:

[1] QSM 5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
No secondary data will be used in support of the SI field effort.				

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SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities at Webster Field Annex is detailed below. All field work will be completed in accordance with the applicable standard operating procedures (SOPs) tabulated on **Worksheet #21** and provided in **Appendix C**.

Mobilization

Prior to mobilization, NAVFAC and MDE will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, procurement of the following subcontractors to support investigation activities will include[1]:

- Utility Locator
- Surveyor
- Driller
- IDW Transportation/Disposal Subcontractor
- Data Validation Subcontractor

Battelle has been procured to provide laboratory analytical services. Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the field team mobilizes for field activities.

Prior to beginning any phase of work, CH2M and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the Health and Safety Plan (HASP).

Prior to beginning any intrusive activities, CH2M will coordinate utility clearance with Miss Utility of Maryland and the Base's approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings.

Temporary Piezometer Installation

Using direct-push technology (DPT) methods, temporary piezometers will be installed in various locations in accordance with **Worksheet #17**. The piezometers will be constructed of 1-inch-diameter polyvinyl chloride and installed to the water table in all identified locations (assumed to vary between approximately 5 and 20 feet bgs), as depicted on **Figure 3** and **Figure 4**. No Teflon, Viton, or other PFAS-containing materials will be used during the installation activities. Lithology data and soil descriptions will be collected, including grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination, as detailed in the SOP.

All temporary piezometers will be installed in accordance with the State of Maryland construction standards by a Maryland-licensed driller.

Surveying

The newly-installed temporary piezometers will be horizontally and vertically located by a Maryland-licensed surveyor. The surveyor will provide coordinates of all horizontal points (X,Y) to the nearest 0.5 foot and vertical points (Z) to the nearest 0.01 foot (0.1 foot for unpaved ground surface elevations).

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[1] The Navy may contract multiple subcontractors to complete the tasks outlined in this SAP. All work will be conducted in accordance with the SOPs included in this SAP, regardless of the subcontractor who performs the work.

Worksheet #14—Summary of Project Tasks (continued)

Groundwater Sampling

Groundwater samples will be collected from newly-installed temporary piezometers in accordance with **Worksheet #18**. Groundwater samples will be collected using low-flow sampling methodology and in accordance with the SOPs. A peristaltic pump will be used to collect samples. The peristaltic tubing will be set at the water table for the piezometers. Teflon-lined tubing will not be used during groundwater sampling.

Water quality parameters (WQPs) to include pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, and oxidation-reduction potential (ORP) will be collected during purging at each sample point using a water quality meter and flow-through cell. Water quality readings will be collected once one volume of the sampling tube and flow-through cell has been purged. Purging will continue until water quality measurements collected after 3 consecutive readings note stabilized water quality parameters to within 10% of one another. Once parameters have stabilized, the flow-through cell will be disconnected, and samples will be collected into laboratory-prepared sample bottles and packed on ice for overnight shipment to Battelle. The water quality meter will be calibrated daily (at a minimum) and the calibration documented in the field notes on loose-leaf paper.

Soil Sampling

Co-located surface/subsurface soil samples will be collected from the locations presented on **Figure 3** and **Figure 4**. For this investigation, surface soil is defined as 0 to 6 inches bgs (or 0 to 0.5 foot bgs). Surface soil samples will be collected using a stainless-steel hand auger, shovel, fluorine-free plastic disposable scoop, post-hole digger, or other appropriate tool following soil sampling protocol. For this investigation, subsurface soil is defined as 36 to 48 inches bgs (or 3 to 4 feet bgs). Subsurface soil samples will be collected using a stainless-steel hand auger, shovel, or post-hole digger following soil sampling protocol.

Water-level Measurements

Following installation of any temporary piezometers at each site, and prior to the start of groundwater sampling, a complete water-level survey at all groundwater sample points (newly-installed temporary piezometers) will be conducted in accordance with the appropriate SOP. An electronic water-level meter with a probe which is not coated with Teflon or other PFAS-containing substances will be used to measure the depth to water from the top of casing to the nearest 0.01 foot.

Equipment Decontamination

Nondisposable sampling equipment will be decontaminated immediately after each use in accordance with the appropriate SOP. Nondisposable equipment will be decontaminated using the following solutions in this order:

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

Decontamination fluids will be contained in 55-gallon drums and disposed of offsite as described below.

Cross-contamination of PFAS in accordance with the SOP will be considered during equipment decontamination between sites. Also, an equipment decontamination process will occur prior to field commencement before any samples are collected. This process will be documented accordingly.

Worksheet #14—Summary of Project Tasks (continued)

Investigation-derived Waste Management

IDW is expected to consist of soil from the DPT borings advanced for temporary piezometer installations, purge water from groundwater sampling, and decontamination fluids. Aqueous and solid IDW will be contained in 55-gallon drums. If PFAS concentrations in aqueous IDW accumulated during field activities exceed the USEPA lifetime health advisory of 70 ng/L for individual or combined PFOA or PFOS analytes, the PFAS IDW SOP will be followed (**Appendix C**). A location at Webster Field Annex will be identified prior to initiation of the field work where IDW will temporarily be stored. IDW drums will be labeled in accordance with the SOP.

Disposable equipment, including personal protective equipment, will be decontaminated in accordance with the SOP included in **Appendix C** and disposed of with normal facility trash. The IDW subcontractor has not been selected for this investigation. However, once the subcontractor is identified, the Navy will be notified.

PFAS Field Blank Collection

To collect a PFAS field blank for non-drinking water samples, PFAS-free laboratory-supplied water will be slowly poured directly into Trizma-free laboratory-provided sample containers (**Worksheet #19**). The preservative Trizma is only required for aqueous samples collected from chlorinated drinking water sources. Since the field samples are not from chlorinated drinking water sources, the laboratory-supplied PFAS-free water for the PFAS field blanks for non-drinking water samples, as well as the sample containers, do not contain Trizma.

Analytical and Validation Tasks

- Quality Control
  - SOPs for field (**Appendix C**) and laboratory (**Appendix E**) tasks being performed will be implemented.
  - QC samples to be collected are outlined on **Worksheet #20**.
- Analytical Tasks
  - The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24** and **#25**).
  - The laboratory will process and prepare samples for analysis.
  - The laboratory will analyze samples as shown on **Worksheet #18**.
- Procedures for recording data, including guidelines for recording and correcting data
  - Project Assessment and Audit (**Worksheets #31** and **#32**)
  - Data Review
    - Data Validation (**Worksheets #34** through **#36**)
    - Data Usability Assessment (**Worksheet #37**)

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

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.3[1] Table B-15)
Matrix: Groundwater

Analyte	CAS No.	Lifetime Health Advisory[2] (µg/L)	Tapwater RSL[2,3] (HQ = 0.1) (µg/L)	Project Action Limit[2,4] (µg/L)	PQL Goal[5] (µg/L)	Laboratory Specific Limits (µg/L)			Accuracy Control Limit (%R)[6]		Precision Control Limit (% RPD)
						LOQs	LODs	DLs			
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.07	0.04	0.04	0.02	0.005	0.0010	0.00044	40	144	30
Perfluorooctanoic acid (PFOA)	335-67-1	0.07	0.04	0.04	0.02	0.005	0.0015	0.00051	49	141	30
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NC	40	40	20	0.005	0.0005	0.00014	56	134	30
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NC	NC	NC	0.01	0.005	0.0010	0.00050	51	131	30
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NC	NC	NC	0.01	0.005	0.0010	0.00035	50	146	30
Perfluorodecanoic acid (PFDA)	335-76-2	NC	NC	NC	0.01	0.005	0.0005	0.00014	59	135	30
Perfluorododecanoic acid (PFDoA)	307-55-1	NC	NC	NC	0.01	0.005	0.0005	0.00019	75	131	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	NC	NC	NC	0.01	0.005	0.0010	0.00026	48	136	30
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NC	NC	NC	0.01	0.005	0.0004	0.00011	52	128	30
Perfluorohexanoic acid (PFHxA)	307-24-4	NC	NC	NC	0.01	0.005	0.0015	0.00053	51	137	30
Perfluorononanoic acid (PFNA)	375-95-1	NC	NC	NC	0.01	0.005	0.0010	0.00031	58	122	30
Perfluorotetradecanoic acid (PFTA)	376-06-7	NC	NC	NC	0.01	0.005	0.0020	0.00073	42	158	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	NC	NC	NC	0.01	0.005	0.0005	0.00015	42	148	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NC	NC	NC	0.01	0.005	0.0005	0.00022	64	134	30
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	NC	NC	NC	0.005	0.005	0.0005	0.00025	70	130	30
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NC	NC	NC	0.005	0.005	0.0010	0.00027	70	130	30
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NC	NC	NC	0.005	0.005	0.0005	0.00023	70	130	30
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NC	NC	NC	0.005	0.005	0.0010	0.00027	70	130	30

Notes:

1 QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

2 NC: No Criteria (no screening level for this compound)

3 RSLs were derived using USEPA's RSL calculator on October 31, 2019; all based on target risk of 10^{-6} and target HQ of 0.1.

4 The Project Action Limit (PAL) is the minimum of "Lifetime Health Advisory" and "Tapwater RSL". Although not a PAL, the "Lifetime Health Advisory" has been considered to ensure maximum usability of the data. Refer to **Worksheets #10** and **#11** for a detailed discussion on development of PALs.

5 The Project Quantitation Limit (PQL) Goal is 1/2 the PAL, or the Laboratory Specific LOQ, as applicable.

6 In-house laboratory limits are the basis for laboratory control sample (LCS) and matrix spike/matrix spike duplicate (MS/MSD) limits.

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

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.3[1] Table B-15)
Matrix: Surface Soil[2], Subsurface Soil[2]

Analyte	CAS No.	Residential Soil RSL[3] (HQ = 0.1) (µg/kg)	Project Action Limit[3,4] (µg/kg)	PQL Goal[3,5] (µg/kg)	Laboratory Specific Limits (µg/kg)			Accuracy Control Limit (%R)[6]		Precision Control Limit (% RPD)
					LOQs	LODs	DLs			
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	130	130	65	5.0	2.0	0.69	40	144	30
Perfluorooctanoic acid (PFOA)	335-67-1	130	130	65	5.0	2.0	0.61	49	141	30
Perfluorobutanesulfonic acid (PFBS)	375-73-5	130,000	130,000	65,000	5.0	1.0	0.35	56	134	30
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NC	NC	5	5.0	2.0	0.75	51	131	30
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NC	NC	5	5.0	2.5	1.02	50	146	30
Perfluorodecanoic acid (PFDA)	335-76-2	NC	NC	5	5.0	1.0	0.46	59	135	30
Perfluorododecanoic acid (PFDoA)	307-55-1	NC	NC	5	5.0	2.0	0.61	75	131	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	NC	NC	5	5.0	1.5	0.51	48	136	30
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NC	NC	5	5.0	2.0	0.81	52	128	30
Perfluorohexanoic acid (PFHxA)	307-24-4	NC	NC	5	5.0	2.0	0.71	51	137	30
Perfluorononanoic acid (PFNA)	375-95-1	NC	NC	5	5.0	1.0	0.49	58	122	30
Perfluorotetradecanoic acid (PFTA)	376-06-7	NC	NC	5	5.0	2.5	1.08	42	158	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	NC	NC	5	5.0	1.0	0.28	42	148	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NC	NC	5	5.0	1.0	0.46	64	134	30
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	NC	NC	5	5.0	2.0	0.64	70	130	30
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NC	NC	5	5.0	2.0	0.83	70	130	30
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NC	NC	5	5.0	1.5	0.52	70	130	30
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NC	NC	5	5.0	1.0	0.48	70	130	30

Notes:

1 QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

2 Soil ESVs for PFOS (100 µg/kg for invertebrates; 39 µg/kg for terrestrial plants; 2,200 µg/kg-dry weight for herbivorous mammals and birds) and PFOA (160 µg/kg for invertebrates; 12 µg/kg-dry weight for secondary consumers) being used at NAS Willow Grove will be considered during evaluation of the data to ensure adequate analytical sensitivity. No formal ESVs have been issued by the USEPA for PFAS.

3 NC: No Criteria (no screening level for this compound)

4 The Project Action Limit (PAL) is the "Residential Soil RSL". Refer to **Worksheets #10** and **#11** for a detailed discussion on development of PALs.

5 The Project Quantitation Limit (PQL) Goal is 1/2 the PAL, or the Laboratory Specific LOQ, as applicable.

6 In-house laboratory limits are the basis for laboratory control sample (LCS) and matrix spike/matrix spike duplicate (MS/MSD) limits.

SAP Worksheet #16—Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable
		Anticipated Date(s) of Initiation	Anticipated Date of Completion	
Prepare and Submit Preliminary Draft SAP	CH2M		July 2019	Preliminary Draft SAP
Base and Navy Review of Preliminary Draft SAP	NAS Patuxent River / NAVFAC Washington	July 2019	October 2019	Comments
Prepare and Submit Draft SAP	CH2M	October 2019	November 2019	Draft SAP
MDE Review of Draft SAP	MDE	November 2019	January 2020	Comments
Prepare and Submit Final SAP	CH2M	January 2020	April 2020	Final SAP
Anticipated Fieldwork	CH2M	April 2020	September 2020	Field Updates
Prepare and Submit Preliminary Draft SI Report	CH2M	September 2020	December 2020	Preliminary Draft SI Report
Base and Navy Review of Preliminary Draft SI Report	NAS Patuxent River / NAVFAC Washington	December 2020	January 2021	Comments
Prepare and Submit Draft SI Report	CH2M	January 2021	February 2021	Draft SI Report
MDE Review of Draft SI Report	MDE	February 2021	May 2021	Comments
Prepare and Submit Final SI Report	CH2M	May 2021	June 2021	Final SI Report

Notes:

MDE = Maryland Department of the Environment

NAS = Naval Air Station

NAVFAC = Naval Facilities Engineering Command

SAP = Sampling and Analysis Plan

SI = Site Inspection

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SAP Worksheet #17—Sampling Design and Rationale

Table 17-1 presents the sampling strategy and rationale.

Table 17-1. Sampling Strategy and Rationale
NAS Patuxent River Webster Field Annex, St. Inigoes, Maryland

Matrix	Depth (feet bgs)	Analytical Group	Method	Number of Samples	Sampling Strategy and Rationale
GW	Water Table (piezometers)	PFAS	LC-MS/MS Compliant with QSM v5.3 Table B-15	11	Groundwater samples will be collected from newly-installed temporary piezometers in potentially impacted areas to evaluate concentrations of PFAS at the following sites: Fire Station 3, Building 8076 • 4 temporary piezometers (**Figure 3**) AFFF Crash Truck Maintenance Check Area • 7 temporary piezometers (**Figure 4**)
SO	0 – 0.5 (surface soil) 3 – 4 (subsurface soil)	PFAS	LC-MS/MS Compliant with QSM v5.3 Table B-15	22	Soil samples will be collected in potentially impacted areas to evaluate concentrations of PFAS at the following sites: Fire Station 3, Building 8076 • 4 co-located surface soil/subsurface soil locations (**Figure 3**) AFFF Crash Truck Maintenance Check Area • 7 co-located surface soil/subsurface soil locations (**Figure 4**)

Notes:

bgs = below ground surface

GW = groundwater

PFAS = per-and polyfluoroalkyl substances

SI = Site Inspection

SO = soil

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

Station ID	Sample ID	Matrix	Depth[1]	Analytical Group	Number of Samples	Sampling SOP Reference
Fire Station 3, Building 8076						
PX-WF-B8076-WT01	PX-WF-B8076-WT01-MMYY	GW	Water Table	PFAS	1	See **Worksheet #21**
PX-WF-B8076-WT02	PX-WF-B8076-WT02-MMYY	GW			2 (FD)	
	PX-WF-B8076-WT02P-MMYY					
PX-WF-B8076-WT03	PX-WF-B8076-WT03-MMYY	GW			1	
PX-WF-B8076-WT04	PX-WF-B8076-WT04-MMYY	GW			3 (MS/MSD)	
	PX-WF-B8076-WT04-MMYY-MS					
	PX-WF-B8076-WT04-MMYY-SD					
PX-WF-B8076-SO01	PX-WF-B8076-SS01-000H	SS	0-0.5	PFAS	1	
	PX-WF-B8076-SB01-0304	SB	3-4		2 (FD)	
	PX-WF-B8076-SB01P-0304					
PX-WF-B8076-SO02	PX-WF-B8076-SS02-000H	SS	0-0.5		1	
	PX-WF-B8076-SB02-0304	SB	3-4		1	
PX-WF-B8076-SO03	PX-WF-B8076-SS03-000H	SS	0-0.5		3 (MS/MSD)	
	PX-WF-B8076-SS03-000H-MS					
	PX-WF-B8076-SS03-000H-SD					
	PX-WF-B8076-SB03-0304	SB	3-4		1	
PX-WF-B8076-SO04	PX-WF-B8076-SS04-000H	SS	0-0.5		2 (FD)	
	PX-WF-B8076-SS04P-000H					
	PX-WF-B8076-SB04-0304	SB	3-4		1	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth[1]	Analytical Group	Number of Samples	Sampling SOP Reference
PX-WF-B8076-QC	PX-WF-B8076-FB01-MMDDYY	QC	N/A	PFAS	1	See **Worksheet #21**
	PX-WF-B8076-EB01-MMDDYY-GW				1	
	PX-WF-B8076-EB01-MMDDYY-SO				1	
AFFF Crash Truck Maintenance Check Area						
PX-WF-CTMCA-WT01	PX-WF-CTMCA-WT01-MMYY	GW	Water Table	PFAS	1	See **Worksheet #21**
PX-WF-CTMCA-WT02	PX-WF-CTMCA-WT02-MMYY	GW			2 (FD)	
	PX-WF-CTMCA-WT02P-MMYY					
PX-WF-CTMCA-WT03	PX-WF-CTMCA-WT03-MMYY	GW			1	
PX-WF-CTMCA-WT04	PX-WF-CTMCA-WT04-MMYY	GW			3 (MS/MSD)	
	PX-WF-CTMCA-WT04-MMYY-MS					
	PX-WF-CTMCA-WT04-MMYY-SD					
PX-WF-CTMCA-WT05	PX-WF-CTMCA-WT05-MMYY	GW			1	
PX-WF-CTMCA-WT06	PX-WF-CTMCA-WT06-MMYY	GW			1	
PX-WF-CTMCA-WT07	PX-WF-CTMCA-WT07-MMYY	GW			1	
PX-WF-CTMCA-SO01	PX-WF-CTMCA-SS01-000H	SS	0-0.5	PFAS	1	
	PX-WF-CTMCA-SB01-0304	SB	3-4		2 (FD)	
	PX-WF-CTMCA-SB01P-0304					
PX-WF-CTMCA-SO02	PX-WF-CTMCA-SS02-000H	SS	0-0.5		1	
	PX-WF-CTMCA-SB02-0304	SB	3-4		1	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth[1]	Analytical Group	Number of Samples	Sampling SOP Reference
PX-WF-CTMCA-SO03	PX-WF-CTMCA-SS03-000H	SS	0-0.5	PFAS	3 (MS/MSD)	See **Worksheet #21**
	PX-WF-CTMCA-SS03-000H-MS					
	PX-WF-CTMCA-SS03-000H-SD					
	PX-WF-CTMCA-SB03-0304	SB	3-4		1	
PX-WF-CTMCA-SO04	PX-WF-CTMCA-SS04-000H	SS	0-0.5		1	
	PX-WF-CTMCA-SB04-0304	SB	3-4		1	
PX-WF-CTMCA-SO05	PX-WF-CTMCA-SS05-000H	SS	0-0.5		2 (FD)	
	PX-WF-CTMCA-SS05P-000H					
	PX-WF-CTMCA-SB05-0304	SB	3-4		1	
PX-WF-CTMCA-SO06	PX-WF-CTMCA-SS06-000H	SS	0-0.5		1	
	PX-WF-CTMCA-SB06-0304	SB	3-4		1	
PX-WF-CTMCA-SO07	PX-WF-CTMCA-SS07-000H	SS	0-0.5		1	
	PX-WF-CTMCA-SB07-0304	SB	3-4		1	
PX-WF-CTMCA-QC	PX-WF-CTMCA-FB01-MMDDYY	QC	N/A	PFAS	1	
	PX-WF-CTMCA-EB01-MMDDYY-GW				1	
	PX-WF-CTMCA-EB01-MMDDYY-SO				1	

Notes:
[1] feet below ground surface (bgs)

FD = field duplicate
GW = groundwater
ID = identification
MS/MSD = matrix spike/matrix spike duplicate
N/A = not applicable
PFAS = per- and polyfluoroalkyl substances
QC = quality control
SOP = standard operating procedure

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers (number, size, and type)	Sample Volume[2] (units)	Preservation Requirements (chemical, temperature, light-protected)	Maximum Holding Time[3] (preparation / analysis)
GW	PFAS	LC-MS/MS Compliant with QSM v5.3 Table B-15/ SOP 5-370-10, SOP 5-369-08	Two of 250-mL HDPE	250 mL	≤ 10°C but not frozen	14 days, 28 days
SS, SB	PFAS	LC-MS/MS Compliant with QSM v5.3 Table B-15/ SOP 5-370-10, SOP 5-369-08	One of 8-ounce HDPE Jar	30 g	≤ 10°C but not frozen	14 days, 28 days

Notes:

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

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

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

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SAP Worksheet #20—Field Quality Control Sample Summary Table

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

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Field Blanks	No. of Equip. Blanks[3]	Total No. of Samples to Lab
Fire Station 3, Building 8076							
GW	PFAS	4	1	1	1	2	10
SS		4	1	1		2	9
SB		4					4
AFFF Crash Truck Maintenance Check Area							
GW	PFAS	7	1	1	1	2	13
SS		7	1	1		2	12
SB		7	1				8

Notes:

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

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

3 The number of equipment blanks is based on a fundamental assumption of the number of sampling days each site will require. It was assumed that the soil sampling will occupy a total of two days (per site). It was assumed that the groundwater sampling will occupy a total of two days (per site).

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SAP Worksheet #21—Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title	Revision Date or Version Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-001	Preparing Field Log Books	1/2020	CH2M	Loose-leaf paper, pen (not Sharpie)	Y	No waterproof materials may be used for sampling PFAS. Notetaking procedures outlined will be followed but materials used will be different.
SOP-002	Locating and Clearing Underground Utilities	1/2020	CH2M	Subsurface locating instruments, PFAS-free spray paint (provided by utility locating contractor), historical documents, facility as-built diagrams	N	
SOP-003	Multi RAE Photoionization Detector (PID)	1/2020	CH2M	PID	N	
SOP-004	Global Positioning System (GPS)	1/2020	CH2M	Trimble Pro XS GPS Unit	N	
SOP-005	Equipment Blank and Field Blank Preparation	1/2020	CH2M	Blank liquid (use American Society for Standards and Materials [ASTM] Type II grade water), de-ionized water, sample bottles, and gloves. Field blank procedures outlined in **Worksheet #14** will be followed and water will be certified PFAS-free.	N	
SOP-006	Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III	1/2020	CH2M	Groundwater sampling pumps and tubing, Horiba U-22	N	
SOP-007	Chain-of-Custody	1/2020	CH2M	Paper chain-of-custody form (provided by laboratory)	N	
SOP-008	Packaging and Shipping Procedures for Low-Concentration Samples	1/2020	CH2M	Coolers, duct tape, ice, strapping tape, packaging material, resealable plastic bags, custody seals, chain-of-custody form	N	Efforts will be made to obtain PFAS-free labeling and shipping materials; however, to reduce the potential for cross-contamination, bottles will be sealed prior to labeling.
SOP-009	Disposal of Waste Fluids and Solids	1/2020	CH2M	Fluids: 55-gallon drum, tools to secure drum, funnel, labels, marking pen (not Sharpie), seals for drum Solids: 55-gallon, tools to secure drum, plastic sheets, labels, marking pen (not Sharpie)	N	
SOP-010	Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Meter with Flow-Through Cell	1/2020	CH2M	Water Quality Parameter Meter (Horiba U-22 Water Quality Monitoring System), distilled water in squirt bottle, Horiba U-22 Auto-Calibration Standard Solution	N	
SOP-011	Sampling Contents of Tanks and Drums	1/2020	CH2M	Drum/Tank, sampling instrument, gloves, plastic sheets, labels, monitoring instrument	N	
SOP-012	Water-Level Measurements	1/2020	CH2M	Water level meter (PFAS-free)	N	
SOP-013	Decontamination of Personnel and Equipment	1/2020	CH2M	Certified PFAS-free water, potable water, Liquinox, plastic pails or tubs, 55-gallon drum, gloves, decon pad	N	
SOP-014	Decontamination of Drilling Rigs and Equipment	1/2020	CH2M	Portable steam cleaner and related equipment, potable water, phosphate-free detergent such as Liquinox, buckets, brushes, isopropanol, DI water, PFAS-free aluminum foil	N	
SOP-015	Soil Sampling for PFAS	10/2019	CH2M	Stainless steel tools, carbon steel tools, or steel DPT tooling with acetate sleeves are preferred for PFAS sampling, stainless steel spoon or spatula	N	
SOP-016	Direct-Push Groundwater Sample Collection for PFAS	10/2019	CH2M	DPT rig, groundwater sampling pumps and tubing that do not contain PFAS, Horiba U-22, water level meter	N	

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

Reference Number	Title	Revision Date or Version Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-017	Logging of Soil Borings	1/2020	CH2M	Field notepaper, tape measure/ruler, spatula, HCL (10 percent solution), squirt bottle with water, rock- or soil-color chart, grain-size chart, hand lens, United Soil Classification System index charts and tables to help with soil classification	N	
SOP-018	Management of Liquid Waste Containing PFAS	2/2019	CH2M	55-gallon drum, tools to secure drum, funnel, labels, marking pen (not Sparpie), seals for drum	N	Specific for PFAS sampling
SOP-019	Direct-Push Groundwater Sample Collection	1/2020	CH2M	DPT rig, groundwater sampling pumps and tubing that do not contain PFAS, Horiba U-22, water level meter	N	Specific for non-PFAS sampling
SOP-020	Direct-Push Soil Sample Collection	1/2020	CH2M	DPT rig, sampling tubes and acetate lines	N	Specific for non-PFAS sampling
SOP-021	Groundwater Sampling for PFAS	10/2019	CH2M	Flow-through cell, water level indicator, filter (if necessary), adjustable rate PFAS-free pump, PFAS-free tubing, PFAS-free sample containers, and PFAS-free shipping materials	N	

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

Field Equipment	Activity[1]	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[2]	Comments
Horiba U-22 pH probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	pH reads 4.0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly	FTL	SOP-010 Horiba U-22	**Appendix C**
Horiba U-22 Specific conductance probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-010 Horiba U-22	**Appendix C**
Horiba U-22 Turbidity probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-010 Horiba U-22	**Appendix C**
Horiba U-22 DO and Temperature Probes	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-010 Horiba U-22	**Appendix C**
Horiba U-22	Maintenance – Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes pH reads 4.0 +/- 3% Conductivity reads 4.49 +/- 3% Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	SOP-010 Horiba U-22	**Appendix C**
PID	Calibrate using ambient air and isobutylene 100 parts per million calibration gas	Daily and as Needed	Parameter specific per model/instruction manual	Manufacturer technical support for calibration errors	FTL	SOP-003	**Appendix C**

Notes:

1 Activities may include: calibration, verification, testing, and maintenance.

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

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Revisited if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work? (y/n)
5-369-08	PFAS Analytical; October 2019; Rev. 8		Definitive	GW, SS, SB / PFAS	LC-MS/MS	Battelle	None	N
5-370-10	PFAS Sample Preparation; March 2020; Rev. 10		Definitive	GW, SS, SB / PFAS	N/A	Battelle	None	N
6-010-19	Sample Receipt, Custody, and Handling; October 2018; Rev. 19	November 2019	N/A	N/A	N/A	Battelle	None	N
5-114-09	The Storage and Disposal of Regulated and Non-Regulated Waste; January 2015; Rev. 9	March 2020	N/A	N/A	N/A	Battelle	None	N

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument[3]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
LC-MS/MS (for PFAS)	Initial Calibration (ICAL)	At instrument set-up and after ICV or CCV failure, prior to sample analysis. Calibration can be linear (minimum of 5 standards) or quadratic (minimum of 6 standards); weighting is allowed.	The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commerically available (Isotope Dilution Quantitation). Commercial PFAS standards available as salts are acceptable providing the measured mass is corrected to the neutral acid concentration. Results shall be reported as the neutral acid with appropriate CAS number. If a labeled analog is not commerically available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation. (Internal Standard Quantitation) Analytes must be within 70-130% of their true value for each calibration standard. ICAL must meet one of the two options below: Option 1: The RSD of the RFs for all analytes must be ≤ 20%. Option 2: Linear or nonlinear calibrations must have $r^2 \geq 0.99$ for each analyte. Isotope Dilution is required for all analytes. External Calibration is not allowed for any analyte.	Correct problem then repeat ICAL. Flagging is not appropriate. No samples shall be analyzed until ICAL has passed.	Analyst	5-369-08
	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ±30% of their true value. No samples shall be analyzed until calibration has been verified.	Correct problem, rerun ICV. If problem persists, repeat ICAL. Flagging is not appropriate.		
	Continuing Calibration Verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analytical sequence.	Concentration of analytes must range from the LOQ to the mid-level calibration concentration. Analyte concentrations must be within ±30% of their true value. Instrument Sensitivity Check (ISC) can serve as a bracketing CCV.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Results may not be reported without valid CCVs.		
	Tune Check	When the masses fall outside of the ±0.5 amu of the true value (as determined by the product ion formulas).	Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument and verify. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate. No samples shall be analyzed without a valid tune.		
	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. Mass calibration is verified after each mass calibration, prior to initial calibration (ICAL).	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass calibration must be verified to be ±0.5 amu of the true value, by acquiring a full scan continuum mass spectrum of a PFAS stock standard. Problem must be corrected. No samples may be analyzed under a failing mass calibration. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses fall outside of the ±0.5 amu of the true value, major instrument maintenance is performed, or the instrument is moved).	If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. Flagging is not appropriate.		
	Mass Spectural Acquisition Rate	Each analyte, Extracted Internal Standard Analyte, and Injection Internal Standard Analyte.	A minimum of 10 spectra scans are aquired across each chromatographic peak.	Flagging is not appropriate.		

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

Instrument[3]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
	Calibration, Calibration Verification, and Spiking Standards	All Analytes.	Standards containing both branched and linear isomers must be used when commercially available. PFAS method analytes may consist of both branched and linear isomers, but quantitative standards that contain the linear and branched isomers do not exist for all method analytes. For PFAS that do not have a quantitative branched and linear standard, identify the branched isomers by analyzing a qualitative standard that includes both linear and branched isomers and determine retention times, transitions and transition ion ratios. Quantitate samples by integrating the total response (i.e., accounting for peaks that are identified as linear and branched isomers) and relying on the initial calibration that uses the linear isomer quantitative standard. Standards containing both branched and linear isomers are to be used during method validation to ensure the total response is quantitated for that analyte. Technical grade standards cannot be used for quantitative analysis.	Flagging is not appropriate.		
	Ion Transitions (Parent -> Product)	Prior to method implementation.	In order to avoid biasing results high due to known interferences for some transitions, the following transitions must be used for the quantification of the following analytes: PFOA: 413 → 369 PFOS: 499 → 80 PFHxS: 399 → 80 PFBS: 299 → 80 4:2 FTS: 327 → 307 6:2 FTS: 427 → 407 8:2 FTS: 527 → 507 NEtFOSAA: 584 → 419 NMeFOSAA: 570 → 419 If these transitions are not used, the reason must be technically justified and documented (e.g., alternate transition was used due to observed interferences).	Flagging is not appropriate.		
	Retention Time (RT) window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used. Calculated for each analyte and EIS.	NA.		
	Retention Time (RT) window width	Every field sample, standard, blank, and QC sample.	RT of each analyte and EIS analyte must fall within 0.4 minutes of the predicted retention times from the daily calibration verification or, on days when ICAL is performed, from the midpoint standard of the ICAL. Analytes must elute within 0.1 minutes of the associated EIS. This criterion applies only to analyte and labeled analog pairs. Calculated for each analyte and EIS.	Correct problem and reanalyze samples.		
	Instrument Sensitivity Check (ISC)	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values. No samples shall be analyzed until ISC has met acceptance criteria. ISC can serve as the initial daily CCV.	Correct problem, rerun ISC. If problem persists, repeat ICAL. Flagging is not appropriate.		

Notes:
1 Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).
2 Name or title of responsible person may be used.
3 DoD QSM v5.3 is the basis for specifications on this table.

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

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[2]	SOP Reference[1]
LC-MS/MS	Clean Curtain Plate	PFAS	Visual inspection of curtain plate for residue.	As needed when curtain plate has visible residue present	No visible residue on curtain plate	Remove and clean the instrument curtain plate	Analyst	5-369-08
	Preventative Maintenance	PFAS	Degradation of instrument performance	Every six months or when instrument performance deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards (IS) recovery within acceptance criteria on **Worksheet #28**	Service provider performs Preventative Maintenance and mass calibration. Run tune check. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		
	Replace analytical column	PFAS	Review peak shape, retention times, and peak separation on ICAL, ICC, and CCV samples.	Performed when chromatography deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards (IS) recovery within acceptance criteria on **Worksheet #28**	Replace analytical column. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		
Balance	Verification	Weight	--	Daily	+/- 0.02 gram or +/- 0.1% of calibration weight used (whichever is greater)	Refer to manufacturer's instruction manual		
	Calibration		--	Annually	Per manufacturer	Remove from service, repair, replace		
Pipette	Verification	Volume	--	Daily	+/- 2% difference from true value, < 1% relative standard deviation (n=3)	Remove from service, repair, replace		
	Calibration		--	Quarterly	Per manufacturer	Remove from service, repair, replace		

Notes:

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

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

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SAP Worksheet #26—Sample Handling System

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

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SAP Worksheet #27—Sample Custody Requirements Table

Sample Labeling

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

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

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled, as outlined above. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples below 10°C until they are received by the laboratory. The Chain-of-Custody (COC) will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the airbill number indicated on the COC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples.

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

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

Sample Identification Procedures

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

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

Chain-of-Custody Procedures

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

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Groundwater
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Aqueous Sample Preparation	Each sample and associated batch QC samples.	Solid Phase Extraction (SPE) must be used unless samples are known to contain high PFAS concentrations (e.g., AFFF formulations). Inline SPE is acceptable. Entire sample plus bottle rinsate must be extracted using SPE. Known high PFAS concentration samples require serial dilution be performed in duplicate. Documented project approval is needed for samples prepared by serial dilution as opposed to SPE. Samples with > 1% solids may require centrifugation prior to SPE extraction. Pre-screening of separate aliquots of aqueous samples is recommended.	--		--	
Sample Cleanup Procedure	Each sample and associated batch QC samples. Not applicable to AFFF formulation samples.	ENVI-CarbTM or equivalent must be used on each sample and batch QC sample. Cleanup should reduce bias from matrix interferences.	Flagging is not appropriate.		--	
Sample PFAS Identification	All analytes detected in a sample.	The chemical derivation of the ion transitions must be documented. A minimum of two ion transitions (Precursor → quant ion and precursor → confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist (PFBA and PFPeA). Documentation of the primary and confirmation transitions and the ion ratio is required. In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 50-150%. Signal to Noise Ratio (S/N) must be ≥ 10 for all ions used for quantification and must be ≥ 3 for all ions used for confirmation. Quant ion and confirmation ion must be present and must maximize simultaneously (±2 seconds). For example: Ion Ratio = (quant ion abundance/confirm ion abundance) Calculate the average ratio (A) and standard deviation (SD) using the ICAL standards. An acceptance range of ratio could be within A ±3SD for confirmation of detection.	PFAS identified with Ion ratios that fail acceptance criteria must be flagged. Any quantitation ion peak that does not meet the maximization criteria shall be included in the summed integration and the resulting data flagged as “estimated, biased high”.	Analyst	Accuracy/Bias	Same as Method / SOP QC Acceptance Limits
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ 1/2 the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed. No samples shall be analyzed until instrument blank has met acceptance criteria. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. When the highest standard analyzed is not part of the calibration curve, it cannot be used to extend out the calibration range, it is used only to document a higher concentration at which carryover still does not occur. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left.		Precision/Accuracy/Bias	

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

Matrix: Groundwater
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Extracted Internal Standard (EIS) Analytes	Every field sample, standard, blank, and QC sample.	Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	Correct problem. If required, re-extract and reanalyze associated field and QC samples. If recoveries are acceptable for QC samples, but not field samples, the field samples must be re-extracted and analyzed (greater dilution may be needed). Samples may be extracted and analyzed outside of hold times, as necessary for corrective action associated with QC failure. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative. EIS should be 96% (or greater) purity. When the impurity consists of the unlabeled analyte, the EIS can result in a background artifact in every sample, standard and blank, if the EIS is fortified at excessive concentrations.		Precision/Accuracy/Bias	
Method Blank (MB)	One per preparatory batch.	No analytes detected >1/2 LOQ or >1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Bias/Contamination	
Laboratory Control Sample (LCS)	One per preparatory batch.	Blank spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Precision/Accuracy/Bias	Same as Method / SOP QC Acceptance Limits
Matrix Spike (MS)	1 per batch maximum of 20 samples	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).		Accuracy	

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

Matrix: Groundwater
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

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

Notes:
[1] DoD QSM v5.3 is the basis for specifications on this table.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: PFAS

Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Aqueous Sample Preparation	Each sample and associated batch QC samples.	Solid Phase Extraction (SPE) must be used unless samples are known to contain high PFAS concentrations (e.g., AFFF formulations). Inline SPE is acceptable. Entire sample plus bottle rinsate must be extracted using SPE. Known high PFAS concentration samples require serial dilution be performed in duplicate. Documented project approval is needed for samples prepared by serial dilution as opposed to SPE. Samples with > 1% solids may require centrifugation prior to SPE extraction. Pre-screening of separate aliquots of aqueous samples is recommended.	--		--	
Sample Cleanup Procedure	Each sample and associated batch QC samples. Not applicable to AFFF formulation samples.	ENVI-CarbTM or equivalent must be used on each sample and batch QC sample. Cleanup should reduce bias from matrix interferences.	Flagging is not appropriate.		--	
Sample PFAS Identification	All analytes detected in a sample.	The chemical derivation of the ion transitions must be documented. A minimum of two ion transitions (Precursor → quant ion and precursor → confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist (PFBA and PFPeA). Documentation of the primary and confirmation transitions and the ion ratio is required. In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 50-150%. Signal to Noise Ratio (S/N) must be ≥ 10 for all ions used for quantification and must be ≥ 3 for all ions used for confirmation. Quant ion and confirmation ion must be present and must maximize simultaneously (±2 seconds). For example: Ion Ratio = (quant ion abundance/confirm ion abundance) Calculate the average ratio (A) and standard deviation (SD) using the ICAL standards. An acceptance range of ratio could be within A ±3SD for confirmation of detection.	PFAS identified with Ion ratios that fail acceptance criteria must be flagged. Any quantitation ion peak that does not meet the maximization criteria shall be included in the summed integration and the resulting data flagged as "estimated, biased high".	Analyst	Accuracy/Bias	Same as Method / SOP QC Acceptance Limits.
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ 1/2 the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed. No samples shall be analyzed until instrument blank has met acceptance criteria. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. When the highest standard analyzed is not part of the calibration curve, it cannot be used to extend out the calibration range, it is used only to document a higher concentration at which carryover still does not occur. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left.		Precision/Accuracy/Bias	

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

Matrix: Surface Soil, Subsurface Soil
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

QC Sample[1]	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Extracted Internal Standard (EIS) Analytes	Every field sample, standard, blank, and QC sample.	Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	Correct problem. If required, re-extract and reanalyze associated field and QC samples. If recoveries are acceptable for QC samples, but not field samples, the field samples must be re-extracted and analyzed (greater dilution may be needed). Samples may be extracted and analyzed outside of hold times, as necessary for corrective action associated with QC failure. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative. EIS should be 96% (or greater) purity. When the impurity consists of the unlabeled analyte, the EIS can result in a background artifact in every sample, standard and blank, if the EIS is fortified at excessive concentrations.		Precision/Accuracy/Bias	
Method Blank (MB)	One per preparatory batch.	No analytes detected >1/2 LOQ or >1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Bias/Contamination	
Laboratory Control Sample (LCS)	One per preparatory batch.	Blank spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Precision/Accuracy/Bias	Same as Method / SOP QC Acceptance Limits
Matrix Spike (MS)	1 per batch maximum of 20 samples	Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).		Accuracy	

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

Matrix: Surface Soil, Subsurface Soil
Analytical Group: PFAS
Analytical Method/ SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15 / SOP 5-369-08

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

Notes:
[1] DoD QSM v5.3 is the basis for specifications on this table.

SAP Worksheet #29—Project Documents and Records Table

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

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

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

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

CH2M HILL Project Office:

John Ledbetter/CH2M
2411 Dulles Corner Park, Suite #500
Herndon, VA 20171
(703) 376-5172

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

Iron Mountain Headquarters

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

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

Washington National Records Center

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

SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person, and telephone number)	Backup Laboratory / Organization (name and address, contact person, and telephone number)
GW, SS, SB	PFAS	Refer to **Worksheet #18**	PFAS by LC-MS/MS Compliant with QSM v5.3 Table B-15	28 Calendar-day TAT	Battelle 141 Longwater Drive, Suite 202 Norwell, MA 02061 Jonathan Thorn (781) 681-5565	Vista Analytical Laboratory Attn: Sample Receiving 1104 Windfield Way El Dorado Hills, California 95762 Martha Maier (916) 673-1520

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Field Performance Audit	In accordance with CLEAN program requirements	Int.	CH2M	TBD FTL CH2M	John Ledbetter Activity Manager/Project Manager CH2M	Mark Hoover Task Manager CH2M	John Tomik Activity Quality Manager CH2M
Offsite Laboratory Technical Systems Audit	Laboratories must have current DoD ELAP accreditation which will identify the period of performance.	Ext.	Perry Johnson Laboratory Accreditation, INC. (PJLA)	Tracy Szerszen President/Operations Manager PJLA	Zachary Willenberg Laboratory Quality Systems Manager Battelle	Zachary Willenberg Laboratory Quality Systems Manager Battelle	Tracy Szerszen President/Operations Manager PJLA

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

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

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SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating CA: ______________________________ Date: ______________

Description of problem and when identified:

____
____
____
____
____

Cause of problem, if known or suspected:

____
____
____
____
____

Sequence of CA: (including date implemented, action planned and personnel/data affected)

____
____
____
____
____

CA implemented by: ______________________ Date: ______________

CA initially approved by: ______________________ Date: ______________

Follow-up date: ______________________

Final CA approved by: ______________________ Date: ______________

Information copies to:

____
____
____
____

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SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: ____________________ Date: ____________________

Project Location: ____________________ Signature: ____________________

Team Members

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

Comments ____________________

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

Comments ____________________

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

Comments ____________________

Sample Collection

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

Comments ____________________

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

Comments ____________________

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

Comments ____________________

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

Comments ____________________

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

Comments ____________________

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

Yes No 6) Are QA checks performed as specified in the work plan??

Comments ______________________________

____

Yes No 7) Are photographs taken and documented?

Comments ______________________________

____

Document Control

Yes No 1) Have any accountable documents been lost?

Comments ______________________________

____

Yes No 2) Have any accountable documents been voided?

Comments ______________________________

____

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

Comments ______________________________

____

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

Comments ______________________________

____

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

Comments ______________________________

____

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

Comments ______________________________

____

Yes No 7) Is chain of custody documented and maintained?

Comments ______________________________

____

SAP Worksheet #33—QA Management Reports Table

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

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

Verification Input[1]	Description	Step I / IIa / IIb	Internal / External[2]	Responsible for Verification (name, organization)
Field Notes	Field notes will be reviewed internally and placed into the project file for archival at project closeout.	Step I	Internal	FTL (TBD)/CH2M
COCs and Shipping Forms	COC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC will be initialed by the reviewer, a copy of the COC retained in the site file, and the original and remaining copies taped inside the cooler for shipment.		Internal / External	FTL (TBD)/CH2M Project Chemist: Juan Acaron/CH2M
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the Project Chemist in the form of laboratory logins.		External	Project Chemist: Juan Acaron/CH2M
Documentation of Laboratory Method Deviations	Laboratory method deviations not included in the laboratory SOP and therefore not included in the DoD ELAP Accreditation letter, will be discussed and approved by the Navy Chemist. Documentation will be incorporated into the case narrative that becomes part of the final hardcopy data package.		Internal / External	Project Chemist: Juan Acaron/CH2M
Electronic Data Deliverables	Electronic data deliverables will be compared against hardcopy laboratory results (10% check). Should discrepancies be identified, a 25% check will be completed.		External	Project Chemist: Juan Acaron/CH2M
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and are applicable to the data packages.		External	Data Validator: TBD
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.		Internal	Laboratory QA Officer (Battelle)
Laboratory Data	The data will be verified for completeness by the Project Chemist. In order to ensure completeness, EDDs will be compared to the SAP. This is a verification that all samples were included in the laboratory data and that correct analyte lists were reported.		External	Project Chemist: Juan Acaron/CH2M
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.		Internal	AM/PM: John Ledbetter/CH2M Project Chemist: Juan Acaron/CH2M
CA Reports	CA reports will be reviewed by the Project Chemist or PM and placed into the project file for archival at project closeout.		External	AM/PM: John Ledbetter/CH2M Project Chemist: Juan Acaron/CH2M
Laboratory Methods	During the pre-validation check, ensure the laboratory analyzed samples using the correct methods specified in the SAP. If methods other than those specified in the SAP were used, the reason will be determined and documented.	Step IIa	External	Project Chemist: Juan Acaron/CH2M
Target Compound List and Target Analyte List	Ensure the laboratory reported all analytes from each analysis group as described in **Worksheet #15**. If the target compound list is not correct, then it must be corrected prior to sending the data for validation. Once the checks are complete, the project manager is notified via email.		External	Project Chemist: Juan Acaron/CH2M
Reporting Limits (RLs)	Ensure the laboratory met the project-designated reporting limits as described in **Worksheet #15**. If reporting limits were not met, the reason will be identified and documented.		External	Project Chemist: Juan Acaron/CH2M
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.		External	Data Validator: TBD
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Step IIb	External	Data Validator: TBD
Raw Data	10 percent Stage 4 review of raw data to confirm laboratory calculations and manual integrations. For a recalculated result, the DV attempts to re-create the reported numerical value. The laboratory is asked for clarification if a discrepancy is identified which cannot reasonably be attributed to rounding. In general, this is outside 5% difference. The remaining 90% of data will receive Stage 2B review.		External	Data Validator: TBD

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

Verification Input[1]	Description	Step I / IIa / IIb	Internal / External[2]	Responsible for Verification (name, organization)
Onsite Screening	All non-analytical field data will be reviewed against QAPP requirements for completeness and accuracy based on the field calibration records.	Step IIb	Internal	FTL (TBD)/CH2M
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.		External	Data Validator: TBD
Documentation of field QC Sample Results	Establish that all required QAPP QC samples were run and met limits.		Internal	Project Chemist: Juan Acaron/CH2M Data Validator: TBD
PFAS[3]	Analytical methods and laboratory SOPs will be evaluated against QA/QC criteria to ensure compliance, as presented in this SAP. QA/QC criteria for field QC samples are presented in **Worksheet #12**. LOQs, LODs, and DLs are presented in **Worksheet #15**. QA/QC criteria for calibrations are presented in Laboratory SOPs (referenced in **Worksheet #23**). Analytical instrument calibration criteria are presented in **Worksheet #24**. QA/QC criteria for laboratory QC samples are presented in **Worksheet #28**. Data may be qualified if QA/QC exceedances have occurred. Guidance and qualifiers from United States Department of Defense "General Data Validation Guidelines" (DoD, 2018) will be applied as appropriate. As specific modules for the analytical methods in this project are published, the data validators will refer to those modules for guidance. In the meantime, if specific guidance is not given for these methods in the General Data Validation Guidelines, the data validator may adapt the guidance from "USEPA National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.4)" (540-R-2017-002; USEPA, 2017) and the "EPA Technical BRIEF for Per- and Polyfluoroalkyl Substances (PFAS): Reviewing Analytical Methods Data for Environmental Samples" (USEPA, 2019b). Although there are no samples being analyzed by EPA Method 537.1, the data validator may reference "EPA Data Review and Validation Guidelines for Perfluoroalkyl Substances (PFASs) Analyzed Using EPA Method 537 (USEPA, 2018) as needed.	Step IIb	External	Data Validator: TBD

Notes:

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

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

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

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

SAP Worksheet #37—Usability Assessment

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

- Non-detected site contaminants will be evaluated to ensure that PQLs in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, J+, J-, or UJ. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an X qualifier as recommended for rejection. The project team will review the PQOs and data validation narrative will decide to replace the X qualifier with the R qualifier (in most cases the data would not be considered usable for project decisions) or other appropriate qualifier. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the investigation report.
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - J+ = Analyte present. Reported value is estimated and may be biased high.
  - J- = Analyte present. Reported value is estimated and may be biased low.
  - UJ = Analyte not detected. Associated non-detect value may be inaccurate or imprecise.
  - X = Result recommended for rejection by the data validator. Result not reliable.
  - R = Rejected result, team decision. Result not reliable.
- If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to the sample detection limit and evaluations will be performed using the USEPA's ProUCL software. For duplicate sample results, the most conservative value will be used for project decisions.
- Additional qualifiers that may be given by the data validation are:
  - N = Tentative ID. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
  - NJ = Qualitative ID questionable due to poor resolution. Presumptively present at approximate quantity.
  - U = Not Detected.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. The checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- Describe the evaluative procedures used to assess overall measurement error associated with the project.
- To assess whether a sufficient quantity of acceptable data is available for decision making, the data will be compared to the 95 percent completeness goal and reconciled with MPC following validation and review of DQIs.

SAP Worksheet #37—Usability Assessment (continued)

- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between laboratory and field precision, the cause will be further evaluated to assess impact on decision making.

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

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

- Data tables will be produced to reflect detected and non-detected site analytes. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation, which will be provided in a technical memorandum as part of the SI report.

Identify the personnel responsible for performing the usability assessment.

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

References

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Klohe, C.A. and C.E. Feehley. 2001. "Hydrogeology and Ground-Water Quality of the Piney-Point Nanjemoy and Aquia Aquifers, Naval Air Station Patuxent River and Webster Outlying Field, St. Mary's County, Maryland." U.S. Geological Survey Water Resources Investigation Report 01-4029.

St. Mary's County, Maryland. 2018. *GIS (http://www.co.saint-marys.md.us/GIS/)*. October.

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U.S. Environmental Protection Agency (USEPA). 2005. *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs - Part 1: UFP-QAPP Manual.* Intergovernmental Data Quality Task Force. EPA-505-B-04-900A. Final Version 1. March.

U.S. Environmental Protection Agency (USEPA). 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4.* EPA/240/B-06/001. February.

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U.S. Environmental Protection Agency (USEPA). 2019b. *Technical BRIEF for Per- and Polyfluoroalkyl Substances (PFAS): Reviewing Analytical Methods Data for Environmental Samples*. April.

U.S. Geological Survey (USGS). 2007. "Hydrogeology of the Piney Point-Nanjemoy, Aquia, and Upper Patapsco Aquifers, Naval Air Station Patuxent River and Webster Outlying Field, St. Mary's County, Maryland, 2000-06." Scientific Investigation Report 2006-5266.

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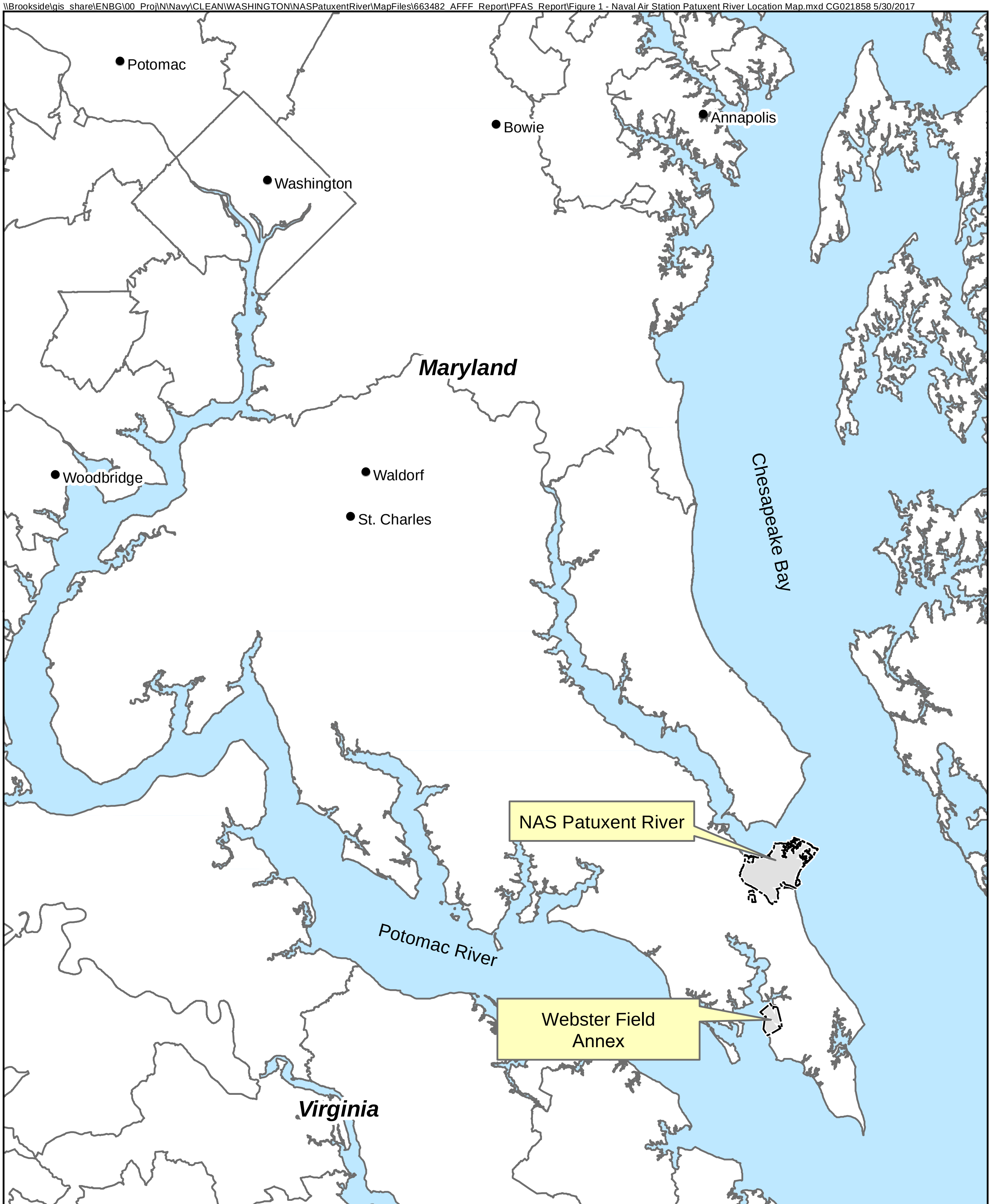
Figures

\\Brookside\gis_share\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\663482_AFFF_Report\PFAS_Report\Figure 1 - Naval Air Station Patuxent River Location Map.mxd CG021858 5/30/2017



Legend
- Cities
- Installation Boundary

N

0 22,500 45,000 Feet

Figure 1
Location Map
Sampling and Analysis Plan for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\703334_WebsterField_SAP\Figure 2 - Potential Source Area for PFAS Supply Wells.mxd beresl 7/10/2019

Legend

- Supply Well
- Estimated Shallow Groundwater Flow Direction
- Fire Station 3, Building 8076
- AFFF Crash Truck Maintenance Check Area
- Nearest Residential Homes with Private Wells
- Installation Boundary
- Storm Sewer Discharge Point
- Catch Basin
- Storm Sewer Manhole
- Storm Sewer Valve Point
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch

N

0 500 1,000
Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 2
Potential Source Area for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m:

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\703334_UFPSAP\Figure 3 - Fire Station Building 8076.mxd7/30/2019AM038876

Legend

- Temporary Piezometer Location (Proposed Groundwater Sample)
- Proposed Surface/Subsurface Soil Sample Location
- Storm Sewer Discharge Point
- Catch Basin
- Estimated Shallow Groundwater Flow Direction
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch
- Surface Water
- Building
- Installation Boundary

N

0 50 100 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 3
Fire Station 3, Building 8076
Sampling and Analysis Plan for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m:

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\703334_UFPSAP\Figure 4 - AFFF Crash Truck Maintenance Check Area.mxd7/30/2019AM038876

Legend

- Temporary Piezometer Location (Proposed Groundwater Sample)
- Proposed Surface/Subsurface Soil Sample Location
- Storm Sewer Discharge Point
- Catch Basin
- Estimated Shallow Groundwater Flow Direction
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch
- Building
- AFFF Crash Truck Maintenance Check Area
- Surface Water
- Taxiway
- Runway
- Installation Boundary

N

0 100 200 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 4
AFFF Crash Truck Maintenance Check Area
Sampling and Analysis Plan for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

Appendix A
Preliminary Assessment for PFAS at Webster Field Annex

Washington

Final

Preliminary Assessment for Per- and Polyfluoroalkyl Substances

Naval Air Station Patuxent River - Webster Outlying Landing Field
St. Inigoes, Maryland

April 2019

Washington

Final

Preliminary Assessment for Per- and Polyfluoroalkyl Substances

Naval Air Station Patuxent River - Webster Outlying Landing Field
St. Inigoes, Maryland

April 2019

Prepared for NAVFAC Washington
by CH2M HILL, Inc.
Herndon, Virginia
Contract N62470-16-D-9000
CTO JU18

Contents

Appendices

Table

Figures

Acronyms and Abbreviations

AFFF	aqueous film-forming foam
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL, Inc.
CLEAN	Navy Comprehensive Long-term Environmental Action—Navy
DASN	Deputy Assistant Secretary of the Navy
DoD	Department of Defense
EDR	Environmental Data Research, Inc.
ER	Environmental Restoration
MIL-SPEC	military specification
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NAVSUP	Naval Supply Systems Command
Navy	Department of the Navy
PA	Preliminary Assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
ppt	part per trillion
PWS	public water system
RfD	reference dose
UCMR 3	Third Unregulated Contaminant Monitoring Rule
USEPA	United States Environmental Protection Agency
Webster Field	Naval Air Station Patuxent River Webster Field Annex
WWTP	wastewater treatment plant

Introduction

This Preliminary Assessment (PA) report of potential sources of per- and polyfluoroalkyl substances (PFAS) at Naval Air Station (NAS) Patuxent River Webster Outlying Landing Field (Webster Field) has been prepared under the Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), Comprehensive Long-term Environmental Action—Navy (CLEAN) 9000 Contract N62470-16-D-9000, Contract Task Order JU18.

1.1 Preliminary Assessment Objectives

This installation-specific PFAS PA is part of a Navy-wide installations assessment of potential historical sources of PFAS use. This PA was conducted in accordance with the United States Environmental Protection Agency's (USEPA's) *Guidance for Performing Preliminary Assessments under CERCLA* (PA Guidance) (USEPA, 1991), with additional guidance from the Navy's *Interim Per-and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/September 2017 Update* (Navy PFAS Guidance) (Navy, 2017). The objectives of this PFAS PA of Webster Field are to:

- Identify and catalog all known and potential PFAS sources.
- Eliminate from further consideration those areas where there is no evidence of a PFAS release or suspected release and document the rationale for their elimination.
- Identify areas requiring further PFAS investigation.
- Identify receptors and migration pathways (both on and off the facility).
- Determine whether an emergency response action is warranted because of current complete exposure pathways (for example, on- Base or off-Base drinking water source within 1-mile downgradient of potential source area).
- If it is the team's preference, prioritize areas identified for further PFAS inspection.

To accomplish these objectives, the following activities were completed:

- A review of existing information to identify potential PFAS releases.
- A review of existing information to identify potential off-Base receptors within 1-mile of the facility boundary. Note: This is less extensive than the study area defined in USEPA's PA Guidance (USEPA, 1991), but will be expanded if necessary in later project phases if complete pathways beyond 1 mile are identified.
- Interviews conducted with appropriate site personnel to validate and verify data collected during the data review, and to provide supplemental information.
- A site reconnaissance of the facility to identify any evidence of PFAS releases and potential receptors and migration pathways, ensure that all areas of concern have been identified, and fill data gaps identified in the data review and interviews.
- Identify any need for initiation of a rapid response drinking water investigation in accordance with the Deputy Assistant Secretary of the Navy (DASN) (E) Policy Memorandum, 20 JUN 2016, and immediately notify Navy if investigation is needed.
- Report findings in the Preliminary Assessment Report and make recommendation for future activities (for example, a Site Inspection [SI] or no further action [NFA]).

1.2 PFAS Background

PFAS have been identified by the Department of Defense (DoD) and USEPA as "emerging contaminants" (USEPA, 2014).[1] PFAS are of environmental concern because of their persistence in the environment and in organisms, their migration potential in aqueous systems (e.g., groundwater), their historically widespread use in commercial products, and their possible health effects at low levels of exposure. PFAS are anthropogenic compounds with multiple strong carbon-fluorine bonds.

1.2.1 General Uses of PFAS

The chemical properties of PFAS make them useful for many commercial products because they are heat-resistant and can repel oil, grease, and water. PFAS have been manufactured for use in a wide variety of products including fire-fighting foam, non-stick cookware, fiber and fabric stain protection, food packaging, and personal care products. The pervasive use of PFAS in commercial and industrial products has led to the discovery of PFAS in soil, air, and groundwater.

1.2.2 Key PFAS Sources at Naval Installations

PFAS have been used in a variety of military applications, including as a component of aqueous film-forming foam (AFFF), a fire-fighting foam that was routinely used at fire-fighting training areas, equipment check areas, and fire suppression systems. In addition, current and historical AFFF storage and transfer areas are of potential concern for release to the environment. As such, identification of areas where AFFF was released to the environment, either as repeated small releases or as a significant one-time release, is key to determining potential PFAS sources to environmental media.

PFAS from AFFF used in firefighting, firefighting training, and fire suppression systems are considered to have the greatest potential for release of PFAS to the environment in terms of mass and concentration at Navy installations. Other potential sources of PFAS to the environment include operations wastes (for example, from electroplating), historical onsite disposal areas and landfills of PFAS-containing materials, wastewater treatment sludges and effluents, and releases of other PFAS-containing materials. Areas of interest for this PFAS PA include those where AFFF may have been applied, released, or stored. These include current and former fire-training areas, equipment check and cleanout areas, buildings with fire-fighting infrastructure (such as hangars, AFFF storage, handling areas, and pump houses), unplanned release areas (such as crash sites), and fire suppression systems located at fuel storage areas.

AFFF in Fire-fighting Training and Fire Suppression

AFFF-containing PFAS was developed in the 1960s for use on Class B fires (fires in flammable liquids or vapors) and was put into routine use by the early 1970s. In November 1969, a military specification (MIL-SPEC) was issued that described characteristics which AFFF needed to demonstrate to be used by the military, including a requirement for formulations containing PFAS. Most AFFF used at military installations after the 1970s likely included some combination of PFAS.

Typically, AFFF concentrate was mixed proportionally into water using in-line eductors or other proportioning devices to create the necessary foam solution, ranging from 3 to 6 percent of the concentrate. Class A fire-fighting foams were used to extinguish wood and grass fires and do not contain PFAS; therefore, Class A fire-fighting foams are not a concern for this PA.

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1 USEPA (2014) defines an "emerging contaminant" as "a chemical or material characterized by a perceived, potential, or real threat of human health or the environment or by a lack of published health standard."

Electroplating

Electroplating, specifically hard chromium plating, is an industrial activity where PFAS-containing mist suppressants may have been used. Electroplating consists of creating an electrolytic cell that enables a thin layer of metal to be deposited onto an electrically conductive metal surface. PFAS were sometimes used during the chromium electroplating process as a surfactant in chromic acid baths. As a surfactant, PFAS lowered the surface tension (adhesion of materials) by creating a thin, foamy layer on the surface of the chrome bath for mist-suppression. This mist-suppressant reduced the formation of airborne chromium aerosols during the plating process, which are known to be carcinogenic and allergenic. Areas where non-chromium electroplating operations were carried out would not be expected to have used PFAS-containing mist suppressants.

Landfill Operations, Waste Disposal Areas, and Wastewater Treatment Plants

Historically, landfills received wastes generated from military installations, including waste streams from operational areas (such as machine shops and electroplating operations), housing areas, and waste from wastewater treatment plants (WWTPs) and/or homeported ships. These waste streams may contain industrial and/or consumer products that were either manufactured with PFAS or contain PFAS constituents which may leach out of the landfill. Additionally, waste material biosolids and sludge from WWTPs can contain PFAS.

Other Potential Sources

Because of the widespread use of PFAS, there may be activities other than the ones mentioned previously, where PFAS were used. For example, PFAS have been included in some anti-fouling and stain-resistant paint formulations. In significant amounts, these could be sources of PFAS to the environment.

1.2.3 PFAS in the Environment

PFAS are a class of anthropogenic compounds characterized by carbon chains of varying lengths containing carbon-fluorine bonds. The strong electronegative force of the carbon-fluorine bond requires a large amount of energy to break, which makes PFAS extremely resistant to biodegradation, photo-oxidation, direct photolysis, and hydrolysis. In addition to their environmental persistence, PFAS are readily soluble in aqueous solution and therefore have potential for migration to groundwater from soil and with groundwater flow to offsite locations. Due to their persistence and mobility, releases of PFAS to the environment present a unique set of challenges and concerns.

1.2.4 Health Effects

Additional research is needed to more clearly understand the potential health effects that may be caused by exposure to PFAS compounds. To date there is limited information on only a few PFAS, specifically, perfluorobutane sulfonate (PFBS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS). To date, there are no Tier 1 toxicity values for any PFAS. Tier 1 toxicity values are the preferred source for toxicity factors in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) assessments.

USEPA’s Superfund Health Risk Technical Support Center has estimated a Tier 2 noncarcinogenic toxicity value for PFBS. The reference dose (RfD) is based on kidney effects observed in female rats. Due to a lack of information in the current literature, toxicity values for inhalation exposure and cancer endpoints could not be estimated for PFBS.

USEPA Office of Water developed an RfD for PFOA which is based on a developmental toxicity study using mice. The critical effects included reduced ossification in parts of the hand/feet and accelerated puberty in male pups following exposure during gestation and lactation (USEPA, 2016). The USEPA Office of Water also determined that PFOA should be classified as “suggestive evidence of carcinogenic potential” and estimated an oral cancer slope factor based on tumor development in rat testes.

USEPA Office of Water estimated an RfD for PFOS based on a developmental toxicity study in rats; the critical effect was decreased pup body weight following exposure during gestation and lactation (USEPA, 2016).

PFOA and PFOS are known to be transmitted to the fetus in cord blood and to the newborn in breast milk. Because the developing fetus and newborn seem particularly sensitive to PFOA- and PFOS-induced toxicity, the RfDs based on developmental effects also are protective of adverse effects in adults.

1.3 Regulatory Background and History

1.3.1 PFOA Stewardship Program

In 2006, USEPA initiated the 2010/2015 PFOA Stewardship Program in which eight major companies in the United States committed to reduce facility emissions and product contents of PFOA and related chemicals on a global basis by 95 percent no later than 2010, and to work toward eliminating emissions and product content of these chemicals by 2015. All companies have met the program goals. To meet the program goals, most companies stopped the manufacture and import of long-chained PFAS, and then transitioned to alternative chemicals. On January 21, 2015, USEPA proposed a Significant New Use Rule under the Toxics Substances Control Act to require manufacturers (including importers) of PFOA- and PFOA-related chemicals to notify USEPA at least 90 days before starting or resuming new uses of these chemicals in any process.

1.3.2 Third Unregulated Contaminant Monitoring Rule and Health Advisories

The USEPA issued the Third Unregulated Contaminant Monitoring Rule (UCMR 3)[2] in May 2012. UCMR 3 required monitoring, between 2013 and 2015, for 30 substances of all large public water systems (PWSs) serving more than 10,000 people and 800 representative PWSs serving 10,000 or fewer people. Six PFAS compounds were included in the UCMR 3 contaminant list. Of these six PFAS, USEPA issued provisional health advisory levels for only two, PFOA and PFOS. USEPA also published toxicity values for one other, PFBS. In May 2016 the USEPA Office of Water issued a drinking water Lifetime Health Advisory for PFOA and PFOS. The Lifetime Health Advisories are not enforceable, regulatory levels. The Lifetime Health Advisory was set at a level that would provide Americans, including the most sensitive populations, with a margin of protection from a life-time of exposure to PFOA and PFOS from drinking water. The Lifetime Health Advisory is 70 parts per trillion (ppt) for PFOA and 70 ppt for PFOS. When both PFOA and PFOS are found in drinking water, the combined concentrations of PFOA and PFOS should be compared with the 70 ppt health advisory level.

The supply water system at Webster Field does not serve more than 10,000 people; therefore, it was not part of the UCMR 3 required monitoring

1.3.3 State Specific Action Levels

Maryland does not have state specific action levels for PFAS.

1.4 Navy Policy

1.4.1 DASN (EI&E) Policy Memo, 21 Oct 2014

Because of Navy releases impacting PWS tested under the UCMR 3, the Navy issued a policy in October 2014, requiring on-Base drinking water sampling for PFOA and PFOS for bases where groundwater was used as drinking water and PFAS could have been released nearby in the past. Under the policy, all installations not previously tested under UCMR 3 that produce drinking water from on-installation sources and have an identified or

[2] The 1996 Safe Drinking Water Act amendments require that once every 5 years USEPA issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs).

suspected PFAS release within approximately 1-mile upgradient of the drinking water source were required to sample their finished drinking water by December 2015.

1.4.2 DASN (E) Policy Memo, 14 Jun 2016

This policy expanded the sampling PFOA and PFOS at all Navy installations where such sampling was not previously completed under the USEPA's UCMR 3 or the Navy's October 2014 policy.

There are three community supply water supply wells located within the Webster Field boundary, two being active, and both active wells were sampled for PFAS in 2016. Additional details concerning these wells and sampling results are presented in **Section 2.3.**

1.4.3 DASN (E) Policy Memo, 20 Jun 2016

Identification of off-Base impacted drinking water during the implementation of the October 2014 policy led the Navy to issue another policy in June 2016. This policy required the Navy to identify and prioritize sites for investigation if drinking water resources, on- or off-Base, are thought to be vulnerable to PFAS contamination from past Navy/Marine Corps PFAS releases. Sites with drinking water sources within 1 mile downgradient of known or potential releases of PFAS were assigned the highest priority. This policy directed the sampling of off-Base drinking water at these high priority (Priority 1) sites within fiscal year 2017.

The primary mechanism to identify potential PFAS release sites and areas of concern, was review of Environmental Restoration (ER), Navy records. Of the sites identified in the initial query, only the Fire Station 3 (Building 8076) and the AFFF Crash Truck Maintenance Check Area were identified as potential impacts to groundwater at Webster Field. Three other ER, Navy sites or buildings were identified, but were determined to require no PFAS investigation because the records reviewed determined no PFAS was used and no complete exposure pathway existed.

Webster Field was not assigned highest priority and therefore, sampling was not required at Webster Field. To date, the Navy has not conducted off-Base drinking water sampling.

1.4.4 DASN (E) Policy Memo, 17 Jun 2016

This policy defines the Navy's intention to remove, dispose, and replace legacy AFFF that contains PFOS and/or PFOA once environmentally suitable substitutes are identified and certified to meet MIL-SPEC requirements. This policy directs the following actions be taken until suitable replacements are certified:

- Immediately cease the uncontrolled environmental release of AFFF for shoreside installations, except for emergency responses. Where such non-emergency operations are deemed necessary, complete containment, capture, and proper disposal mechanisms and procedures must first be in place to the maximum extent practicable before conducting such actions to ensure no AFFF is released to the environment.
- Update and implement Navy and Marine Corps firefighting system requirements, as needed to ensure fire and emergency service vehicles and equipment at Navy installations and facilities are tested and certified in a manner that does not allow the release of AFFF to the environment.
- By the end of fiscal year 2020, remove and dispose of uninstalled PFOS-containing AFFF in drums and cans from local stored supplies for shore installations and ships to prevent future environmental releases.

Currently, the Navy is working with manufacturers to determine the exact chemical composition of AFFF alternatives and plans to publish amended MIL-SPEC in late 2018. The revision will lay the framework for segregating products by PFOS and PFOA content and will establish lower limits to enable acquiring AFFF formulations with the lowest possible levels of PFOS and PFOA (DoD, 2018).

Navy policy also directs the Naval Supply Systems Command (NAVSUP) to coordinate with the Defense Logistics Agency to facilitate replacing AFFF containing PFOS and to enact a method that ensures only AFFF that meets the amended MIL-SPEC is supplied to Navy and Marine Corps customers by September 2018. In addition, NAVSUP will inventory and dispose of all stored legacy AFFF not compliant with the amended MIL-SPEC (DoD, 2018).

1.5 Report Organization

This PFAS PA Report is organized as follows:

Section 1 – Introduction
Section 2 – Facility Description
Section 3 – Investigation Summary
Section 4 – Preliminary Assessment Findings
Section 5 – Conclusions and Recommendations
Section 6 – References

The following appendixes are included:

A List of Rare, Threatened, and Endangered Species of St. Mary's County
B Groundwater Sampling Results – October 2016
C Summary of Records Reviewed
D Aerial Photographs
E Interview Questionnaires

Facility Description

Base information relevant to this PFAS PA, including facility background, environmental setting, and other PFAS investigations, is presented in the following subsections.

2.1 Facility Background

Webster Field is an 850-acre Navy facility located in St. Inigoes, approximately 15 miles southwest of NAS Patuxent River in St. Mary's County, Maryland (**Figure 1**). Webster Field opened October 20, 1943 and was used as a dispersal field in the event of aerial attacks during World War II and as an alternate landing site when air traffic was heavy at NAS Patuxent River. The site was also used as a training site for dive-bombing, aerial gunnery, target practice, and glider control experiments. The facility originally had three intersecting runways. All three runways are 150 feet wide, two runways are 5,000 feet long, and the third is 4,300 feet long (Tetra Tech NUS, 2010). The 4,300-foot runway (Runway 36-18, running north-south) was permanently taken out of use in the 1950s (CH2M, 2012).

After the war, Webster Field became the site of Naval Air Reserve Training Unit for Naval Air Station Anacosta. Between the years of 1967 and 1993, NAS Patuxent River remained in control of the airspace and runways at Webster Field, but the property was run by and renamed the Naval Electronics System Test and Evaluation Facility (later the Naval In-Service Engineering – East). After Base Realignment and Closure (BRAC) in 1994, NAS Patuxent River took over all operations at Webster Field, except for a portion of land that was dedicated to the U.S. Coast Guard in 1976. The facility is now used principally for test activities such as the Unmanned Aerial Vehicle operations. NAS Patuxent River serves as the Navy's principal location for research, development, test evaluation, engineering, and fleet support activities for naval aircraft, engines, avionics, aircraft support systems and ship/shore/air operations. NAS Patuxent River hosts the Navy Test Pilot School, and Webster Field hosts the Unmanned Aerial Vehicle operations, all of which regularly use the installation's airspace complex. Webster Field is designated as a Naval Auxiliary Landing Strip and is used as an auxiliary field for daylight testing. The major tenant at Webster Field is the Ship and Shore Based Electronics Systems Competency which does not use the airfield.

2.2 Environmental Setting

2.2.1 Topography

St. Inigoes Creek borders Webster Field to the north and St. Mary's Rivers borders Webster Field to the west. The topography of Webster Field varies from gently rolling to flat. In general, the topography of the site tends to slope gently from the northeast to the southwest towards St. Mary's River, which empties into the Potomac River (**Figures 1** and **2**). The elevation at the east end of the northeast/southwest trending runway is 21 feet above mean sea level and the elevation at the west end of the runway near St. Mary's River is approximately 12 feet above mean sea level (Tetra Tech NUS, Inc., 2010).

2.2.2 Geology

Webster Field is in the Coastal Plain, about 50 miles southeast of the Piedmont. The sediments of the Coastal Plain are a thick sequence of unconsolidated sand, clay, and gravel that dip (less than 1 degree) to the east and southeast (Fred C. Hart Associates, 1984). The thickness of these sedimentary units varies from approximately 2,000 feet in the northwestern part of St. Mary's County to 3,000 feet in the southeastern area of the county. These sediments overlie crystalline rocks at Webster Field.

2.2.3 Hydrogeologic Setting

The regional hydrogeological system of the Coastal Plain near Webster Field consists of several aquifers within the geologic units. From shallowest to deepest, the aquifers of primary interest with respect to Webster Field are the surficial aquifer, the Piney Point-Nanjemoy aquifer, and the Aquia aquifer. The surficial (water table) aquifer consists of the Lowland deposits and is unconfined. The St. Mary's Formation, as one formation of the low-permeability Chesapeake Group, functions primarily as a confining unit underlying the surficial aquifer. This confining unit is approximately 210 to 250 feet thick. The Piney Point-Nanjemoy, Aquia, and Upper Patapsco aquifers are deeper, confined aquifers below the St. Mary's Formation (Fred C. Hart Associates, 1984).

Groundwater from the surficial aquifer discharges to surface water at Webster Field, including ponds, streams, and the St. Mary's River. The surficial aquifer is recharged by precipitation falling directly on Webster Field and infiltrating the water table.

2.2.4 Soils

The distribution of soils at Webster Field depends on the climate and vegetation, topography, geologic sediment ("parent material') from which the soil is derived, and the time over which the soil has evolved. In St. Mary's County, there are 12 soil groupings or associations (Fred C. Hart Associates, 1984). Based on soil maps of St. Mary's County, it appears that the following general soil association is found at Webster Field.

The Othello-Mattapex Association is a level to gently sloping topography, poorly drained, and moderately well-drained silty soils. Subsoil is also silty. The parent material is generally made of silty Aeolian sediments underlain by coarse fluvial or marine sediments (Fred C. Hart Associates, 1984).

2.2.5 Human Receptors

For the general population, human receptors include people that may use groundwater for drinking water on or off the Base, with ingestion of groundwater considered the primary exposure pathway to PFAS. Additionally, people on-Base, which includes construction workers and other people who work or live on-Base, could be exposed to PFAS in soil at any source area. Migration pathways from PFAS source areas to potential exposure points include:

- Direct release of PFAS to surface and/or subsurface soil
- Leaching of PFAS from surface and/or subsurface soil to groundwater
- Direct releases of PFAS to surface water pathways through stormwater conveyances leading to water bodies used for drinking water
- Transport via advection with groundwater flow to areas downgradient of PFAS source areas

The rates of migration of individual PFAS compounds to possible human health receptors, from source areas to exposure points, can vary based on their affinity for environmental media (that is, air, soil, surface water, groundwater). PFAS are water soluble and can be transported long distances in surface water and groundwater, depending on sorption to sediment and soil. Although most PFAS have a low volatility, they can be transported over long distances in the atmosphere with fugitive dust particles; however, compared to data on ingestion of groundwater, the exposure pathway from inhalation and ingestion of dust particulates is unclear.

There are three community supply wells within the boundary of Webster Field, two of which are active supply wells. The potential for these wells as drinking water receptors is discussed in more details in **Section 2.2.7**.

2.2.6 Ecological Receptors

Grassland and forest species (e.g., vegetation, birds, small animals, reptiles/amphibians) are expected to utilize the available habitat in the land portion of Webster Field. Aquatic flora and fauna are expected to be present in the water portion of the site (such as St. Mary's River). Avian species are expected to be present in the land and water portions of the site (Tetra Tech NUS, Inc., 2010).

A review of the Maryland Department of Natural Resources website provided a list of rare, threatened, or endangered species that have the potential to inhabit Webster Field (Maryland Department of Natural Resources, 2018). The complete list is provided in **Appendix A**.

2.2.7 Water Usage

There are three community supply wells at Webster Field. Well 2 is located at Building 8130 (Coast Guard Building) and Wells 4 and 5 are located at Building 8195 (**Figure 2**). Wells 2 and 4 are screened in the Aquia aquifer at 537 feet and 539 feet, respectively; however, Well 4 is not functioning and is expected to be replaced in 2019. Well 5 is screened in the deeper Upper Patapsco aquifer at 884 feet. These wells connect to the main water supply for the whole Base.

The closest residential community to Webster Field is the St. Inigoes Shores Community near the facility entrance off Villa Road. This community and adjacent properties to Webster Field are not by supplied by county water and are on private water wells (St. Mary's County, 2018). The closest private residential well is approximately 0.54 miles upgradient from AFFF Crash Truck Maintenance Check Area. **Figure 2** shows the location of the St. Inigoes Shores Community in comparison to the AFFF Crash Truck Maintenance Check Area.

2.3 PFAS Sampling at Webster Field

In October of 2016, two grab potable water samples were collected from community water supply wells, Wells 2 and 5, located at Buildings 8130 and Building 8195 at Webster Field (**Figure 2**). Samples were analyzed for six PFAS (PFOS, PFOA, PFBS, perfluorononanoic acid, perfluorohexane sulfonic acid, and perfluoroheptanoic acid). Analytical results indicated no detections of the PFAS constituents analyzed. The analysis report for this sampling event is included in **Appendix B**.

Investigation Summary

As described in **Section 1**, the following activities were performed in support of this PFAS PA:

- Review of existing information to identify and characterize potential PFAS releases and to identify potential off-Base receptors.
- Interviews conducted with relevant site personnel to validate and verify data collected during the data review, and to provide supplemental information.
- Site reconnaissance of the facility to identify any evidence of PFAS releases and potential receptors and migration pathways; identify all areas of concern; and fill data gaps identified in the data review and interviews.

3.1 Archive Search Activities

Information was gathered and evaluated during the archive search to identify and characterize locations of potential PFAS use or disposal. The information was obtained from existing documents and interviews conducted with relevant individuals. A summary of information reviewed is provided as **Appendix C**. The following subsections specify document types were evaluated during the preliminary review.

3.1.1 Environmental Restoration Program Records

Environmental Restoration Program reports from the administrative record, other environmental liabilities database, and Environmental Data Resources, Inc. (EDR) reports (2016a, 2016b, 2016c) were searched for key terms to identify potential PFAS release areas and to obtain information on physical investigations and identification of potential pathways and receptors at those areas.

3.1.2 Internet Records

Internet search engines were utilized to find historical information on crashes, fires, use of AFFF, and spills at Webster Field. Search terms included; “Webster Field Annex,” “Webster Field fires,” Webster Field crash,” and “Fire-Fighting Foam, Webster Field.” There was no evidence of airplane crashes, fires, use of AFFF, or spills of materials that potentially contained PFAS at Webster Field during the internet search.

3.1.3 Maps and Aerial Photographs

Aerial photographs of Webster Field from 1938, 1952, 1957, 1964, 1985, 1993, 2003, 2007, 2013, and 2015 were reviewed to identify potential PFAS use, release, or disposal areas. There was no evidence of burning, firefighting, landfilling, or spills of materials that potentially contained PFAS noted in the aerial photographs. The aerial photographs are included as **Appendix D**.

3.2 Interviews

Interviews were conducted in September 2016 at NAS Patuxent River to gather pertinent information regarding the history and operations at Webster Field and potential PFAS storage, use, or release. Prior to the interviews, a questionnaire was sent to Fire Station 3 personnel with specific or anecdotal knowledge of AFFF usage, including but not limited to active and retired firefighters and fire chiefs, building and hangar representatives at structures with AFFF fire suppression systems, Fire Suppression/AFFF technicians, the Spill Response Manager, the Natural Resources Manager, and the Hazardous Waste Manager. After questionnaires were received and reviewed, interviews were conducted to validate and verify data collected during document and record reviews, and to identify other information related to PFAS not previously found in historical documents. Completed questionnaires are provided in **Appendix E.**

During the interviews, two areas of interest were identified as potential PFAS storage areas. The Fire Station 3-Building 8076 stores AFFF to administer in the case of a fuel fire at Webster Field. The AFFF Crash Truck Maintenance Check Area is where the fire department at Webster Field conducted monthly AFFF spray checks with the crash truck from Fire Station 3, Building 8076, approximately 100 feet to 150 feet from the "T" on the taxiway adjacent Runway 13-42 (**Figure 4**).

3.3 Summary of Areas Evaluated

A list of all the areas evaluated in this PFAS PA is presented in **Table 3-1.** This table also lists whether each area was determined to be a potential PFAS release area, along with the rationale for that determination. An evaluation of the potential PFAS release area is detailed in **Section 4.**

Table 3-1. Areas Evaluated for Potential PFAS Releases

Area	Potential PFAS Release Area (Yes/No)	Rational
Fire-Training Areas		
No current or former fire-training areas were identified at Webster Field	--	--
Fire Stations		
Fire Station 3 – Building 8076	Yes	Building holds approximately 310 gallons of 3 percent AFFF. The date of start of AFFF storage is not known. No known release of AFFF was identified. (Correspondence with retired firefighters Don Ervin and Bobby Johnson; interview with Michael Carroll [**Appendix E]**).
AFFF Maintenance Checks		
AFFF Crash Truck Maintenance Check Area	Yes	Monthly crash truck AFFF equipment check. The spray of AFFF would occur at the "T" of the taxiway approximately 100 to 150 feet right and left on the runway to ensure the equipment functioned and the foam set up correctly. (Correspondence with Bobby Johnson, January 2017; emails from Heidi Morgan, NAVFAC, January 2017 **[Appendix E]**).
Hangars		
Flight line hangar for Fleet Composite Squadron 6 (VC-6) Pioneer unmanned aircraft systems	No	Two adjoining hangars covering 87,000 square feet with concrete apron surrounding it (Tetra Tech NUS, 2010). There is no AFFF system within the hangar.
Plating Shop		
No current or former chrome electroplating shops identified at Webster Field	No	--
Storage Areas of PFAS Materials		
No current or former storage areas containing PFAS materials identified at Webster Field	--	--
Wastewater Treatment Plants		
No current or former WWTP identified at Webster Field	--	--

Table 3-1. Areas Evaluated for Potential PFAS Releases

Area	Potential PFAS Release Area (Yes/No)	Rational
ER Sites		
Rubble Area 1 – Site 32	No	Formally referred to as Site 32, this site was the official disposal area for Webster Field from early 1960s to 1967. The area is known to contain garbage from mess halls, construction debris, vegetation matter, waste oils, concrete, brick, wood, one inert ordnance shape, and expended parachute illumination flares (CH2M, 2005). No record was found of this area containing PFAS materials and the dates of use predate widespread use of PFAS-containing AFFF.
Rubble Area 2 – Site 33	No	Formally referred to as Site 33. Very little is known about the history; the area is known to contain construction debris and concrete (CH2M, 2005). No record was found of this area containing PFAS materials.
Paints		
Paint Shop – Building 8229	No	PFAS are used in a wide range of consumer goods and may be found in paints. No formal records of paint releases were identified during document or interview review (Tetra Tech NUS, 2010). If there was a paint release incident, it was likely a small-volume spill and not enough to lead to groundwater impacts and there is no record of paint used in this building containing AFFF.
Pesticides		
No current or former pesticide storage areas identified at Webster Field	--	--
Petroleum Oil, Lubricants		
Aboveground storage tanks storing petroleum products	No	No evidence of AFFF storage was found.
Crash Sites		
Glider crash	No	Occurred in the 1970s. The use of AFFF on a glider crash is unlikely. (Correspondence between Heidi Morgan, NAVFAC and Mike Smolek **[Appendix E]**).
Sikorsky CH53E Super Stallion Helicopter crash	No	Occurred in 1978. No evidence of AFFF use. (Correspondence between Heidi Morgan, NAVFAC and Mike Smolek **[Appendix E]**).

Two sites with storage and potential release of AFFF at Webster Field were identified during the desktop document research: Fire Station 3 (Building 8076) and AFFF Crash Truck Maintenance Check Area.

Preliminary Assessment Findings

This section summarizes the characteristics of the locations on Webster Field identified as potential PFAS release areas, describes the potential for PFAS to have been used or released at each area, and assesses the migration pathways and potential exposure that could result from a PFAS release. If no PFAS use or release was identified at an area, the potential migration pathways and exposures were considered incomplete and were not evaluated.

4.1 Potential Exposure Points and Routes

Through the historical use of materials containing PFAS, those substances may have been released to the environment. Because of their chemical structure, PFAS are chemically and biologically stable and resist typical degradation processes. As a result, PFAS persist in the environment. Additionally, PFAS are water-soluble and migrate readily from soil to groundwater where they can be transported long distances (USEPA, 2014). Various receptors could potentially be exposed to PFAS in the following media: groundwater, soil, air, sediment, and surface water.

4.1.1 Groundwater

In areas where groundwater is within the potential depth of construction activities, construction workers could be exposed to PFAS in groundwater through dermal contact with groundwater during excavation activities due to shallow groundwater in some portion of the facility. There are no regulatory screening levels or other criteria for dermal contact with PFAS in groundwater. Shallow groundwater is not used as a source of drinking water within or in the vicinity of Webster Field; however, if contaminants migrated into deep aquifers, potential consumers of drinking water could be exposed through ingestion.

4.1.2 Soil and Air

Residents, construction workers, maintenance/industrial workers, and trespassers could be exposed to PFAS in soil through incidental ingestion of, and dermal contact with, surface and subsurface soil or respiration of surface soil dust in the air. Terrestrial ecological receptors could be exposed to PFAS in soil through direct exposure with soil; however, there are currently no USEPA screening criteria available to evaluate ecological receptors.

4.1.3 Sediment

Residents and trespassers could be exposed to PFAS in sediment through incidental ingestion of, and dermal contact with, sediment. Terrestrial ecological receptors could be exposed to PFAS in sediment through direct exposure with sediment; however, there are currently no USEPA screening criteria available to evaluate ecological receptors.

4.1.4 Surface Water

Residents and trespassers could be exposed to PFAS in surface water through dermal contact with surface water and incidental ingestion. There are no screening levels or other criteria for dermal contact with surface water. Terrestrial and aquatic ecological receptors could be exposed to PFAS in surface water primarily through direct exposure to surface water; however, there are currently no USEPA screening criteria available to evaluate ecological receptors.

4.2 Potential PFAS Release Areas

The following areas were identified as a PFAS storage/release areas based on information gathered during the PA investigation.

4.2.1 Fire Station 3 (Building 8076)

Description and Operational History

Fire Station 3, Building 8076, is located at the northwestern portion of Webster Field, approximately 200 feet east of St. Mary's River (**Figure 3**). Building 8076 was constructed in 1968, a one-story permanent structure, encompassing approximately 2,600 square feet. This building currently serves as a fire station. Representatives of Fire Station 3 stated AFFF was stored at Fire Station 3 (interview with Michael Carroll **[Appendix E]**). It is important to note that all fire training is conducted at NAS Patuxent River and not at Webster Field.

Waste Characteristics

Webster Field Fire Station 3 stores approximately 310 gallons of 3M Light Water 3 percent AFFF, MIL-Spec F-24385F in the crash truck and the two separate tanks at Building 8076. Records regarding the date the AFFF was first stored at the facility or whether other AFFF formulations, besides 3M product, were ever stored were not found. Five-gallon buckets are used to fill the AFFF to the crash truck from the storage tanks. There is no record of where empty containers are disposed. Currently, only water is used when the crash truck is tested for spray patterns to make sure the equipment is working properly (interview with Michael Carroll **[Appendix E]**). The spray checks in the past were conducted daily at the Crash Truck Maintenance Check Area, as discussed in **Section 4.2.2.**

Pathway and Environmental Hazard Assessment

The current and former firefighter representatives at Webster Field are not aware of any historical or current release of AFFF at Fire Station 3 (correspondence with retired firefighters Don Ervin and Bobby Johnson and interview with the current fire chief, Michael Carroll [**Appendix E**]). The only potential release of AFFF would be during transfer or refilling of AFFF to the crash truck. The potential for PFAS contamination in the various site media (shallow groundwater, surface water, soil, and air) is minimal.

Groundwater Pathway and Targets

Groundwater in and around Webster Field can only be practically accessed by wells. This area is entirely paved, with minimal natural ground exposure. Landscaped areas surrounding Fire Station 3 consist of grasses, shrubs, and mulch. There is a parking lot to the east of the building. The pathway to groundwater could be exposed through cracks in the pavement, which may or may not have been present during the daily equipment checks. There are two active supply wells (Wells 2 and 5) within Webster Field (**Figure 2**). The nearest supply well to Fire Station 3 is Well 2, approximately 0.7-mile northeast of the site. The other supply well (Well 5) is approximately 0.9 mile south to southeast of the site; however, these wells are screened in deeper aquifers and testing data indicates no detections of PFAS constituents. The potential for PFAS contamination in shallow groundwater is minimal at this site.

Surface Water Pathways and Targets

The closest water body to Fire Station 3 is St. Mary's River – approximately 200 feet to the northwest and 265 feet to the southwest. The closest pond to Fire Station 3 is approximately 490 feet to the northeast. Langley Pond is the largest pond at Webster Field, approximately 2,170 feet southeast of the fire station. Surface water runoff from Building 8076 would move toward the St. Mary's River. The Basewide and site maps (**Figures 2** and **3**) show a storm sewer discharge point adjacent to the building. The potential for PFAS contamination to surface water is minimal at the site.

Soil and Air Pathways and Targets

This area is entirely paved, with minimal natural ground exposure. Landscaped areas surrounding Fire Station 3 consist of grasses, shrubs, and mulch. There is a parking lot to the east of the building. There is no evidence of a PFAS release at this site. However, if PFAS had been released to soil at Fire Station 3, the nature of the asphalt surface surrounding the building would limit infiltration to soil or air transport of dust from potential PFAS-impacted soil particles. The potential for PFAS contamination in soil is minimal at the site.

Because this site is a fire station, there are onsite workers at this site. There are no residential areas within a 1-mile radius downgradient of the fire station. The closest residences are located upgradient of the fire station in the St. Inigoes Shores Community adjacent to the facility entrance. Workers and trespassers present within a 1-mile radius of Fire Station 3 could potentially be exposed to AFFF through inhalation of AFFF during spraying and handling of AFFF. However, most PFAS are not volatile and there are no day care facilities, medical centers, nursing homes, schools, or hospitals within a 2-mile radius of Webster Field (EDR, 2016b).

4.2.2 AFFF Crash Truck Maintenance Check Area

Description and Operational History

The AFFF Crash Truck Maintenance Check Area is where the fire department at Webster Field conducted monthly AFFF spray checks with the crash truck from Fire Station 3, Building 8076. This check area is approximately 100 feet to 150 feet from the "T" on the taxiway adjacent Runway 13-42 (**Figures 2** and **4**). These checks verify the equipment is functioning properly and the spray pattern of AFFF is setup correctly. The period over which equipment functioning testing with AFFF was conducted is unknown, but guidance for using NoFoam Kits in lieu of the AFFF spray checks has been available since the mid-2000s. The crash truck at Webster Field is currently tested monthly with water only at the Crash Truck Maintenance Check Area (interview with Michael Carroll [**Appendix E]**).

Waste Characteristics

The AFFF Crash Truck is available to support the extinguishing of fires of any aircraft crashes. The crash truck carries a storage tank holding approximately 200 gallons of 3 percent AFFF solution. Three percent AFFF is stored at Fire Station 3 as a re-supply if needed. However, there is no record of AFFF having been used during aircraft crashes at Webster Field (**Appendix E**). The only use of AFFF in the past has been during the monthly spray checks in the Crash Truck Maintenance Check Area along the taxiway.

Pathway and Environmental Hazard Assessment

Groundwater Pathway and Targets

Groundwater in and around Webster Field can only be practically accessed by wells. This area is entirely paved, with minimal natural ground exposure. The pathway to groundwater could be exposed through cracks in the pavement, which may or may not have been present during the monthly equipment checks. Cracks in the pavement and/or overland flow of AFFF during equipment checks to nearby unpaved areas may potentially have allowed some migration of AFFF to groundwater. There are two active supply wells within Webster Field (**Figure 2**). The nearest supply well to The AFFF Crash Truck Maintenance Check Area is approximately 0.5-mile northeast of the site. The other well is approximately 0.6 mile southeast of the site. The potential exists for shallow groundwater contamination from PFAS at the site because AFFF spray checks were conducted monthly over an extended period in the past. Drinking water wells are screened in the deeper aquifers and have been tested for PFAS; no detections of PFAS constituents were noted.

Surface Water Pathway and Targets

The Basewide and site maps show stormwater conveyances leading south from the AFFF Crash Truck Maintenance Check Area to Langley Hollow Pond, which is approximately 750 feet from the site (**Figures 2** and **4**). St. Mary's River is approximately 785 feet west of the site. The potential exists for surface water contamination from PFAS at the site because AFFF spray checks were conducted monthly over an extended period of time in the past.

Soil and Air Pathways and Targets

This area is entirely paved, with minimal natural ground exposure. The pathway to soil could be exposed through cracks in the pavement, which may or may not have been present during the monthly equipment checks. Because the area is paved, soil contaminated with PFAS is minimal. Workers and trespassers could be exposed to AFFF through inhalation of AFFF during handling of AFFF. Because it is possible to be exposed to be AFFF during handling of AFFF, there is potential for inhalation exposure to PFAS; however, most PFAS are not volatile.

Because this site is a taxiway adjacent to a runway, there are onsite workers but no residents at this site. There are no residential areas within a 1-mile radius downgradient of the AFFF Crash Truck Maintenance Check Area. The closest residences are located upgradient of the fire station in the St. Inigoes Shores Community adjacent to the facility entrance. There are no day care facilities, medical centers, nursing homes, schools, or hospitals within a 2-mile radius of Webster Field (EDR, 2016b).

SECTION 5

Conclusions and Recommendations

This PFAS PA report evaluated areas for potential PFAS releases. Based on the gathered information on the storage, use, and potential release of AFFF at Webster Field, two sites with storage and potential release of AFFF at Webster Field were identified: Fire Station 3 (Building 8076) and AFFF Crash Truck Maintenance Check Area.

Fire Station 3 stores approximately 310 gallons of 3 percent AFFF solution in the crash truck and the two separate tanks at Building 8076. Currently, spray checks are conducted daily with water, and spray checks were performed in the past at the Crash Truck Maintenance Check Area. There is a potential of AFFF being released at Fire Station 3 from possible spills during transfer or refilling of AFFF to the crash truck. Therefore, additional investigation is recommended for Fire Station 3 through a SI.

At the AFFF Crash Truck Maintenance Check Area, the crash truck from Fire Station 3 performed monthly AFFF spray checks along the taxiway. Although the area is entirely paved, the pathway to groundwater and soil could be exposed through AFFF runoff and cracks in the pavement. Because an exposure pathway from a release to environmental media and from environmental media to potential receptors exists, the AFFF Crash Truck Maintenance Check Area is recommended for additional investigation through a SI.

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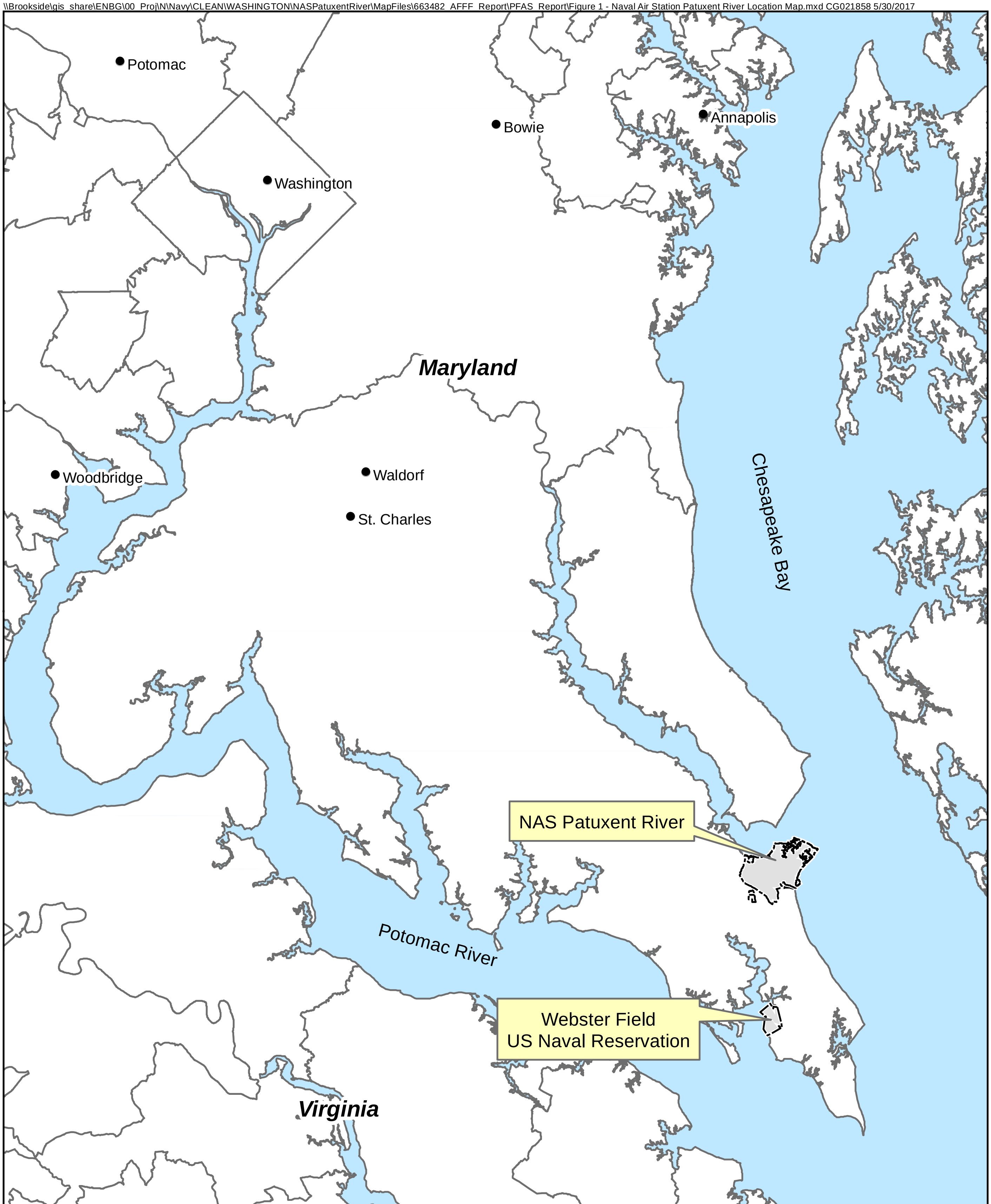
Figures

\\Brookside\gis_share\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\663482_AFFF_Report\PFAS_Report\Figure 1 - Naval Air Station Patuxent River Location Map.mxd CG021858 5/30/2017



Legend
- Cities
- Installation Boundary

N

0 22,500 45,000 Feet

Figure 1
Location Map
Preliminary Assessment for PFAS
NAS Patuxent River Webster Field Annex
St. Mary's County, Maryland

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\703334_WebsterField_SAP\Figure 2 - Potential Source Area for PFAS Supply Wells.mxd beresl 7/10/2019

Legend

- Supply Well
- Estimated Shallow Groundwater Flow Direction
- Fire Station 3, Building 8076
- AFFF Crash Truck Maintenance Check Area
- Nearest Residential Homes with Private Wells
- Installation Boundary
- Storm Sewer Discharge Point
- Catch Basin
- Storm Sewer Manhole
- Storm Sewer Valve Point
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch

N

0 500 1,000 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 2
Potential Source Area for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\663482_AFFF_Report\PFAS_Webster_Field\Figure 3 - Fire Station Building 8076.mxd2/27/2019AM038876

Legend

- Storm Sewer Discharge Point
- Catch Basin
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch
- Surface Water
- Building
- Installation Boundary

N

0 50 100 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 3
Fire Station, Building 8076
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m.

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\663482_AFFF_Report\PFAS_Webster_Field\Figure 4 - AFFF Crash Truck Maintenance Check Area.mxd2/27/2019AM038876

Legend

- Storm Sewer Discharge Point
- Catch Basin
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch
- Building
- AFFF Crash Truck Maintenance Check Area
- Surface Water
- Taxiway
- Runway
- Installation Boundary

N

0 100 200 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 4
AFFF Crash Truck Maintenance Check Area
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m:

Appendix A
List of Rare, Threatened, and Endangered Species of St. Mary's County

List of Rare, Threatened, and Endangered Species of St. Mary's County

February 2018

Maryland Wildlife and Heritage Service
Natural Heritage Program

Larry Hogan, Governor
Mark Belton, Secretary

Wildlife & Heritage Service
Natural Heritage Program
Tawes State Office Building, E-1
580 Taylor Avenue
Annapolis, MD 21401
410-260-8540
Fax 410-260-8596
dnr.maryland.gov/wildlife

Additional Telephone Contact Information:
Toll free in Maryland: 877-620-8DNR ext. 8540 OR
Individual unit/program toll-free number
Out of state call: 410-260-8540
Text Telephone (TTY) users call via the Maryland Relay

ACKNOWLEDGMENTS

The Maryland Department of Natural Resources would like to express sincere appreciation to the many scientists and naturalists who willingly share information and provide their expertise to further our mission of conserving Maryland's natural heritage.

Publication of this list is made possible by taxpayer donations to Maryland's Chesapeake Bay and Endangered Species Fund.

IMPORTANT NOTES

This list is a subset of the main reports:
Maryland Natural Heritage Program. 2016. List of Rare, Threatened, and Endangered Plants of Maryland DNR 03-010418-42 and
Maryland Natural Heritage Program. 2016. Rare, Threatened, and Endangered Plants of Maryland DNR 03-010418-43 and
Maryland Natural Heritage Program. 2016. List of Rare, Threatened, and Endangered Animals of Maryland DNR 03-1272016-633

Please refer to these for important information including history, purpose, governing laws and regulations, understanding state and federal conservation status ranks and legal statuses, and for additional resources.

This list is derived from an extensive data collection effort and numerous field surveys to determine distribution and abundance of plants and animals native to Maryland. Although based on a large volume of information, this list should not be viewed as complete or definitive. While much is known about some species, very little is known about others. The Maryland Natural Heritage Program welcomes additional information or recommendations regarding any of the taxa listed herein.

HOW YOU CAN HELP

You can take an active part in conserving Maryland's rare species by contacting the Wildlife and Heritage Service with the following types of information:

1. Location details should be included (exact mapped location using GPS is preferred, but not required). Online applications such as Google Earth are invaluable but precise, written directions including driving and walking are acceptable.

2. Documentation that includes a photograph, description of the species, identification source, and habitat description should accompany the report.

3. Information on the ecology and or biology of the species including observed and/or identified pollinators should accompany the report.

**Additional information, including a downloadable PDF of our rare plant reporting form can be found at: dnr.maryland.gov/wildlife/Pages/plants_wildlife/rte_reportinginst.aspx

Definitions of qualifiers used in the county distribution of species.

Distributional Qualifier	Definition
{species}$^{?}$	Record for the county is reported but unverified or may indicate that the record occurs outside of the known range or in atypical habitat.
{species}^{h}	Record for the county is based upon a historical collection but no extant population is known.
{species}^{I}	Record for the county is the result of an introduction.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	STATE STATUS	FEDERAL STATUS
Animals					
Alasmidonta heterodon	Dwarf Wedge Mussel	G1G2	S1	E	LE
Caecidotea sp. 1	An Isopod	G1	S1		
Centrarchus macropterus	Flier	G5	S1S2	T	
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G3G4T2	S1	E	LT
Circus cyaneus	Northern Harrier	G5	S2B	I	
Cistothorus platensis	Sedge Wren	G5	S1B	E	
Cordulegaster obliqua	Arrowhead Spiketail	G4	S2		
Fundulus luciae	Spotfin Killifish	G4	S2?		
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	G5	S1S2	E	
Gomphus rogersi	Sable Clubtail	G4	S2	I	
Haliaeetus leucocephalus	Bald Eagle	G5	S3S4		
Hermeuptychia sosybius	Carolina Satyr	G5	S1S3		
Lucanus elaphus	Giant Stag Beetle	G3G5	SU		
Sternula antillarum	Least Tern	G4	S2B	T	
Stygobromus indentatus	Tidewater Amphipod	G3	S1		
Tachopteryx thoreyi	Gray Petaltail	G4	S3		
Plants					
Ammannia latifolia [h]	Koehne Ammannia	G5	S2		
Arnica acaulis [h]	Leopard's-bane	G4	S1	E	
Aronia x prunifolia	Purple Chokeberry	GNA	S3		
Asclepias verticillata [h]	Whorled Milkweed	G5	S3		
Atriplex mucronata [h]	Seabeach Orach	G5	S1S2		
Bartonia paniculata	Twining Screwstem	G5	S3		
Carex bullata	Button Sedge	G5	S3		
Carex buxbaumii	Buxbaum's Sedge	G5	S2	T	
Carex louisianica	Louisiana Sedge	G5	S3		
Carex oxylepis	Sharpscale Sedge	G5?	S1		
Carex pellita	Wooly Sedge	G5	S2?		
Carex striatula	Lined Sedge	G4G5	S3		
Carex venusta	Dark Green Sedge	G4	S3S4		
Castanea dentata	American Chestnut	G4	S2S3		
Centrosema virginianum	Coastal Butterfly Pea	G5	S2		
Chelone obliqua	Red Turtlehead	G4	S2	T	
Chimaphila umbellata	Common Wintergreen	G5	S3		
Cuscuta coryli [h]	Hazel Dodder	G5?	S1	X	
Cuscuta indecora [h]	Bigseed Dodder	G5	S2?		
Dichanthelium ravenelii [h]	Ravenel's Witchgrass	G5	SH		
Drosera capillaris [h]	Pink Sundew	G5	S1	E	
Eleocharis albida [h]	White Spikerush	G4G5	S2S3		
Eleocharis engelmannii	Engelmann's Spikerush	G4G5	S3		
Eleocharis tortilis	Twisted Spikerush	G5	S3		

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	STATE STATUS	FEDERAL STATUS
Elephantopus tomentosus	Tobaccoweed	G5	S1	E	
Fimbristylis annua [?]	Annual Fimbry	G5	S3		
Fimbristylis puberula [h]	Hairy Fimbristylis	G5	SU		
Galactia volubilis	Downy Milkpea	G5	S3		
Gonolobus suberosus var. suberosus	Angular-fruit Milkvine	G5	S2		
Gratiola viscidula	Short's Hedge-hyssop	G4G5	S1	E	
Hylodesmum pauciflorum [h]	Few-flowered Tick-trefoil	G5	S2	E	
Hypericum gymnanthum [h]	Clasping-leaf St. John's-wort	G4	S3		
Ilex decidua	Deciduous Holly	G5	S2		
Iris prismatica	Slender Blueflag	G4G5	S2	E	
Juncus elliottii	Elliott's Rush	G4G5	S1		
Krigia dandelion	Potato Dwarf-dandelion	G5	S2S3		
Lechea maritima [h]	Virginian Beach Pinweed	G5	S3		
Linum intercursum	Sandplain Flax	G4	S2	T	
Liparis liliifolia [h]	Large Twayblade	G5	S2S3		
Listera australis	Southern Twayblade	G4	S3		
Malaxis unifolia	Green Adder's-mouth Orchid	G5	S1S3		
Myosotis macrosperma	Large-seed Forget-me-not	G5	S3S4		
Orbexilum psoralioides [?]	False Scurfpea	G5T4?	SX		
Panicum philadelphicum [h]	Philadelphia Panicgrass	G5	SU		
Pilea fontana [h]	Springs Clearweed	G5	S3		
Platanthera cristata	Crested Yellow Orchid	G5	S3		
Polygala incarnata [h]	Pink Milkwort	G5	S2S3		
Polygonum glaucum	Seabeach Knotweed	G3	S1	E	
Polygonum ramosissimum [h]	Bushy Knotweed	G5	SH	X	
Potamogeton perfoliatus	Claspingleaf Pondweed	G5	S3		
Prunus maritima	Beach Plum	G4	S1	E	
Rhynchospora glomerata	Clustered Beakrush	G5	S3		
Sarracenia purpurea [l]	Northern Pitcherplant	G5	S2	T	
Sceptridium oneidense [h]	Blunt-lobe Grapefern	G4	S1	E	
Scleria triglomerata	Whip Nutrush	G5	S3		
Smilax pseudochina	Long-stalk Greenbrier	G4G5	S2	T	
Symphyotrichum concolor [h]	Eastern Silvery Aster	G5	S1	E	
Thyrsanthella difformis	Climbing Dogbane	G4G5	S1	E	
Torreyochloa pallida var. pallida	Pale Mannagrass	G5	S3		
Typha domingensis	Southern Cattail	G4G5	S3		
Utricularia inflata	Swollen Bladderwort	G5	S2	E	
Utricularia subulata	Zigzag Bladderwort	G5	S3		

Appendix B
Webster Analysis Report – Potable Water

eurofins | Lancaster Laboratories Environmental

Analysis Report

2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300 • Fax: 717-656-2681 • www.LancasterLabs.com

ANALYTICAL RESULTS

Prepared by:	Prepared for:
Eurofins Lancaster Laboratories Environmental 2425 New Holland Pike Lancaster, PA 17601	Inspection Experts, Inc. 9220 Rumsey Road Bay #5 Columbia MD 21045

Report Date: December 21, 2016

Project: NAVFAC - Pax River Sampling

Submittal Date: 10/07/2016
Group Number: 1718862
PO Number: 15-0011-219
State of Sample Origin: MD

Client Sample Description	Lancaster Labs (LL) #
Soloman-6041 Grab Potable Water	8635204
Webster Field-8130 Grab Potable Water	8635206
Webster Field-8195 Grab Potable Water	8635208

The specific methodologies used in obtaining the enclosed analytical results are indicated on the Laboratory Sample Analysis Record.

Regulatory agencies do not accredit laboratories for all methods, analytes, and matrices. Our current scopes of accreditation can be viewed at http://www.eurofinsus.com/environment-testing/laboratories/eurofins-lancaster-laboratories-environmental/resources/certifications/ . To request copies of prior scopes of accreditation, contact your project manager.

Electronic Copy To   Inspection Experts Inc.   Attn: Kosala De Silva

Respectfully Submitted,

Stacy L. Hess
Project Manager

(717) 556-7236

Sample Description: Soloman-6041 Grab Potable Water
NAVFAC-Pax River Sampling

LL Sample # PW 8635204
LL Group # 1718862
Account # 38771

Project Name: NAVFAC - Pax River Sampling

Collected: 10/06/2016 07:50 by GK

Submitted: 10/07/2016 18:45
Reported: 12/21/2016 14:11

Inspection Experts, Inc.
9220 Rumsey Road
Bay #5
Columbia MD 21045

CAT No.	Analysis Name	CAS Number	Result	Method Detection Limit*	Limit of Quantitation	Dilution Factor
Misc. Organics	**EPA 537 Rev. 1.1 modified**		**ng/l**	**ng/l**	**ng/l**	
10954	Perfluorooctanoic acid	335-67-1	N.D.	1	2	1
10954	Perfluorononanoic acid	375-95-1	N.D.	1	2	1
10954	Perfluoroheptanoic acid	375-85-9	N.D.	1	2	1
10954	Perfluorobutanesulfonate	375-73-5	N.D.	4	10	1
10954	Perfluorohexanesulfonate	355-46-4	N.D.	4	10	1
10954	Perfluoro-octanesulfonate	1763-23-1	N.D.	5	10	1

The stated QC limits are advisory only until sufficient data points can be obtained to calculate statistical limits.

Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
10954	PFAAs in Water by LC/MS/MS	EPA 537 Rev. 1.1 modified	1	16291011	10/22/2016 01:09	Jason W Knight	1
14091	PFAA Water Prep	EPA 537 Rev. 1.1 modified	1	16291011	10/18/2016 19:00	Devon M Whooley	1

*=This limit was used in the evaluation of the final result

Sample Description: Webster Field-8130 Grab Potable Water
NAVFAC-Pax River Sampling

LL Sample # PW 8635206
LL Group # 1718862
Account # 38771

Project Name: NAVFAC - Pax River Sampling

Collected: 10/06/2016 08:50 by GK

Submitted: 10/07/2016 18:45
Reported: 12/21/2016 14:11

Inspection Experts, Inc.
9220 Rumsey Road
Bay #5
Columbia MD 21045

CAT No.	Analysis Name	CAS Number	Result	Method Detection Limit*	Limit of Quantitation	Dilution Factor
Misc. Organics	**EPA 537 Rev. 1.1 modified**		ng/l	ng/l	ng/l	
10954	Perfluorooctanoic acid	335-67-1	N.D.	1	2	1
10954	Perfluorononanoic acid	375-95-1	N.D.	1	2	1
10954	Perfluoroheptanoic acid	375-85-9	N.D.	1	2	1
10954	Perfluorobutanesulfonate	375-73-5	N.D.	4	10	1
10954	Perfluorohexanesulfonate	355-46-4	N.D.	4	10	1
10954	Perfluoro-octanesulfonate	1763-23-1	N.D.	5	10	1

The stated QC limits are advisory only until sufficient data points can be obtained to calculate statistical limits.

Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
10954	PFAAs in Water by LC/MS/MS	EPA 537 Rev. 1.1 modified	1	16291011	10/22/2016 01:42	Jason W Knight	1
14091	PFAA Water Prep	EPA 537 Rev. 1.1 modified	1	16291011	10/18/2016 19:00	Devon M Whooley	1

*=This limit was used in the evaluation of the final result

Sample Description: Webster Field-8195 Grab Potable Water
NAVFAC-Pax River Sampling

LL Sample # PW 8635208
LL Group # 1718862
Account # 38771

Project Name: NAVFAC - Pax River Sampling

Collected: 10/06/2016 09:12 by GK

Submitted: 10/07/2016 18:45
Reported: 12/21/2016 14:11

Inspection Experts, Inc.
9220 Rumsey Road
Bay #5
Columbia MD 21045

CAT No.	Analysis Name	CAS Number	Result	Method Detection Limit*	Limit of Quantitation	Dilution Factor
Misc. Organics	**EPA 537 Rev. 1.1 modified**		ng/l	ng/l	ng/l	
10954	Perfluorooctanoic acid	335-67-1	N.D.	1	2	1
10954	Perfluorononanoic acid	375-95-1	N.D.	1	2	1
10954	Perfluoroheptanoic acid	375-85-9	N.D.	1	2	1
10954	Perfluorobutanesulfonate	375-73-5	N.D.	4	10	1
10954	Perfluorohexanesulfonate	355-46-4	N.D.	4	10	1
10954	Perfluoro-octanesulfonate	1763-23-1	N.D.	5	10	1

The stated QC limits are advisory only until sufficient data points can be obtained to calculate statistical limits.

Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
10954	PFAAs in Water by LC/MS/MS	EPA 537 Rev. 1.1 modified	1	16291011	10/22/2016 01:58	Jason W Knight	1
14091	PFAA Water Prep	EPA 537 Rev. 1.1 modified	1	16291011	10/18/2016 19:00	Devon M Whooley	1

*=This limit was used in the evaluation of the final result

Quality Control Summary

Client Name: Inspection Experts, Inc. Group Number: 1718862
Reported: 12/21/2016 14:11

Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

All Inorganic Initial Calibration and Continuing Calibration Blanks met acceptable method criteria unless otherwise noted on the Analysis Report.

Method Blank

Analysis Name	Result ng/l	MDL** ng/l	LOQ ng/l
Batch number: 16291011	Sample number(s): 8635204,8635206,8635208		
Perfluorooctanoic acid	N.D.	1	2
Perfluorononanoic acid	N.D.	1	2
Perfluoroheptanoic acid	N.D.	1	2
Perfluorobutanesulfonate	N.D.	4	10
Perfluorohexanesulfonate	N.D.	4	10
Perfluoro-octanesulfonate	N.D.	5	10

LCS/LCSD

Analysis Name	LCS Spike Added ng/l	LCS Conc ng/l	LCSD Spike Added ng/l	LCSD Conc ng/l	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 16291011	Sample number(s): 8635204,8635206,8635208								
Perfluorooctanoic acid	200	167.38	200	149.06	84	75	70-130	12	30
Perfluorononanoic acid	200	148.47	200	141.11	74	71	70-130	5	30
Perfluoroheptanoic acid	200	164.76	200	136.34	82	68*	70-130	19	30
Perfluorobutanesulfonate	177	145.6	177	140.39	82	79	70-130	4	30
Perfluorohexanesulfonate	189	166.34	189	158.46	88	84	70-130	5	30
Perfluoro-octanesulfonate	191	159.48	191	158.25	83	83	70-130	1	30

MS/MSD

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike

Analysis Name	Unspiked Conc ng/l	MS Spike Added ng/l	MS Conc ng/l	MSD Spike Added ng/l	MSD Conc ng/l	MS %Rec	MSD %Rec	MS/MSD Limits	RPD	RPD Max
Batch number: 16291011	Sample number(s): 8635204,8635206,8635208 UNSPK: 8635204									
Perfluorooctanoic acid	N.D.	199.52	153.25			77		70-130		
Perfluorononanoic acid	N.D.	199.52	137.65			69*		70-130		
Perfluoroheptanoic acid	N.D.	199.52	139.65			70		70-130		
Perfluorobutanesulfonate	N.D.	176.58	154.33			87		70-130		
Perfluorohexanesulfonate	N.D.	188.55	165.41			88		70-130		

*- Outside of specification
**-This limit was used in the evaluation of the final result for the blank
(1) The result for one or both determinations was less than five times the LOQ.
(2) The unspiked result was more than four times the spike added.
P###### is indicative of a Background or Unspiked sample that is batch matrix QC and was not performed using a sample from this submission group.

Quality Control Summary

Client Name: Inspection Experts, Inc. Group Number: 1718862
Reported: 12/21/2016 14:11

MS/MSD (continued)

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike

Analysis Name	Unspiked Conc ng/l	MS Spike Added ng/l	MS Conc ng/l	MSD Spike Added ng/l	MSD Conc ng/l	MS %Rec	MSD %Rec	MS/MSD Limits	RPD	RPD Max
Perfluoro-octanesulfonate	N.D.	190.54	159.18			84		70-130		

*- Outside of specification
**-This limit was used in the evaluation of the final result for the blank
(1) The result for one or both determinations was less than five times the LOQ.
(2) The unspiked result was more than four times the spike added.
P###### is indicative of a Background or Unspiked sample that is batch matrix QC and was not performed using a sample from this submission group.

Environmental Analysis Request/Chain of Custody

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Acct. # 38771 Group # 1718862 Sample # 8635203-08

Client: Inspection Experts Inc.		Matrix	Total # of Containers	Analyses Requested	For Lab Use Only
Project Name/#: NAVFAC - Pax River Sampling	Site ID #:			Preservation Codes	SF #:
Project Manager: Kosala De Silva	P.O. #: 15-0011-219				SCR #:
Sampler: Gayan Kularatne	PWSID #:				
Phone #: 410-715-3939	Quote #:				
State where samples were collected: ____	For Compliance: Yes ☐ No ☐				

Preservation Codes: H = HCl, T = Thiosulfate, N = HNO_3, B = NaOH, S = H_2SO_4, P = H_3PO_4, O = Other

Matrix: Soil ☐ Sediment ☐ Tissue ☐; Water: Potable ☐ NPDES ☐ Ground ☑ Surface ☐; Other:

Sample Identification	Collection Date	Collection Time	Grab	Composite	Soil/Sediment/Tissue	Water	Other	Total # of Containers	PFOS/PFOA (EPA 537)										Remarks
Soloman - 6041 - FB	10/06	0746	X						1										Field Reagent Blank to be
Soloman - 6041	10/06	0750	X						3										analyzed only with confirmed
Webster field - 8130 - FB	10/06	0845	X						1										positive result of respective
Webster Field - 8130	10/06	0850	X						3										sample
webster Field - 8195 - FB	10/06	0908	X						1										
webster Field - 8195	10/06	0912	X						3										

Turnaround Time Requested (TAT) (please check): Standard ☑ Rush ☐
(Rush TAT is subject to laboratory approval and surcharges.)

Date results are needed:

Rush results requested by (please check): E-Mail ☑ Phone ☐

E-mail Address: kosala@ieinc.net

Phone:

Relinquished by:	Date	Time	Received by:	Date	Time
[signature]	10/06/16		[signature]	10/6/16	1200
[signature]	10/7/16		[signature]	10-7-16	10:35
[signature]	10-7-16	2100			
			[signature]	10/7/16	18:45

Relinquished by Commercial Carrier:
UPS ______ FedEx ______ Other ______

Temperature upon receipt 1.3°C °C ③

Data Package Options (please check if required)

Type I (Validation/non-CLP)	☐	MA MCP	☐
Type III (Reduced non-CLP)	☐	CT RCP	☐
Type VI (Raw Data Only)	☐	TX TRRP-13	☐
NJ DKQP	☐	NYSDEC Category ☐ A or ☐ B	

EDD Required? Yes ☐ No ☐ If yes, format: ______

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Sample Administration Receipt Documentation Log

Doc Log ID: 164629

Group Number(s): 1718862

Client: Inspection Experts Inc.

Delivery and Receipt Information

Delivery Method: ELLE Courier

Arrival Timestamp: 10/07/2016 18:48

Number of Packages: 1

Number of Projects: 1

Arrival Condition Summary

Shipping Container Sealed:	Yes
Custody Seal Present:	Yes
Custody Seal Intact:	Yes
Samples Chilled:	Yes
Paperwork Enclosed:	Yes
Samples Intact:	Yes
Missing Samples:	No
Extra Samples:	No
Discrepancy in Container Qty on COC:	No

Sample IDs on COC match Containers:	Yes
Sample Date/Times match COC:	Yes
VOA Vial Headspace ≥ 6mm:	N/A
Total Trip Blank Qty:	0
Air Quality Samples Present:	No

Unpacked by Cathy Murphy (10960) at 22:55 on 10/07/2016

Samples Chilled Details

Thermometer Types: *DT = Digital (Temp. Bottle)* *IR = Infrared (Surface Temp)* *All Temperatures in °C.*

Cooler #	Thermometer ID	Corrected Temp	Therm. Type	Ice Type	Ice Present?	Ice Container	Elevated Temp?
1	DT121	1.3	DT	Wet	Y	Bagged	N

2425 New Holland Pike
Lancaster, PA 17605-2425

T | 717-656-2300
F | 717-656-2681
www.LancasterLabs.com

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Explanation of Symbols and Abbreviations

The following defines common symbols and abbreviations used in reporting technical data:

BMQL	Below Minimum Quantitation Level	**mg**	milligram(s)
C	degrees Celsius	**mL**	milliliter(s)
cfu	colony forming units	**MPN**	Most Probable Number
CP Units	cobalt-chloroplatinate units	**N.D.**	none detected
F	degrees Fahrenheit	**ng**	nanogram(s)
g	gram(s)	**NTU**	nephelometric turbidity units
IU	International Units	**pg/L**	picogram/liter
kg	kilogram(s)	**RL**	Reporting Limit
L	liter(s)	**TNTC**	Too Numerous To Count
lb.	pound(s)	**µg**	microgram(s)
m3	cubic meter(s)	**µL**	microliter(s)
meq	milliequivalents	**umhos/cm**	micromhos/cm

< less than

> greater than

ppm parts per million - One ppm is equivalent to one milligram per kilogram (mg/kg) or one gram per million grams. For aqueous liquids, ppm is usually taken to be equivalent to milligrams per liter (mg/l), because one liter of water has a weight very close to a kilogram. For gases or vapors, one ppm is equivalent to one microliter per liter of gas.

ppb parts per billion

Dry weight basis Results printed under this heading have been adjusted for moisture content. This increases the analyte weight concentration to approximate the value present in a similar sample without moisture. All other results are reported on an as-received basis.

Laboratory Data Qualifiers:

C - Result confirmed by reanalysis
E - Concentration exceeds the calibration range
J (or G, I, X) - estimated value ≥ the Method Detection Limit (MDL or DL) and < the Limit of Quantitation (LOQ or RL)
P - Concentration difference between the primary and confirmation column >40%. The lower result is reported.
U - Analyte was not detected at the value indicated
V - Concentration difference between the primary and confirmation column >100%. The reporting limit is raised due to this disparity and evident interference…
W - The dissolved oxygen uptake for the unseeded blank is greater than 0.20 mg/L.

Additional Organic and Inorganic CLP qualifiers may be used with Form 1 reports as defined by the CLP methods.
Qualifiers specific to Dioxin/Furans and PCB Congeners are detailed on the individual Analysis Report.

Analytical test results meet all requirements of the associated regulatory program (i.e., NELAC (TNI), DoD, and ISO 17025) unless otherwise noted under the individual analysis.

Measurement uncertainty values, as applicable, are available upon request.

Tests results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff.

This report shall not be reproduced except in full, without the written approval of the laboratory.

Times are local to the area of activity. Parameters listed in the 40 CFR Part 136 Table II as “analyze immediately” are not performed within 15 minutes.

WARRANTY AND LIMITS OF LIABILITY - In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. THE FOREGOING EXPRESS WARRANTY IS EXCLUSIVE AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. WE DISCLAIM ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR PARTICULAR PURPOSE AND WARRANTY OF MERCHANTABILITY. IN NO EVENT SHALL EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL, LLC BE LIABLE FOR INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITHER SOLE OR CONCURRENT) OF EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL AND (B) WHETHER EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. We accept no legal responsibility for the purposes for which the client uses the test results. No purchase order or other order for work shall be accepted by Eurofins Lancaster Laboratories Environmental which includes any conditions that vary from the Standard Terms and Conditions, and Eurofins Lancaster Laboratories Environmental hereby objects to any conflicting terms contained in any acceptance or order submitted by client.

Appendix C
Summary of Records Reviewed

Appendix C
Summary of Records Reviewed
Webster Field Annex, St. Inigoes, Maryland

Date	Title	Author Affiliation
Environmental Restoration Program Record Research		
September 2010	Draft Preliminary Assessment for Munitions Response Program Webster Field Annex, Saint Inigoes, Maryland.	Tetra Tech NUS, Inc.
July 2012	Technical Memorandum- Expanded Preliminary Assessment - Former Aerial Bombing Range -Webster Field Annex, St. Inigoes, Maryland.	CH2M HILL
May 2012	Geophysical System Verification Results, Former Aerial Bombing Range	CH2M HILL
February 2012	Surface Geophysical Investigation Plan, Former Aerial Bombing Range - Webster Field Annex, St. Inigoes, Maryland.	CH2M HILL
October 2012	Draft Site Inspection Report- UXO 0001 Former Aerial Bombing Range, Webster Field Annex, St. Inigoes, Maryland.	CH2M HILL
November 2005	Draft Site Inspection Report for Rubble Area 1 and Rubble Area 2, Webster Field Annex, Naval Air Station Patuxent River, St. Mary's County, Maryland.	CH2M HILL
February 2003	Webster Field Annex, NAS Patuxent River, Site Visit TM	CH2M HILL
2018 - search	Other Environmental Liabilities database search - Building 8008 (Technical Services Lab)	OEL search
2018- search	Other Environmental Liabilities database search - Building 8076 (Fire Station 3)	
November 2016	EDR NEPA Check EDR Offsite Receptor Report EDR GeoCheck Report	Environmental Data Research, Inc.
2002 through 2016	NAS Patuxent River Complex Spill History (September 2002 - July 2016)	Naval Air Station Patuxent River
Internet Records		
October 2016	UCMR3. https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule	USEPA
February 2018	List of Rare, Threatened, and Endangered Species of St. Mary's County. http://dnr.maryland.gov/wildlife/Documents/StMarys_County_RTEs.pdf	Maryland Department of Natural Resources
October 2018	St. Mary's County, Maryland- GIS: http://www.co.saint-marys.md.us/GIS/	St. Mary's County, Maryland
October 2018	https://catalog.archives.gov/	National Archives Catalog
October 2018	https://aviation-safety.net/database/databases.php (ASN Accident Databse and Wikibase)	Aviation Safety Network
October 2018	http://www.baaa-acro.com/	Bureau of Aircraft Accidents Archives
October 2018	The Lexington Park Leader online news source: https://lexleader.net/fire-scout-hard-landing-at-webster-field-investigatedfield/	The Lexington Park Leader
October 2018	Southern Maryland Online: http://www.somdnews.com/enterprise/	The Enterprise
October 2018	County Times: https://countytimes.somd.com/	County Times, St. Mary's County, Calvert County
October 2018	Capital Gazette: http://www.capitalgazette.com/	Capital Gazette
Maps and Aerial Photographs		
1938- 1985	Aerial Photographs - 1938, 1952, 1957, 1964, 1985	Naval Air Station Patuxent River
1993- 2015	Aerial Photographs - 1993, 2003, 2007, 2013, 2015	Google Maps

Appendix D
Aerial Photographs

File Path: C:\Webster_Field\webster_field.apr

Figure 1
Webster Field
1938 Imagery

CH2MHILL

File Path: C:\Webster_Field\webster_field.apr

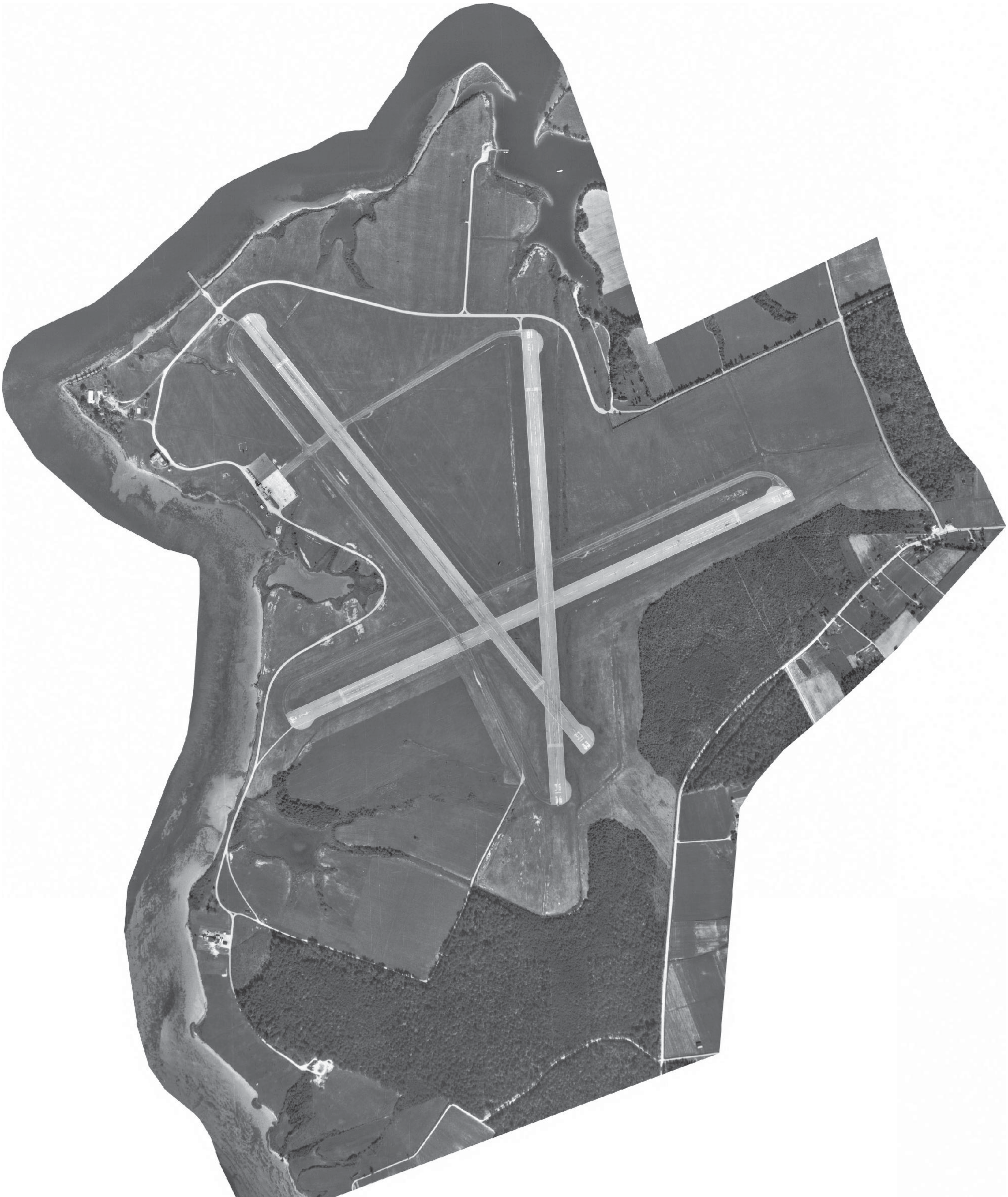
N

0 800 1600 2400 3200 Feet

Figure 1
Webster Field
1952 Imagery

CH2MHILL

File Path: C:\Webster_Field\webster_field.apr

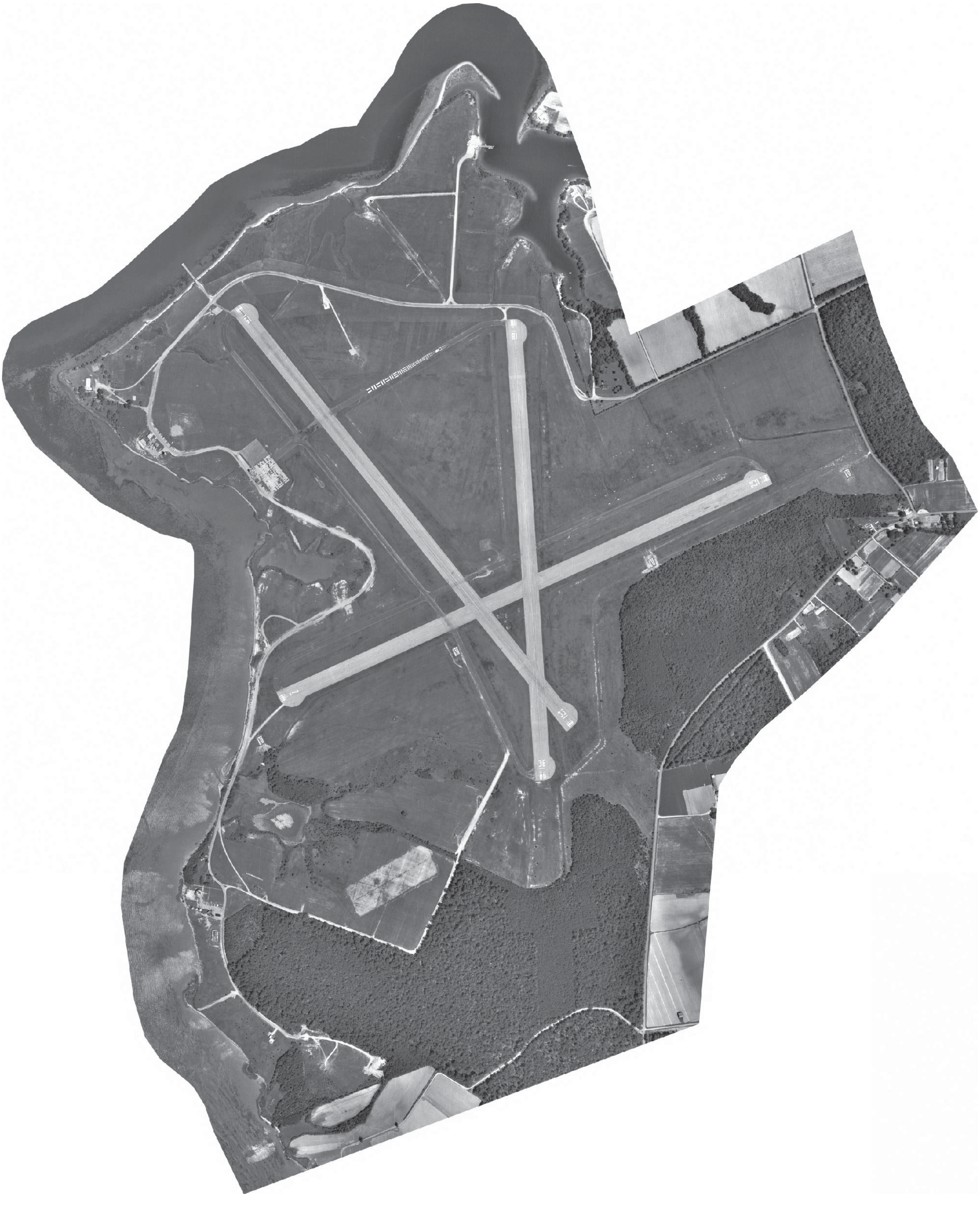


N

0 800 1600 2400 3200 Feet

Figure 1
Webster Field
1957 Imagery

CH2MHILL



N

0 800 1600 2400 3200 Feet

Figure 1
Webster Field
1964 Imagery

Figure 1
Webster Field
1985 Imagery

N

0 800 1600 2400 3200 Feet

CH2MHILL

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\682394_Webster_Field_PA\Historical_Imagery\Figure X - 1993.mxd9/18/2018AM038876

Legend

Installation Boundary

Historical Imagery - 1993
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

N

0 450 900
Feet

Imagery Source: ©1993 Google
Modifications have been made

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\682394_Webster_Field_PA\Historical_Imagery\Figure X - 2003.mxd9/18/2018AM038876

Legend

Installation Boundary

N

0 450 900

Feet

Imagery Source: ©2003 Google
Modifications have been made

Historical Imagery - 2003
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\682394_Webster_Field_PA\Historical_Imagery\Figure X - 2007.mxd9/18/2018AM038876

Legend

Installation Boundary

N

0 450 900 Feet

Imagery Source: ©2007 Google
Modifications have been made

Historical Imagery - 2007
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\682394_Webster_Field_PA\Historical_Imagery\Figure X - 2013.mxd9/18/2018AM038876

Legend

Installation Boundary

N

0 450 900 Feet

Historical Imagery - 2013
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

Imagery Source: ©2013 Google
Modifications have been made

ch2m

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\682394_Webster_Field_PA\Historical_Imagery\Figure X - 2015.mxd9/18/2018AM038876

Legend

Installation Boundary

N

0 450 900 Feet

Imagery Source: ©2015 Google
Modifications have been made

Historical Imagery - 2015
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

Appendix E
Interview Questionnaires and Communication Records

Review of the Historical Use of AFFFs and Potential Release of PFCs
NAS Patuxent River and Webster Field Annex

Introduction: The purpose of this survey is to determine the possible environmental releases or storage of AFFFs at NAS Patuxent River and Webster Field Annex, and to determine whether a follow-up interview is needed to obtain further information. The survey and interview will help us identify and document locations (i.e., sites) where PFC releases may have occurred. The information collected will be evaluated to determine if the site warrants further investigation, including soil or groundwater sampling.

This form is voluntary and any information you provide will be used strictly to evaluate the need for further site investigation. Please respond to all questions you are able to answer, in part or in whole. Please leave cells blank if an answer cannot be provided.

Your time and expertise are greatly appreciated.

Date/Time of Interview: Select date Select time	**Work Location (Installation/Building/Area):** Webster Field Annex 8076
Interviewee Name: Mr. Michael Carroll	**Position/Job Title:** District Fire Chief
How many years at current position: 2	**Phone/Email:** 3017574680 mike.carroll@navy.mil
1. What types of firefighting foams are currently used at the installation?	3% AFFF: Webster Field Annex 6% AFFF: Select an installation High Expansion Foam: Select an installation Other; please list:
2. What manufacturer's AFFF products are currently used at the installation?	3M ☑ Ansul ☐ Chemguard ☐ Other; please list:
3. Where are the AFFF solutions currently stored, transferred, or handled at the installation? Please describe.	3M Light Water AFFF 3% Mil Spec F-24385F
4. Is there a secondary containment in the AFFF storage area(s)?	Yes ☐ No ☑ Additional information:
5. Are your automated fire suppression systems currently fitted for AFFF or have they been retrofitted for use of high expansion foam?	☐ Currently fitted for AFFF ☐ Retrofitted for use of high expansion foam

(Question 5 continued)	Additional information:
6. Do you have an inventory of the amount of AFFF currently stored on the installation(s) or present in the automated fire suppression systems?	Yes ☑ No ☐ Additional information:
7. Can you describe the procedure for how the suppression systems are supplied with AFFF?	
8. Have there been inadvertent releases of AFFF from hangar fire suppression systems within recent years? a) If yes, provide the time frame, and the b) estimated location of the release	Yes ☐ No ☐ Year Month Select a month Location of release: Select location Additional information:
9. How are the discharges handled? (i.e. when the suppression system goes off)? Please describe.	
10. Provide a list of trucks and trailers currently carrying AFFF and where they are parked/stored? Use the "additional information" box to add more numbers or elaborate if needed.	Identify Truck/Trailer: / Location: 1. Foam 143 / 1. Fire Station 3 bldg 8076 2. Foam 144 / 2. Fire Station 3 bldg 8076 3. Engine 141 / 3. Fire Station 3 bldg 8076 4. / 4. Additional information:

11. Approximately how much AFFF (gallons) is carried/stored in the specified trucks/trailers?	Number of Gallons: 1. 50 2. 210 3. 50 4.
12. Are the truck(s) tested for spray patterns to make sure the equipment is working properly?	Yes ☑ No ☐ Additional information: Water Only
13. Is AFFF used during spray pattern testing or are foam distribution test kits used to eliminate AFFF waste stream?	☐ AFFF is used ☐ Foam distribution test kit is used
14. If AFFF is used during spray pattern testing, please describe the procedures used to contain and/or clean up the AFFF after release.	N/A
15. How often are these spray tests performed?	Spray test frequency: Daily Additional information:
16. Can you provide the locations of these spray tests?	Front of fire station.
17. Can you describe the procedure for how trucks and trailers are supplied with AFFF, and where this resupply occurs?	5 gallon buckets
18. Can you provide the procedures for how these vehicles are currently cleaned/decontaminated?	soap and water

19. When AFFF was used during a fire training exercise, how was the AFFF cleaned up and disposed of?	Not used.
20. Do you have recollection or records of AFFF being used? a) If yes, please indicate if they were used in response to the following:	Yes ☑ No ☐ Emergency response sites (i.e. crash sites and other fires) Additional information:
21. If no written records or incomplete written records are available, do you have anecdotal/verbal information and locations of spills or other emergency response incidents where AFFF was used? Please provide the approximate date, location, and a brief description of the incident(s).	1. 2. 3. 4. Date Location Description

22. Identify all Fire-Training Areas (FTAs) which currently or historically used AFFF.	Identify FTA Location	Current/Historic?
	1. N/A	1. Select one
	2. Location	2. Select one
	3. Location	3. Select one
	4. Location	4. Select one

<table>
<tr><td rowspan="2">23. For the FTAs identified above, please indicate:
a) The years of operation or date range.
b) The date when fire training at each FTA was last conducted.</td><td>Date Range:</td><td>Last Fire Training:</td></tr>
<tr><td>1. N/A
2.
3.
4.</td><td>1.
2.
3.
4.</td></tr>
<tr><td rowspan="2">24. Do you have information on how many gallons of AFFF were released in these FTAs?</td><td colspan="2">Number of Gallons</td></tr>
<tr><td colspan="2">1. N/A
2.
3.
4.</td></tr>
<tr><td rowspan="2">25. What types of fuels/flammables were used at each FTA?</td><td colspan="2">Fuel Type</td></tr>
<tr><td colspan="2">1. N/A
2.
3.
4.</td></tr>
<tr><td rowspan="2">26. Was remedial action conducted at these FTAs?
a) If “Yes”, please describe the remedial action.
b) Indicate the year remedial action was conducted, if known.
c) Indicate whether or not a new FTA was constructed on top of the original FTA following remediation in the “Additional Information” section.</td><td colspan="2">Yes ☐ Year
No ☐</td></tr>
<tr><td colspan="2">Additional Information:</td></tr>
<tr><td>27. What are the current fire-fighting training practices at this installation? Please describe.</td><td colspan="2">We do not conduct AFFF training.</td></tr>
<tr><td rowspan="2">28. What are the non-FTA locations where AFFF suppression systems are installed or AFFF/PFCs stored or used or disposed (i.e. hangars, fire stations, maintenance areas, wastewater treatment plants, metal plating facilities, AFFF ponds/lagoons, and/or aerospace, automotive, electronic facilities)</td><td colspan="2">Identify Non-FTA Location (site/building number/description)</td></tr>
<tr><td colspan="2">1. Fire Station 3 Bldg 8076 (245 gallons)
2.
3.
4.</td></tr>
</table>

29. Do these location(s) currently contain or have they historically contained AFFF/PFCs? a) If yes, please indicate the years/date range each location contained AFFF/PFCs.	Years or Date Range 1. Yes 2. Select one 3. Select one 4. Select one Additional information:
30. If applicable, when was the system at this **Non-FTA** converted from an AFFF to a high expansion foam? a) Indicate year of conversion.	Year of Conversion to High Expansion Foam 1. 2. 3. 4. Additional information:
31. Is there a metal plating/electroplating shop on base? a) If yes, please indicate the years of operation or date range.	Yes ☐ No ☐ Years of operation and additional information:
32. Is there anyone else or other base organization personnel that you would recommend we interview? If so, please list.	1. First Last 2. First Last 3. First Last 4. First Last

Thank you for your participation!

AFFF Inventory for Webster Field Annex				
Location/ Bldg	**Quantity (gal)**	**System Ready (SR) vs External Storage (ES)**	**Product Type**	**Notes**
Webster Field				
8076 Webster Fire Station	310	ES	3M 3%	3 different storage areas
8139 UAV			N/A	
Web Total	**310**			

Provided to CH2M September 2016 by District Fire Chief, Michael Carroll

Subject: Email correspondence concerning AFFF use at Webster Field Annex: Heidi Morgan (NAVFAC Washington) and Michael Carroll (District Fire Chief): Date September 2018

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Sent: Monday, September 24, 2018 10:18 AM
To: Ledbetter, John/WDC <John.Ledbetter1@jacobs.com>
Subject: [EXTERNAL] FW: Webster Bldg 8008

John,

See below. I checked the property record for the building and does not include it as well. Between the FD an medical surveillance group (industrial hygienist), I would conclude the building did not have that type of system in it. If you are still unsure then I would come for a building visit and look through old building maps (which are being organized in the vault currently).

Thanks Heidi
-----Original Message-----
From: Carroll, Mike D CIV CNI, N30
Sent: Monday, September 24, 2018 10:10 AM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Subject: RE: Webster Bldg 8008

Heidi,

I was told there are not any AFFF systems at Webster.

Mike

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Sent: Monday, September 17, 2018 9:56 AM
To: Carroll, Mike D CIV CNI, N30 <mike.carroll@navy.mil>
Subject: FW: Webster Bldg 8008

Hi Mike,

Who would know the following answers?

Thanks Heidi

-----Original Message-----
From: Ledbetter, John/WDC <John.Ledbetter1@jacobs.com>
Sent: Thursday, September 13, 2018 10:18 AM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Cc: Saunders, Carrie/AUS <Carrie.Saunders@jacobs.com>
Subject: [Non-DoD Source] Webster Bldg 8008

Good morning Heidi,

Hey, we are trying to wrap up the draft PA report for PFAS at Webster Field and in the process had to do a "Other Environmental Liabilities or OEL"
query in a database we have access to. Seems this is part of the PA process and SOPs we have been told to follow just in the last few months. In the process we found that Building 8008 is listed as a plating shop/machine shop. We also pulled some of the documents related to the building and see it has ventilation hoods/system so doesn't look to use any kind of mist suppressant system that would have PFAS. Just to be sure, we were wondering if you could confirm there was no usage of a mist suppressant system at this
building and PFAS has for fire suppressant hasn't been used. May be a
quick email or visit to that building tenant would confirm this.

This would help us to show we did look at other things from the query we did and did not find anything. Tanks and paint shops were also in the query but there is no evidence of any PFAS materials or spills.

John Ledbetter, P.G.
CH2M is now a Jacobs Company

Subject: Email correspondence concerning AFFF use and drinking water sampling at Webster Field Annex: Heidi Morgan (NAVFAC Washington), Justin Barlow (NAVFAC Washington): Date January 2017

-----Original Message-----
From: Barlow, Justin CIV NAVFAC Washington
Sent: Wednesday, January 25, 2017 2:07 PM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Cc: Donmoyer, Larry C. CIV NAVFAC Washington
Subject: RE: New AFFF Information

Heidi,
It was not required by EPA to do the testing at Webster or Solomons. However, the region had the sampling conducted a few months ago, but I have not received the reports yet. I will email to see when I can expect them.

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Sent: Wednesday, January 25, 2017 2:04 PM
To: Steckler, David J CIV NAVFAC Washington; John.Ledbetter@CH2M.com; Quinn.Philiposian@ch2m.com
Cc: Rambo, Kyle E CIV NAVFAC Washington, Environmental Dept; McDaniel, Lance E CIV NAVFAC Washington, PAXR PWD; Donmoyer, Larry C. CIV NAVFAC Washington; Barlow, Justin CIV NAVFAC Washington
Subject: New AFFF Information

All,

Last week we had a site visit w/ a retired Fire Fighter (Don Ervin) from Pax River. Mr. Ervin showed us where AFFF was used. He showed us where daily checkouts of crash rescue fire truck equipment were conducted (the old wash rack at Taxiway Alpha-Taxiway Bravo). The checkout included spraying AFFF (to ensure it was functioning). Kyle it is where you showed me.

We asked Mr. Ervin if AFFF was used at Webster (because we were told through interviews it was not). He stated he didn't think so, but called me after the site visit and said he spoke to one the retired fire captains (Bobby Johnson) from Webster and he stated they did checkouts as well.

I just spoke to the Mr. Johnson and he said they checked the fire truck AFFF equipment monthly along the runway. He also stated he did not go out for the monthly checks, but he had a call into another retired fire fighter that worked at Webster that knew where it was used. I asked Mr. Johnson if he and the other fire fighter were willing to show me where on Webster and he said yes, and that he would be in touch once he heard back from the other fire fighter.

Justin or Larry was the drinking water well over there included in the UMCR3.
r/
Heidi Morgan
NAVFAC Pax River Environmental
Environmental Restoration Program Manager
301-757-4897

Subject: Email correspondence concerning AFFF use at Webster Field Annex: Heidi Morgan (NAVFAC Washington), Quinn Philiposian (CH2M). Date January 2017

Note: Only Item 2 refers for Webster Field Annex. All other items concern NAS Patuxent River.

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River [mailto:heidi.a.morgan@navy.mil]
Sent: Tuesday, January 31, 2017 1:48 PM
To: Philiposian, Quinn/WDC <Quinn.Philiposian@ch2m.com>
Cc: Ledbetter, John/WDC <John.Ledbetter@CH2M.com>; Saunders, Carrie/AUS <Carrie.Saunders@ch2m.com>; Struve, Susana/WDC <Susana.Struve@CH2M.com>
Subject: RE: Action items from yesterday 01/19 [EXTERNAL]

All,

Item 2 below - See attached map showing were the AFFF was used on Webster Field. Fire Department personnel stated they would approach the taxiway at the T and either go right or left. Then go about 100'- 150' and spray the AFFF on the runway to ensure the equipment functioned and the foam set up correctly.

In addition, attached is the site table with some recommendations.

Item 3 below - I will check and see if the photo lab POC was able to get us the old photos at the end of the week.

Item 4 - no update.

Heidi
-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Sent: Friday, January 27, 2017 7:20 AM
To: 'Quinn.Philiposian@ch2m.com'
Cc: John.Ledbetter@CH2M.com; Carrie.Saunders@ch2m.com; Susana.Struve@CH2M.com; Steckler, David J CIV NAVFAC Washington
Subject: RE: Action items from yesterday 01/19

All,

See my comments under the actions below.

-----Original Message-----
From: Quinn.Philiposian@ch2m.com [mailto:Quinn.Philiposian@ch2m.com]
Sent: Friday, January 20, 2017 8:35 AM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Cc: John.Ledbetter@CH2M.com; Carrie.Saunders@ch2m.com; Susana.Struve@CH2M.com
Subject: [Non-DoD Source] Action items from yesterday 01/19

Good morning Heidi,

Per your request, I've prepared a list of action items for you to follow up on at the base.

1. 2385 HAZMART - ask Gomez about quantity of May 2013 release.

50 gallons on AFFF was released.

2. Webster - Call Bobby Johnson, former (Fire Captain?) at Webster who can show us where they tested truck AFFF spray regularly. Phone number is (301) 481-7022.

Contacted Bobby see email sent 1/25/2017 - waiting to hear back from him to show us where on Webster AFFF was used.

3. Photo Lab - check for old photos of crash incidents. Per Mr. Ervin, a photographer was always present on the scene of crashes. Wish we had heard about this before!

The photo lab does not have any pictures, they were sent to Navy Yard Archives, but I spoke to the former photographer who has some pictures of training exercises with an off base Fire Department at Site 41 (when using AFFF) and he will provided me copies. I will forward when I receive.

4. Air Ops Dept. Supply - Check if they have records of when they first procured AFFF. Mr. Ervin said all their supplies would have been ordered through Air Ops Dept. Supply, and the woman who worked there at the time was Mary (last name unknown).

This action item was to see if possible archival procurement records which could show how much AFFF was ordered.

I spoke to Air Ops the employee who would know has retired. I have another POC that I will speak with, but she is new to the position.

Thanks! Have a great weekend.

- Quinn

Quinn Philiposian

Geologist

D 703.376.5212

C 808.285.0700

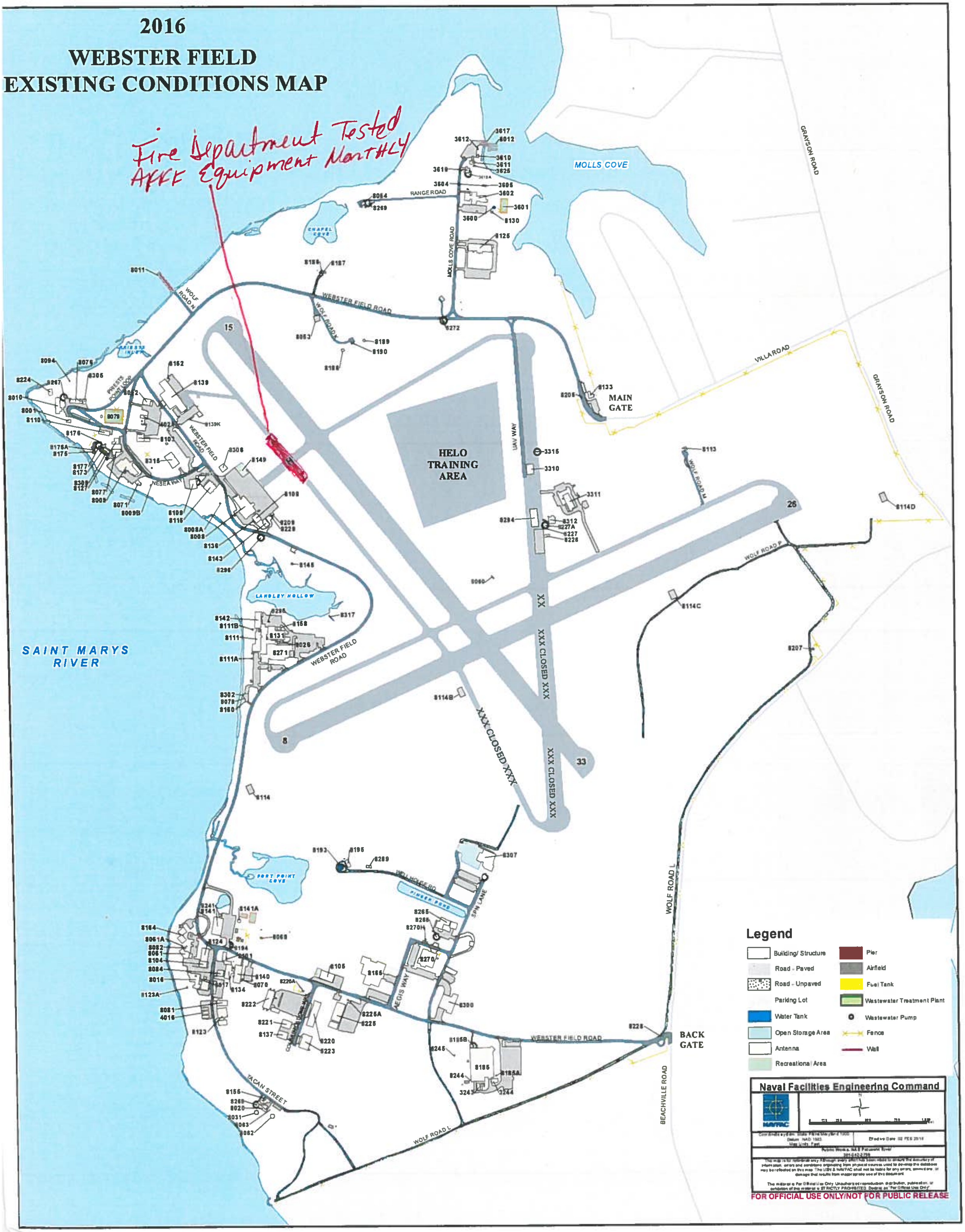
CH2M

2411 Dulles Corner Park, Suite 500

Herndon, VA 20171

2016
WEBSTER FIELD
EXISTING CONDITIONS MAP

Fire Department Tested AFFF Equipment MonTHLY



Subject: Email correspondence concerning AFFF use at Webster Field Annex: Heidi Morgan and David Steckler (NAVFAC Washington), Glen Yannayon and Joseph Spalding and Kevin Wood (PAX/ Webster Field Annex Fire Department)

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River [mailto:heidi.a.morgan@navy.mil]
Sent: Tuesday, February 09, 2016 3:26 PM
To: Ledbetter, John/WDC <John.Ledbetter@CH2M.com>
Subject: FW: Water Supplies at Webster and Solomons

FYI, for future use. In addition, Mr. Spalding provided me with some great information. I told him you all would be interviewing him as well. Mr. Wood is knowledge to all the systems now and any releases in the past years.

Heidi

-----Original Message-----
From: Steckler, David J CIV NAVFAC Washington
Sent: Tuesday, February 09, 2016 3:13 PM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Subject: RE: Water Supplies at Webster and Solomons

That should do it--thanks.

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Sent: Tuesday, February 09, 2016 2:56 PM
To: Steckler, David J CIV NAVFAC Washington
Subject: RE: Water Supplies at Webster and Solomons

David,

I spoke to Joseph Spalding (who starting work here in 1982, he maintained all the suppression systems on base until recently) and Kevin Wood who has maintained the systems for the last 7 years (taking over from Mr. Spalding). Joseph said they started using AFFF 6% in the 1990's and stopped approximately 5 years ago. He stated the only AFFF (at 3%) at Webster is in a fire apparatus in case a aircraft crash. There has never been an aircraft crashes that required a fire to extinguished at Webster. All fire training was conducted at Pax and not Webster.

The Solomons Building 6454 (Hazmat Storage) has fire suppression system containing AFFF at 3%. Bldg. 6454 was built in the late 1990's and did have 6% AFFF in it up until 2 years ago. The system never discharged any AFFF.

Hope this helps and let me know if you need anything else.

Heidi

-----Original Message-----
From: Steckler, David J CIV NAVFAC Washington
Sent: Tuesday, February 09, 2016 9:52 AM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Subject: RE: Water Supplies at Webster and Solomons

Thanks--that's exactly the kind of information that I was looking for.

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Sent: Tuesday, February 09, 2016 9:38 AM
To: Steckler, David J CIV NAVFAC Washington
Subject: RE: Water Supplies at Webster and Solomons

I spoke with the Glen Yannayon with Base Fire Department (FD) and asked about AFFF being stored, used or spilled at Webster and Solomons. There is an aircraft rescue and firefighting response vehicle at Webster to support aircraft crashes with AFFF at 3%. Glen has been with the FD for 20 years and said that AFFF was never used to put out and aircraft fire at Webster. All the crashes at Webster have been what they call hard crash (no fire involved). In addition all crash training was performed at Pax. I spoke to M. Smolek he said that there were no aircraft hangers at Webster, there are now but for UAV's. I will inquire to the type of system it is with IAP (contractor maintains the fire suppression systems on base).

I am going to talk to the IAP contractor. They have one individual that has been around for 40 plus years and hopefully can recall whether Webster used AFFF.

Solomon's never had AFFF stored or used for aircraft fire suppression. They do however have a hazmat building that has 3% AFFF in the buildings fire suppression system. I don't believe this building to be old. I will check the on the age.

Subject: Email correspondence concerning AFFF use at Webster Field Annex: Heidi Morgan (NAVFAC Washington) and Michael Smolek (NAVFAC Washington): Date August 2016

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Sent: Tuesday, November 13, 2018 10:36 AM
To: Ledbetter, John/WDC <John.Ledbetter1@jacobs.com>
Subject: RE: Webster Field AFFF [EXTERNAL]

John

I remember asking this question and was told that AFFF was not used on the helicopter crash. We could not find the crash report, a lot them were disposed of.

Thanks Heidi

-----Original Message-----
From: Ledbetter, John/WDC <John.Ledbetter1@jacobs.com>
Sent: Monday, November 12, 2018 2:26 PM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Cc: Saunders, Carrie/AUS <Carrie.Saunders@jacobs.com>
Subject: [Non-DoD Source] RE: Webster Field AFFF [EXTERNAL]

Hey Heidi,
I hate to bug you again about Webster and previous information we received below from Mike Smolek but one of our PFAS folks was asking if we could get any more information about the CH-53E helicopter crash and if AFFF was used on it. I found on the internet that that crash happened on October 6, 1978 at Webster and 3 crew escaped with minor injuries but we don't know if the crash truck and foam was used. Is there any kind of crash report that can be accessed or if the fire department has any records of this crash? Or better yet, would they have even used foam on a helicopter crash?

If not, we won't worry about it. Thank you.

Thank you.

-----Original Message-----
From: Morgan, Heidi A CIV Navfac Wash, PWD Pax River <heidi.a.morgan@navy.mil>
Sent: Monday, August 08, 2016 1:58 PM
To: Ledbetter, John/WDC <John.Ledbetter1@jacobs.com>
Subject: FW: Webster Field AFFF [EXTERNAL]

See below.

-----Original Message-----
From: Smolek, Michael A Sr. CIV NAVFAC Washington, ENV
Sent: Monday, August 08, 2016 1:24 PM
To: Morgan, Heidi A CIV Navfac Wash, PWD Pax River
Subject: RE: Webster Field AFFF

Heidi-- Solomons- The only aircraft that were ever at Solomons for flight ops purposes were blimps during WWII. There is an helicopter pad there now used only for emergency evacuations. But it is my understanding this is very rarely used and wouldn't have foam capability.

Webster- Until the UAV hangars were built there recently there were never any hangars at Webster. Also the runways are short, built for WWII aircraft. I talked with Pat Woodburn who was the Facilities Manager there from 1974-2015 and he told me that he thought that during some flight operations that a crash truck was sent from the main base on a special basis. He didn't know if they carried foam or not. He remembered only two crashes from his 40 years there. One was a crash in the late 1970s or early 1980's of a CH53(E?) helicopter. He was not on board that day so doesn't know if foam was used or not. It was at the approach end of R/W32 and left a large crater. The other was a glider, so foam would not have been used. He indicated that jets didn't land at Webster because of the short runways.

Mike

Appendix B
Health and Safety Plan

Naval Facilities Engineering Command

Washington
St. Inigoes, Maryland

Health and Safety Plan
Basewide PFAS Investigation at Webster Field Annex

Naval Air Station Patuxent River
St. Inigoes, Maryland

March 2020

Washington
St. Inigoes, Maryland

Health and Safety Plan
Basewide PFAS Investigation at Webster Field Annex

Naval Air Station Patuxent River
St. Inigoes, Maryland

March 2020

Prepared for NAVFAC Washington
by CH2M HILL, Inc.
Herndon, Virginia
Contract N62470-16-D-9000
CTO 4256

Emergency Contacts

24-hour Injury Reporting – 1-888-449-7787 Global Assistance and Response Hotline – 443-221-6281	
Medical Emergency – 301-342-3911 (from a base phone dial 3911) Facility Medical Response #: 301-342-3911 **Non-Emergency Urgent Care** – Abell House Lane 45325 Abell House Lane California, MD 20619 301-862-1807	**Non-Emergency Medical Injuries** WorkCare: 1-888-449-7787 Call no matter how minor the injury as soon as possible
Fire/Spill Emergency – 301-342-3911 (from a base phone dial 3911)	**HSE Lead – Health, Safety, Security & Environment** Stephanie DeWitt/DEN (720) 346-4851
Security & Police – 301-342-3911 (from a base phone dial 3911)	**CH2M HILL Responsible Health and Safety Manager (RHSM)** Name: Carl Woods Office: 513-889-5771 Mobile Phone: 513-319-5771
Utilities Emergency Phone Numbers Emergency Response for Utility (Gas/Oil Leaks): 301-342-3911 (from a base phone dial 3911) **Also Report ALL Utility Hits to Dig Permit Coordinator:** 301-342-3911 and 301-757-4710 (off duty number 202-439-7083)	**CH2M HILL Human Resources Department** Phone: Employee Connect toll-free number 1-877-586-4411 (U.S. and Canada)
CH2M Project Manager Name: John Ledbetter Phone: 540-454-9039 Or Name: Mark Hoover Phone: 352-316-65183344	**CH2M HILL Worker's Compensation:** Contact Market HR dept. to have form completed
CH2M Safety Liaison (SL) Name: Don Martinson Phone: 540-270-7859	**Media Inquiries Corporate Strategic Communications** **Name:** Lorrie Paul Crum **Phone: (**720) 286-0255
CH2M HILL Project Environmental Manager Name: Erin Twamley Phone: 559-943-7468	**Automobile Accidents** **Rental**: Vehicle Accident Form required to be sent to AutoClaims@jacobs.com (see Vehicle Accident Guidance attached to this plan) **Fleet Vehicle**: Karyna Zarate 281-721-8634
Federal Express Dangerous Goods Shipping Phone: 800/238-5355	**CHEMTEL (hazardous material spills)** **Phone: 800/255-3924**
Facility Alarms: -TBD upon site arrival	Evacuation Assembly Area(s): -TBD upon site arrival
Facility/Site Evacuation Route(s): -TBD upon site arrival	

Directions and Map to Local Hospital

Local Hospital

St. Mary's Hospital
25500 Point Lookout Rd., Leonardtown, Maryland
(301) 475-6110

Local Hospital Directions

1) Leave NAS Patuxent River through Gate 2.
2) Proceed straight across Route 235 on Route 246 (Great Mills Rd).
3) Follow Route 246 (Great Mills Rd), for approximately 3 miles to Route 5.
4) Make a right onto Route 5 (west) and follow for 8 miles to Leonardtown Maryland.
5) Follow the signs to St. Mary's Hospital.

Contents

Attachments

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Approval

This Health and Safety Plan (HSP) has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific project and site conditions and identified scope(s) of work and must be amended if those conditions or scope(s) of work change.

By approving this HSP, the Responsible Health and Safety Manager (RHSM) certifies that the personal protective equipment has been selected based on the project-specific hazard assessment.

ORIGINAL PLAN

Original Plan Written by: Carl Woods, CSP **Date:** 3/17/2020

RHSM Approval: Carl Woods, CSP **Date:** 3/17/2020

Project Manager Approval: Mark Hoover **Date:** 3/20/2020

REVISIONS:

Revisions Made By: **Date:**

Description of Revisions to Plan:

Revisions Approved By: **Date:**

1 Applicability

Note: CH2M is a subsidiary of Jacobs. For purposes of this document, CH2M Core Standards, Standards of Practice (SOPs) may still be referenced. Reference to CH2M employees may still be referenced if the prime contract is held by CH2M.

This HSP applies to:

- All Jacobs staff, including subcontractors and tiered subcontractors of Jacobs working on the site;
- All visitors to Jacobs construction or remediation sites in the custody of Jacobs (including, but not limited to, visitors from the Client, the Government, or the public,).

In addition, Subcontractors and tiered subcontractors shall also follow any of their company HSE programs, and site-specific HSPs and AHAs.

This HSP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of Jacobs.

This HSP defines the procedures and requirements for the health and safety of staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HSP will be kept onsite during field activities and will be reviewed as necessary. The HSP will be revised as project activities or conditions change or when supplemental information becomes available. The HSP adopts, by reference, the CH2M Enterprise-Wide Core Standards and Standard of Practice (SOPs), as appropriate. In addition, applicable requirements contained in the CH2M Health, Safety and Environment (HSE) Field Handbook (Handbook) will be implemented. The Handbook is available as a stand-alone Handbook at the project site. The HSP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HSP and any governing regulation, the more stringent and protective requirement shall apply.

All staff and subcontractors must sign the employee sign-off form (Attached to this HSP) to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Liaison (SL).

2 General Project Information

2.1 Project Information and Background

Project Number: 663482	**Project/Site Name:** Basewide Per- and Polyfluoroalkyl Substances (PFAS) Site Investigation at Webster Field Annex
Client: Department of the Navy; Naval Facilities Engineering Command- Washington	**Site Address:** Webster Field Annex, St. Inigoes, Maryland
CH2M HILL Project Manager: John Ledbetter	**CH2M HILL Office:** WDC
DATE HSP Prepared/Revised: 3/17/2020	**Date(s) of Site Work:** April 2020 – December 2020

Site Access Requirements:

Base access must be coordinated with Heidi Morgan (301-757-4897) from NAS Patuxent River, CH2M's base contact, by completing a Contractor Base Access Request Form prior to work.

2.2 Site Background, Setting, and Map

Webster Field Annex is in St. Inigoes, Maryland, under the command of Naval Air Station (NAS) Patuxent River.

A total of 2 sites at Webster Field Annex will be included in the Site Inspection (SI) and investigation activities. This SI is being conducted for the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), under the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) 9000 Program.

Webster Field Annex, under the command of NAS Patuxent River, was identified as an installation where aqueous film-forming foam (AFFF) was likely used in fire-fighting activities, resulting in potential releases of PFAS to groundwater.

The primary Navy releases of PFAS were through the use of AFFF for fire and emergency responses and during testing and training activities; however, PFAS may be released to the environment from other activities, including industrial operations (specifically chrome plating) and the storage, handling, or disposal of PFAS-containing materials or wastes. Interviews with fire department and base personnel completed for the Preliminary Assessment (PA) report for PFAS (CH2M HILL, Inc. [CH2M], 2019) identified two areas at Webster Field Annex where AFFF was reportedly or potentially released. The focus of the PA was on releases of AFFF.

Potential PFAS source areas included in this SI are:

- Fire Station 3, Building 8076
- AFFF Crash Truck Maintenance Check Area

2.3 Description of Tasks

Below is a description of the tasks covered by this plan. Any additions or changes in scope will require a revision to this HSP; see Change Management below.

The following objectives were identified for each site:

- ***Determine whether PFAS (if present) exhibit concentrations that exceed the project action limits (PALs) for soil and groundwater at the suspected source areas identified in the April 2019 PA.***
- ***Determine the potential for PFAS (if present) to migrate offsite.***

Scope of work covered by this HSP includes:

- Surveying/Utility Locating
- Surface Soil and Subsurface Sample Collection (via DPT)
- Monitoring Well Installation for PFAS Soil and GW Samples and Water Level Measurements
  - Temporary piezometers will be installed/sampled
- Surface Water and Sediment Soil Sampling
- IDW Management and Disposal

2.4 Change Management

Changes to this HSP shall be documented and approved by the CH2M HILL Responsible Health and Safety Manager for the project. The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and

2

- New hazards or hazards not previously identified that are not addressed in this HSP.

2.5 Changes to Health and Safety Plans

Changes to the HSP shall be documented and accepted by using the Health and Safety Field Change Request (FCR) form (included in Attachments) or by resubmitting a revised HSP for acceptance. A revised HSP should be produced when a large number of changes (e.g., 15 or more not including AHAs) using FCRs has been employed. The CH2M HILL Project Manager (PM) and RHSM shall be responsible for the review and acceptance of the FCR, and the RHSM will maintain an FCR log of approved changes. Field Change Requests are not required for safety-related changes that a Safety Coordinator (SC) or RHSM would normally make in the field, such as upgrade or downgrade to PPE within pre-established action levels, expansion or reduction of work control zones based on air monitoring results, and similar changes made within the operating parameters of the HSP. The field copy of the HSP shall be kept up to date by annotating the appropriate section (i.e., update to AHA) to indicate that an FCR is in effect; copies of FCRs should be kept with the HSP. The FCR number must be referenced in the HSP and available for review.

2.6 Daily Safety Meetings and Pre-Task Safety Plans

Safety meetings are to be held with all project personnel in attendance to review the hazards, controls, and required procedures/AHAs that apply for each day’s activities, as well as any environmental issues, requirements and/or best management practices:

- Everyone involved in the day’s work needs to sign a sign-in form to show they’ve had a briefing/attended a meeting.
- Pre-Task Safety Plans (PTSPs) serve the same purpose as general safety meetings, but the PTSPs are completed by individual crews to focus on those hazards posed by their specific work.
- For smaller crews, or if there is just one activity, the PTSP is often used as a means to document the overall Safety Meeting.

A copy of the PTSP and Daily Safety Meeting sign-in sheet is included as an Attachment.

2.7 StepBack Process

(Reference BIAF Global Guide, BIAF-350-G-01, HSE StepBack Process)

The StepBack process applies to all Jacobs employees and subcontractors that are performing tasks in an office or at a site location. It is a critical thinking process to supplement HSE planning tools such as the Pre-Task Safety Plan, AHAs, and HSPs and should be applied at the start of shift, after a break, when the task or location change, when adjacent work may present additional hazards, or any other hazard or change to task is identified. Training for initial roll-out will be provided via 8-hour HAZWOPER refreshers or a briefing from the RHSM.

The process is comprised of three key steps:

Identify: Prior to and while executing the task, “StepBack” and identify any new hazards or changes to the environment, including reviewing personal physical and mental preparedness. Ask the questions on the card (see wallet card or the form attached to this plan); if “yes” is the answer to all questions, the task may proceed. If you answer “no” to any of the questions, STOP work and contact your HSM/EM. Together you will work through the following steps to identify corrective actions.

Evaluate: Assess the risk associated with the new hazard or change to the environment to understand the level of risk.

Act: Take appropriate action. Engage with project management or supervisors as necessary to identify the risk mitigation measures. Mitigation measures (changes to means/methods, use of different PPE than specified in the AHA, or similar) would require RHSM involvement and potentially revision to the AHA and or HSP.

Completion: After the job has finished ask:

Did you feel safe doing the job?
Were others nearby working safely?
Can any improvements be made next time?

If any of these questions yield a "no" response, follow up with feedback to the PM, RHSM, or your supervisor.

2.8 Subcontractor HSE Chartering Meeting

A subcontractor HSE chartering meeting shall be held with subcontractors performing field work on the project. The purpose of the meeting is to discuss and agree on key HSE requirements on a project, and to emphasize and reinforce CH2M HILL expectations for subcontractor HSE performance. The target audience includes key CH2M HILL project staff with HSE responsibilities (e.g., PM, RHSM, SC, Field Team Leader (FTL)) and key Subcontractor staff (e.g., project manager, supervisors, designated field HSE contact, drill team leads, foreman). For small scale projects (e.g., small drill crew and limited CH2M HILL staff), all the subcontractor crew members should attend if available. The meeting should be held prior to mobilization with enough time to ensure that HSE issues identified can be addressed prior to the start of work. The meeting can be held over the phone or in person depending on project needs. An example agenda can be found in the E&NM Program Element Guideline, "Subcontractor HSSE Chartering Meeting."

3 Project Organization and Responsibilities

A full description of responsibilities, including Employee Responsibilities and Authority, can be found in the Handbook, Section 3, "Roles and Responsibilities."

3.1 Client

Contact Name:	David Steckler - Navy Remedial Project Manager (RPM)
Phone:	202-685-3275
Facility Contact Name:	Heidi Morgan
Phone:	301-757-4897

3.2 CH2M HILL

Project Manager:	
PM Name:	John Ledbetter
Office:	WDC
Telephone number:	703-376-5172
Cellular Number:	540-454-9039

Environmental Manager:	
EM Name:	Erin Twamley
Office:	RAL
Telephone number:	919-875-4311x51763
Cellular Number:	559-943-7468

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Responsible Health and Safety Manager:	
RHSM Name:	Carl Woods
Office:	CIN
Telephone number:	513-889-5771
Cellular Number:	513-319-5771

Safety Liaison:	
SC Name:	Don Martinson
Office:	WDC
Telephone number:	540-667-1904
Cellular Number:	540-270-7859

3.3 CH2M HILL Subcontractors

Subcontractor: To Be Determined	
Contact Name:	
Telephone number:	
Cellular Number:	

Subcontractor: To Be determined	
Contact Name:	
Telephone number:	
Cellular Number:	

3.4 Client Contractors

Client Contractor:	
Contact Name:	
Telephone number:	
Cellular Number:	

Client Contractor:	
Client Name:	
Telephone number:	
Cellular Number:	

This HSP does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the client contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues).

4 Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the standards of conduct stated in the Handbook (Section 4, "Standards of Conduct"), comply with all requirements of this HSP, and Subcontractors must also comply with the safety requirements of the Subcontractor HSP. Forms related to Subcontractor Safety (i.e., Observation Hazard Form and Stop Work Order Form) are attached to this HSP.

5 Project Hazard Analysis

A health and safety risk analysis (Table 1) has been completed for this project. Specific project activities are listed in Table 1 with a designation of who performs the task, CH2M HILL (C) or Subcontractor (S). An Activity Hazard Analysis has been developed for each project activity. AHAs prepared for CH2M HILL activities are included as an attachment to this HSP.

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL prior to the start of work. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project-specific safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

- Surveying/Utility Locating

- Surface Soil and Subsurface Sample Collection (via DPT)
- Monitoring Well Installation for PFAS Soil and GW Samples and Water Level Measurements
  - Temporary piezometers will be installed/sampled
- Surface Water and Sediment Soil Sampling
- IDW Management and Disposal

Table 1. Health and Safety Risk Analysis Table

Associated Hazard Section	Project Activity	Utility Clearance, Surveying	Surface and Subsurface Soil Sampling, Groundwater Sampling	Monitoring Well Installation (Drilling)/Soil Sampling	IDW Mgmt.
General Hazards – Refer to General Hazards and Controls in HSE Handbook, Section 7.					
Bloodborne Pathogens		C, S	C, S	C, S	C, S
Chemical Storage			C, S	C, S	C, S
Driving Safety		C, S	C, S	C, S	C, S
Electrical Safety			C, S	C, S	C, S
Field Vehicles		C, S	C, S	C, S	C, S
Fire Prevention		C, S	C, S	C, S	C, S
General Practices and Housekeeping		C,S	C, S	C, S	C, S
Hazard Communication		C,S	C, S	C, S	C, S
Knife Use				C, S	
Lighting		C, S	C, S	C, S	C, S
Manual Lifting		C,S	C, S	C, S	C, S
Personal Hygiene		C, S	C, S	C, S	C, S
Personal Security		C, S	C, S	C, S	C, S
Shipping and Transportation of Hazardous Waste			C	C,S	C,S
Substance Abuse		C,S	C, S	C, S	C, S
Project-Specific Hazards – Refer to HSE Handbook, Section 8, and the additional project-specific controls in this plan when specified.					
All-Terrain (ATV) Vehicles			C,S	C,S	
Compressed Gas Cylinders			C,S	C,S	C,S
Drilling			C,S	C,S	C,S
Drum and Portable Tank Handling				C,S	C,S
Drum Sampling Safety				C,S	C,S
Flightline Safety		C,S	C,S	C,S	C,S
Forklifts Operations			C,S	C,S	C,S
Groundwater Sampling/Water Level Measurements			C	C, S	C, S
Hand and Power Tools		C,S	C,S	C,S	C,S
Portable Generators			C,S	C,S	
Pressurized Lines/Equipment			C,S	C,S	C,S
Pressure Washing Operations			C,S	C,S	

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Table 1. Health and Safety Risk Analysis Table

Associated Hazard Section / Project Activity	Utility Clearance, Surveying	Surface and Subsurface Soil Sampling, Groundwater Sampling	Monitoring Well Installation (Drilling)/Soil Sampling	IDW Mgmt.
Steep Slopes and Uneven Walking Surfaces	C,S	C,S	C,S	C,S
Stream Crossing	C,S	C,S	C,S	C,S
Traffic Control	C,S	C,S	C,S	C,S
Utilities (overhead)			C,S	
Utilities (underground)			C,S	
Working around Material Handling Equipment			C,S	C,S
Working Alone	C,S			
Noise	C,S	C,S	C,S	C,S
Ultraviolet Light exposure (sunburn)	C,S	C,S	C,S	C,S
Temperature Extremes	C,S	C,S	C,S	C,S
Biological Hazards – Refer to Biological Hazards in HSE Handbook, Section 10, and the additional project-specific controls in this plan when specified.				
Bees and Other Stinging Insects	C,S	C,S	C,S	C,S
Mosquito Bites	C,S	C,S	C,S	C,S
Poison Ivy, Oak and Sumac	C,S	C,S	C,S	C,S
Snakes	C,S	C,S	C,S	C,S
Spiders – Brown Recluse and Black Widow	C,S	C,S	C,S	C,S
Ticks	C,S	C,S	C,S	C,S

C – Hazard section applicable to CH2M HILL personnel

S – Hazard section applicable to Subcontractor personnel

6 Hazards and Controls

Safe work practices and hazard control measures to reduce or eliminate potential hazards as identified in Table 1 are stated in the Handbook, Sections 7-10, the associated CH2M HILL SOP, and are addressed in project AHAs. Any additional project-specific control measures, or those hazards requiring additional emphasis, are identified in the following sections.

Always consult the appropriate CH2M HILL Enterprise SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

7 Hazard Communication

As indicated in Section 7 of the Handbook, under “Hazard Communication,” the hazard communication (HazCom) coordinator (the SC or qualified designee) must perform the following (additional HazCom duties are outlined in the Handbook):

- Complete an inventory of chemicals brought on site by Jacobs using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by subcontractors is available;
- Request or confirm locations of Globally Harmonized System (GHS) compliant (i.e., consisting of 16 sections that appear in the same order and contain uniform information regarding the chemical) safety data sheets (SDSs) from the client, contractors, and subcontractors for chemicals to which Jacobs employees potentially are exposed;
- For chemicals used by Jacobs workers, before or as the chemicals arrive onsite, obtain a SDS for each hazardous chemical and include on the chemical inventory sheet (attached to this HSP) and add the SDS to the SDS attachment section of this HSP (or maintain in an accessible binder onsite). Ensure everyone knows where SDSs are kept;
- The six required elements of the GHS label must include the product identifier, pictograms, signal word, hazard statements, precautionary statements, and the name, address, and telephone number of the chemical manufacturer, importer or other responsible party;
- The manufacturer's original label on any incoming regulated product must not be removed or defaced. The manufacturer's label and markings must be retained on the package or container until it is sufficiently cleaned of residue and purged of vapors to remove any potential hazards;
- Ensure all secondary containers are labeled in compliance with GHS labeling requirements. If GHS compliant information has not yet been provided by the manufacturer or chemical distributor, the HCC must contact the manufacturer or chemical distributor and document in the chemical inventory when the GHS labeling information will be available, until the labeling requirement is fulfilled;
- In the United States, the container label shall be in English, although labels in other languages may be kept as well. Container labels in other languages for non-speaking English speaking workers will be made available when specified by the client for their project site or facility;
- Give employees required chemical-specific HazCom training using the chemical-specific training form included as an attachment to this HSP and ensure that the GHS supplemental VO module has been completed.

8 Contaminants of Concern

Considerations of the potential contaminants of concern (COCs) and their occupational exposure limits and signs and symptoms of exposure were used to determine engineering and administrative controls described in the "Project-Specific Hazard Controls" section of this HSP, as well as PPE and site monitoring requirements.

8.1 Per- and polyfluorinated alkyl substances

What are per- and polyfluorinated alkyl substances?

Per- and polyfluorinated alkyl substances (PFAS), or more accurately perfluoroalkyls, are manmade compounds used in the manufacture of stain, oil, and water resistant consumer products. They are also found in products such as firefighting foams, cleaners, cosmetics, paints, adhesives and insecticides. PFAS are persistent in the environment, because natural processes do not rapidly degrade them.

The U.S. Environmental Protection Agency has identified several PFAS used in manufacturing that the agency considers potentially important environmental contaminants. They are: perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA) and perfluorobutanesulfonic acid (PFBS).

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In 2006, EPA and eight major companies launched the 2010/15 PFOA Stewardship Program. As part of this program, those companies committed to reduce emissions and product content of PFAS by 95 percent by 2010, and to work toward eliminating emissions and product content by 2015.

How are people exposed to PFAS?

PFAS are used in manufacturing processes, so they are not present at high concentrations in most consumer products. However, when they are not properly disposed of, PFAS can reach sources of drinking water, be present in dust, and even accumulate in fish and other animals that we consume. Some PFAS uses such as in insecticides, carpet treatments and firefighting foams can lead to additional exposures.

Are PFAS in drinking water a health concern?

Environmental risks usually depend on the concentration of the PFAS contaminant and on exposure conditions. Individuals exposed to large amounts of PFAS in the air have been found to suffer negative health effects. If ingested above certain levels, various PFAS can cause problems in the liver, kidneys and nervous system and may also create developmental and reproductive issues. As part of its Third Unregulated Contaminant Monitoring Rule testing, EPA is determining how prevalent certain perfluorinated compounds are in U.S. drinking water supplies and at what level they appear. This information will help EPA better determine if PFAS can be a health concern in drinking water.

PFAS at anticipated concentrations do not require direct reading monitoring as no reasonable possibility of employee exposure exists.

9 Site Monitoring

(Reference CH2M HILL SOP HSE-207, Exposure Monitoring for Airborne Chemical Hazards)

For each task listed in the table below, perform the associated monitoring ensuring the equipment is calibrated daily (or bump test) according to the manufacturer's recommendations.

Note: The term "calibration" is used but it may actually be a "bump test" depending on what the manufacturer requires. There is a difference between actually calibrating (manually adjusting sensors to read a value) and "bump testing" (field verification that the instrument is reading what it's supposed to.) Many equipment manufacturers now say that performing actual calibration daily can damage the sensors, so they recommend a "bump test" daily or before use to verify the instrument is reading correctly, and they state a prescribed calibration frequency requirement. Refer to the manufacturer's instrument manual on the recommended daily calibration or bump test requirements. Be sure the calibration/bump test is documented.

Use the Daily Site Monitoring Form (or equivalent) to document the calibration (or bump test) and the readings taken. Retain area monitoring readings with project records.

Exposure records (breathing zone and personal air sampling) must be preserved for the duration of employment plus thirty years. Copies of all project exposure records (e.g., copies of Daily Site Monitoring form or field logbook pages where breathing zone readings are recorded along with associated calibration) shall be sent to the Sector Safety Program Assistant (SPA) for retention and also maintained in the project files.

Subcontractors are responsible for monitoring and performing integrated personal sampling for their employees as documented in their HSP or, if permitted, according to the table below.

9.1 Direct Reading Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency [b]	Calibration
Toxic Gas Monitor: MultiRAE Plus with 10.6 eV lamp (VOCs, O_2, LEL, CO, H_2S)	All Intrusive Tasks	0-1 ppm 1-5 ppm >5 ppm	Level D Level C Stop work, call RHSM, PM	Initially and periodically during task	Daily
Dust Monitor: Visual	All Intrusive Tasks (Dust Producing)	No Dust Visible Dust	Level D Practice Dust Suppression Techniques, Contact HSM	Initially and periodically during task	Zero Daily
Noise-Level Monitor [d]	Drilling	<85 dB(A) 85-120 dB(A) 120 dB(A)	No action required Hearing protection required Stop; re-evaluate	Initially and periodically during task	Daily
Heat Stress Monitor - Refer to Flow Chart Below ☐ Ambient Temperature ☐ Heat Index ☐ WBGT ☒ Physiological ☐ Pulse ☐ Temperature	All tasks when heat index reaches criteria	Refer to the Handbook for the type of monitoring conducted.	Refer to the Handbook for the type of monitoring conducted.	When Heat Index reaches criteria.	

[a] Action levels apply to sustained breathing-zone measurements above background.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.

[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.

[d] Noise monitoring and audiometric testing also required.

9.2 Heat Stress Monitoring Flow Chart

Use the flow chart below and refer to the applicable protocol in Section 9 of the Handbook for heat stress monitoring.

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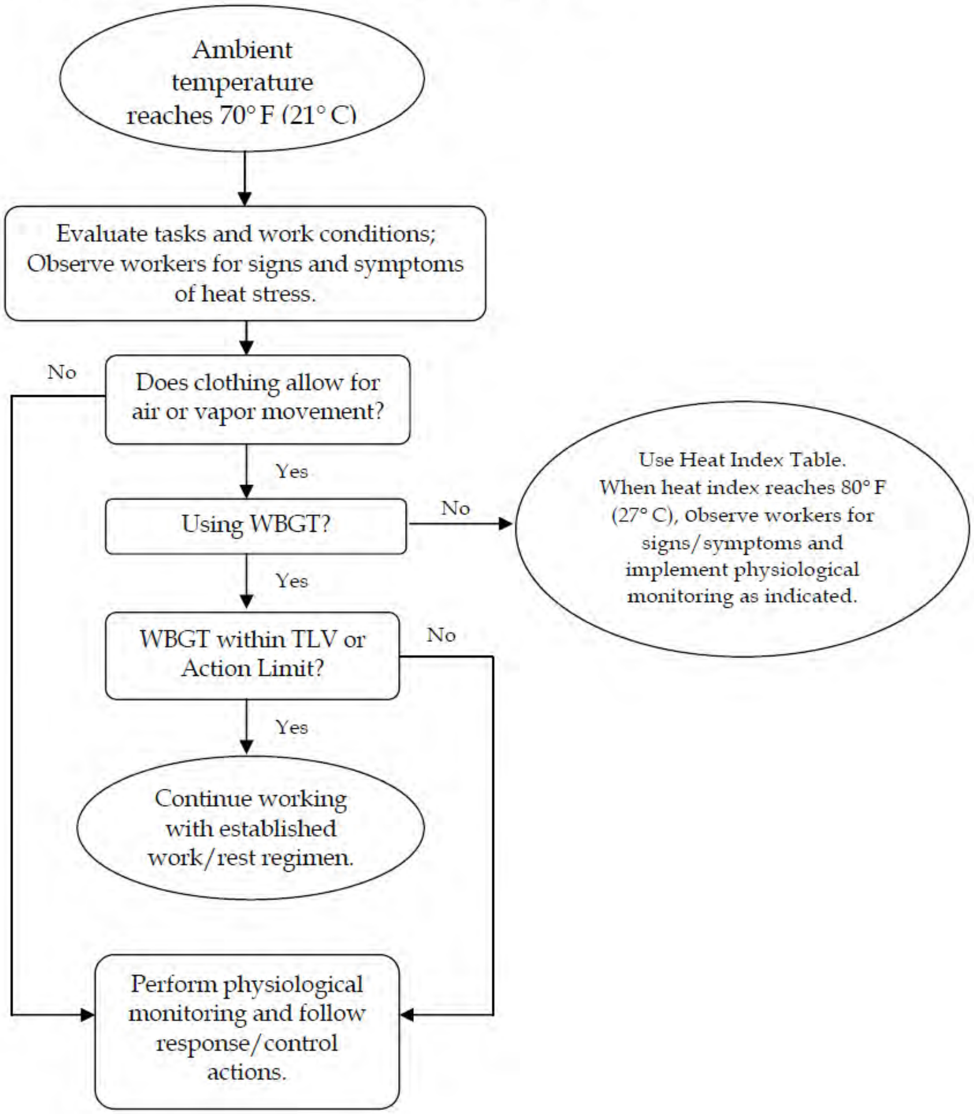
Thermal Stress Monitoring Flow Chart



10 Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, Personal Protective Equipment, and Section 11 of the Handbook)

10.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Refer to the Handbook, Section 11, "Personal Protective Equipment," for requirements on the use, care, and maintenance of PPE.

The table below outlines PPE to be used according to task based on project-specific hazard assessment. If a task other than the tasks described in this table needs to be performed, contact the RHSM so this table can be updated.

- Surveying/Utility Locating
- Surface Soil and Subsurface Sample Collection (via DPT)
- Monitoring Well Installation for PFAS Soil and GW Samples and Water Level Measurements
  - Temporary piezometers will be installed/sampled
- Surface Water and Sediment Soil Sampling
- IDW Management and Disposal

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
General fieldwork outside in Support Zone -Utility Locating -Surveys	D	☒ Work clothes (sleeved shirt, long pants) ☐ Cotton Coveralls ☐ Safety-toed Boots ☐ Gloves (leather) ☒ ANSI/ISEA 107-2010 high visibility vest ☐ Other: (specify)	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☐Hearing protection [d]	None required
-PFAS Soil Sampling -Monitoring Well Installation for PFAS Soil and GW Samples -Surface Soil Sampling -Subsurface Soil Sampling -IDW Mgmt and Disposal	Modified D	☒Work clothes ☐ Cotton coveralls ☒ Uncoated Tyvek if work clothes likely to get contaminated ☒ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots or ☒ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☒ Inner surgical-style nitrile ☒ Outer chemical-resistant nitrile gloves as necessary. ☐ Other: (specify):	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒Hearing protection [d] ☐ Face shield ☐ Chemical goggles	None required.
Equipment decontamination if using pressure washer	Modified D with splash protection	☒ Polycoated Tyvek or ☒ Rain Suit ☒ ANSI/ISEA 107-2010 high visibility vest or high visibility rain suit ☐ Safety-toed boots ☒ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☒ Inner surgical-style nitrile ☒ Outer chemical-resistant nitrile gloves. ☐ Other: (specify)	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒Hearing protection [d] ☒ Face shield ☐ Chemical goggles	None required.
When action levels above are exceeded (none anticipated)	C	☐Uncoated Tyvek ☒Polycoated Tyvek ☒ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots or ☒ Safety-toed rubber boots (can be deconned in a boot wash) ☒ Outer boot covers ☒ Inner surgical-style nitrile ☒ Outer chemical-resistant nitrile gloves as necessary. ☐ Other: (specify)	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒Hearing protection [d]	☒ Full-face MSA Ultratwin or equivalent air-purifying respirator ☒ Cartridges [e]: will be specified as a field change request.

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Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
Tasks requiring upgrade (none anticipated)	B	☒ Polycoated Tyvek ☒ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots with boot covers, or ☒ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☒ Inner surgical-style nitrile ☒ Outer chemical-resistant nitrile gloves. ☐ Other: (specify)	☒ ANSI Z89.1 Hardhat [c] ☒ Hearing protection [d]	☒ Positive-pressure demand self-contained breathing apparatus (SCBA) or ☒ MSA Ultratlite ☐ MSA PremAire ☐ Other:

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels in the "Site Monitoring" section exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting.
[e] See cartridge change-out schedule.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

10.2 Respiratory Protection

(Reference CH2M HILL SOP HSE-121, Respiratory Protection)

Implement the following when using respiratory protection:

- Respirator use shall be limited to those activities identified in this plan. If site conditions change that alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan;
- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use;
- Canisters/cartridges shall be replaced according to the change-out schedule specified in this plan. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade;
- Respirators in regular use shall be inspected before each use and during cleaning;
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition;
- Respirators shall be properly stored to protect against contamination and deformation;
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service; and

- The SC or designee shall complete the Self-Assessment Checklist – Respiratory Protection included in as attachment to this plan to verify compliance with CH2M HILL's respiratory protection program.

Respirator Change-Out Schedule

N/A

11 Worker Training and Qualification

11.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, Training, and Section 12 of the Handbook)

The following training is required for CH2M HILL personnel working onsite. Copies of training will either be available onsite, or readily available from the CH2M HILL HandS training database system. Refer to Section 12 of the Handbook for a description of HAZWOPER-related and Safety Coordinator training.

Required CH2M HILL Worker Training	CH2M HILL Task or Equipment-Specific Training (if performing task)
☒ 40-hour HAZWOPER Training	☐ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Confined Space Entry Training
☒ 3-day HAZWOPER OJT	☐ Excavation Safety Training
☒ CH2M HILL HSP Training	☐ Fall Protection (site-specific)
☒ CH2M HILL E&NBG HSE Handbook	☐ Forklift Operator
☒ CH2M HILL AHAs	☒ Hazard Communication
☒ Subcontractor HSP	☐ On-Track Railroad Safety Training
☐ 10-hour OSHA Construction Safety Training	☐ NFPA 70E Training (energized electrical safety training)
☒ At least one SC-HW (refer to worker category for all applicable training needed)	☐ Qualified Earthmoving Equipment Operator
☒ HWW (refer to worker category for all applicable training needed)	☐ Scaffold Training
☐ At least one SC-C (refer to worker category for all applicable training needed)	☐ Other (specify):
☐ Other (specify)	☐ Other (specify):
Project-Specific Required (VO) Training	
☐ 3R Munitions Safety Awareness Training	☒ Hand Safety Training
☐ Arsenic Training	☐ Hydrogen Sulfide Hazard Recognition Training
☐ Asbestos Awareness Training	☐ Ionizing Radiation Training
☐ Bear Awareness Training	☐ Lead Exposure Training
☐ Benzene Training	☐ Lockout/Tagout Training
☐ Cadmium Training	☒ Manual Lifting Training
☐ Chromium Training	☐ Methylene Chloride Training
☐ Confined Space Awareness Training	☒ Noise Training
☒ Drum Handling Training	☐ Radio Frequency Safety Awareness
☐ Electrical Safety Training	☐ Railroad Safety On-line Training
☐ Excavation Safety Training	☐ Respirators Level C Training
☐ Fall Protection Training	☐ Stairways and Ladders
☒ Globally Harmonized System Training (HazCom	☐ Traffic Safety Training

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The designation of **competent person** is a specific position of knowledge and authority for a particular activity with defined roles and responsibilities and, in some cases, requisite qualifications. When CH2M HILL is self-performing work, a qualified competent person must be designated for certain activities. The following tasks on this project require a competent person. The CH2M HILL project manager or their designee will coordinate with the RHSM to verify that the employee assuming this role has the requisite training and experience to be identified as the competent person.

11.2 Subcontractor Worker Training

The following training is required for Subcontractor personnel working onsite. Copies of training shall be available onsite.

Required Subcontractor Worker Training	Subcontractor Task or Equipment-Specific Training (required if performing this work)
☒ 40-hour HAZWOPER Training	☐ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Asbestos Competent Person
☒ 8-hour HAZWOPER Supervisor	☐ Asbestos Training (Supervisor, Worker)
☒ 3-day HAZWOPER OJT	☐ Confined Space Entry Training
☒ CH2M HILL HSP Training	☐ Certified Crane Operator
☒ Subcontractor AHAs	☐ Crane Assembly/Disassembly Competent Person
☐ Subcontractor HSP	☐ Demolition Competent Person
☐ 10-hour OSHA Construction Safety Training	☐ Excavation Competent Person
☐ 30-hour OSHA Construction Safety Training	☐ Fall Protection (site-specific)
☐ Respiratory Protection Training	☐ Flagger Training
☒ CH2M HILL HSE Handbook	☒ Forklift Operator
☒ First Aid/CPR/BBP – at least 2 people	☐ Hazard Communication
☐ Other (specify)	☐ Ladder Safety Training
	☐ Lead Training
	☐ Lockout/Tagout Training
	☐ On-Track Railroad Safety Training
	☐ NFPA 70E Training (energized electrical safety training)
	☒ Qualified Drill Rig Operator
	☐ Qualified Earthmoving Equipment Operator
	☐ Qualified Rigger
	☐ Qualified Crane Signaler
	☐ Scaffold Training
	☐ Other (specify):

11.3 HAZWOPER-Exempted Tasks

The following tasks are not within the scope of the HAZWOPER standard so HAZWOPER training is not required for workers performing these tasks:

Task	Task
Non-intrusive Utility Location (Not Vacuum Excavation)	
Surveying	

12 Medical Surveillance and Qualification

(Reference CH2M HILL SOP HSE-113, Medical Surveillance, and Section 13 of the Handbook)

The following medical surveillance is required for CH2M HILL and subcontractor personnel working onsite. Copies of physician's medical opinion will either be available onsite, or for CH2M HILL staff, readily available from the CH2M HILL HandS training database system. Refer to Section 13 of the Handbook for a description of HAZWOPER, respirator user, and hearing conservation medical surveillance.

General Required Medical Surveillance	Job or Activity-Specific Medical Surveillance (required if performing this work)
☒ HAZWOPER Medical Clearance	☐ Noise
☒ Respirator Medical Clearance	☐ Baseline Blood Lead
	☐ Asbestos Medical Clearance
	☐ Other (specify):
Personnel or Tasks Not Requiring Medical Surveillance	
Non-intrusive Utility Clearance	
Surveying	

13 Site-Control Plan

(Reference CH2M HILL SOP HSE-218, Hazardous Waste Operations, and Section 14 of the Handbook)

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas. Task-specific control measures are listed below. **Use of the Buddy System will be implemented unless a Working Alone protocol has been established and approved as indicated in Sections 5 and 6 above.**

Site Control for General Work Area(s)			
☒ Perimeter fencing	Location: around base	☐ Barricades	Location:
☒ Signage	Location: as necessary for traffic	☐ Other: __________________	Location:
☒ Traffic control devices	Location: as necessary for traffic	☐ Other: __________________	Location:

Location	Site Control Procedure (discuss important elements such as signs, barricades, briefings, qualifications, required supplies and equipment, sign-in/out logs, etc.)
Support Zone	PTSP sign in, HSP, drinking water, shade/rest area (vehicle), tape barricade surrounding drill site
Contamination Reduction Zone	Exit from exclusion zone, disposable PPE bag/can
Exclusion Zone	Hazwoper trained personnel only.

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14 Decontamination

(Reference CH2M HILL SOP HSE-218, Hazardous Waste Operations, and Section 15 of the Handbook)

Refer to the Handbook, Section 15, "Decontamination," for a complete description of decontamination activities and diagrams of typical decontamination areas. Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones.

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with project plans.

Type of Decon	Activity	Equipment	Process/Protocol
Personnel	☒ All intrusive tasks	☐ Tubs/brushes for boot/glove wash ☒ Solids disposal bag or drum (used PPE) ☐ Liquid disposal drum (decon water)	☐ Boot wash/rinse ☒ PPE disposal (no decon) ☐ PPE waste area identified ☐ Other: _______
Equipment	☒ Drill equipment	☐ Table for equipment decon/staging ☐ Decon pad for vehicles ☒ Pressure Washer ☒ PPE used during decon ☐ Decon supplies (brushes, brooms) ☒ Containers/method to capture decon water and or sludge	☒ Equipment wiped/cleaned before leaving CRZ ☐ Vehicle tires dry deconned prior to leaving site ☐ Vehicle tires washed prior to leaving site ☐ Other: _______
Equipment	☒ Sampling eqp.	☐ Table for equipment decon/staging ☐ Decon pad for vehicles ☐ Pressure Washer ☒ PPE used during decon ☒ Decon supplies (brushes, brooms) ☒ Containers/method to capture decon water and or sludge	☐ Equipment wiped/cleaned before leaving CRZ ☐ Vehicle tires dry deconned prior to leaving site ☐ Vehicle tires washed prior to leaving site ☐ Other: _______

14.1 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency lifesaving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

15 Communications

A primary and backup means of communication for field crews have been established as described below:

Type of Communication	Primary Means	Backup Means
Communication between field crew	☒ Voice ☐ Radio ☐ Phone	☒ Voice ☐ Radio ☐ Phone
Communication with Office crew	☐ Radio ☒ Phone	☐ Radio ☒ Phone
Communication with Fire and Emergency Services	☐ Radio ☒ Phone	☐ Radio ☒ Phone

16 Required Facilities and Equipment

The following facilities and equipment are required and used for safe completion of work:

Facility	Type	Location
☒ Restrooms	Base Specific	TBD by Base
☒ Emergency Eyewash	Bottle type	Field vehicle
☒ First aid kit/supplies	Field first aid kit	Field vehicle
☒ Fire extinguishers	ABC	Field vehicle
☒ Spill Kit(s)	Petroleum/oil	Drill support truck
☒ Potable Water	Bottled water or water cooler	Field vehicle or trailer
☒ Shade/rest area	Field vehicle/trailer	Field vehicle/trailer
☒ Heated rest area	Field vehicle/trailer	Field vehicle/trailer
☒ Other: Communication cell phone	Cell phone	SSC

17 Emergency Response Plan

(Reference CH2M HILL SOP HSE-106, Emergency Planning, and Section 16 of the Handbook)

Personnel responsible for coordinating emergency situations during site activity are identified below. The Emergency Contacts Page is at the front of this Plan. A site map showing assembly points and directions to the authorized medical facility is attached. Documented rehearsal and critique of this plan is required at least once during the task, or more often as necessary.

Responsibility	Name	Phone Number(s)
Emergency Response Coordinator (ERC)	Don Martinson	540-270-7859
Alternate ERC	TBD	
Type (desk or field) and frequency of rehearsal		

If an emergency situation develops which requires evacuation of the work area, the following steps shall be implemented.

Evacuation Step	Methods and comments:
Notify affected workers	Voice/Radio
Evacuate to safe location	Vehicle/Foot
Assemble and account for workers	At Field Vehicle or TBD
Notify Supervisor/Manager	Phone
Complete incident report	Within 24hrs - Online

Potential emergency situations and response actions are identified below.

In case of:	Response actions:
Injury or illness	Major Medical: FA/CPR trained personnel respond. If additional response required, contact local emergency responders and 911. Have a designee assist with guiding ambulance service to site if needed. If Jacobs BIAF employee, call WorkCare at 888-449-7787. Minor Medical: FA/CPR trained personnel respond. If Jacobs BIAF employee, call WorkCare at 888-449-7787. Transport to occupational health clinic if advised to do so.
Chemical exposure	Decon affected employee, seek medical treatment if necessary. Utilize eyewash and shower if needed. If additional response required, contact local emergency responders. If Jacobs BIAF employee, call WorkCare at 888-449-7787.
Fire or explosion	Evacuate site to designated location, call 911. Provide necessary first aid, seek treatment if necessary. For small fires, only respond to trash can size fires with site fire extinguishers.
Adverse weather	Seek shelter for lightning and thunder roar using the 30-30 rule at minimum
Heat Stroke	Call 911, have a designee give location and directions to ambulance service if needed. If Jacobs BIAF employee, call WorkCare at 888-449-7787.
Material spill or release	Appropriate spill response materials for all chemicals must be present at the job site. Only qualified (by training and previous experience) who have proper PPE and equipment available shall provide spill response operations, when safe to do so.
Active Shooter	Have a plan when working on client premises—look for at least 2 evacuation routes/points. Program emergency numbers in your phone (client emergency service numbers, RHSM, PM, Supervisor, WorkCare, Global Assistance and Response number). If an active shooter is on the premises follow Run, Hide, Fight: • Run: Leave belonging behind. Try to get out of the building or danger area if possible using exits. Call 911 when in a safe area and then call the Global Assistance and Response Hotline (443-221-6281) PM and RHSM. • Hide: Act quickly - Find a place, closet or office, or something to hide behind out of the vision of shooter. Lock or barricade or otherwise secure the spot if possible. Turn off lights, silence cell phones. Stay calm and quiet • Fight: Last resort! If your life is at risk—work alone as or as a group. Use improvised weapons, act aggressively, disarm or injure the shooter, commit to your actions. When law enforcement arrives – stay calm—show hands, spreading fingers. Avoid sudden movements, yelling or pointing. Allow law enforcement to do their job to control the area. Their first priority is finding the shooter. Once you are safe – be sure to notify your supervisor, the PM, and HSM of your status. The PM/Supervisor shall follow the incident reporting process, including notification in accordance with the incident reporting flowchart. RHSM will complete an Intelex report.

Evacuation Signals:	Meaning:
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

In the event of a **large quantity spill** notify emergency services. Personnel discovering a spill shall (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist, then leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC shall be notified immediately;
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes);
- Clear personnel from the spill location and barricade the area;
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread;
- Use sorbent materials to control the spill at the source;
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill;
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified;
- Contact the RHSM and Project EM in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required;
- Assess possible hazards to human health or the environment as a result of the release, fire or explosion; and
- Follow incident notification, reporting, and investigation section of this plan.

18 Incident Notification, Reporting, and Investigation

(Reference Section 16 of the Handbook for complete definitions and protocol)

18.1 Incident Notification

All employees and subcontractors' employees shall immediately report any incident (including "near misses,") in which they are involved or witness to their supervisor.

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC (see incident notification flowchart at the end of this section).

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name and Site Manager;
- Date and time of incident;
- Description of incident;
- Extent of known injuries or damage;

- Level of medical attention; and
- Preliminary root cause/corrective actions

If the incident was an environmental permit issue (potential permit non-compliance, other situation that result in a notice of violation) or a spill or release, contact the Project EM immediately so evaluation of reportable quantity requirements and whether agency reporting is required.

18.2 Drug and Alcohol Testing for CH2M HILL Employees

As required by CH2M HILL Policy 810, U.S. Employees are subject to post-incident and reasonable suspicion drug and alcohol testing. The Employee must submit to drug and alcohol testing if the supervisor has a reasonable suspicion, and when any of the following occur:

- Work-related injury in which the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor;
- Incident resulting in property damage over USD$500 as determined by the Company;
- Injury on or in Company Property/Workplace (to Employee or third parties) involving the Employee's use of heavy machinery as determined by the Company;
- Incident considered to be a serious near-miss injury that occurs in the field or in the office as determined by the Company and where the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor to the serious near miss injury;
- Other circumstances as dictated by Employee Relations; or
- An Employee contributes to any of the above.

Refer to the HSE Handbook and CH2M HILL Policy 810 for additional information and specific requirements.

18.3 Drug and Alcohol Testing for Subcontractors

The drug and alcohol testing requirements stated above apply to subcontractors when required by the subcontract.

18.4 Intelex and Incident Report Form

The RHSM or EM shall complete an entry into the Intelex system located on JacobsConnect. The SC shall summarize or use the hard copy Incident Report Form and Root Cause Analysis Form (attached to this plan) and forward it to the RHSM within 24 hours.

18.5 Injury Management/Return-to-Work (for US/Puerto Rico based BIAF Jacobs Staff Only)

In the event of an injury, or potential injury (i.e., involvement in motor vehicle collision with no apparent injury; a puncture wound with no bleeding or apparent infection, etc.), the following actions shall be taken:

- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-888-449-7787 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week. **Employees are encouraged to enter this phone number into their cell phones prior to starting field work.**
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.

- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- SC or designee shall verbally notify the RHSM and PM. The SC or designee may use the hardcopy Incident Report attached to this plan to forward to the RHSM for Intelex entry. RHSM completes the Intelex entry within 24 hours.
- Nurse notifies appropriate Jacobs staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor and/or PM ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor and/or PM ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

18.6 Serious Incident Reporting Requirements

Serious incidents include the following:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Global Assistance and Response Hotline 443-221-6281, then follow the standard incident reporting procedure.

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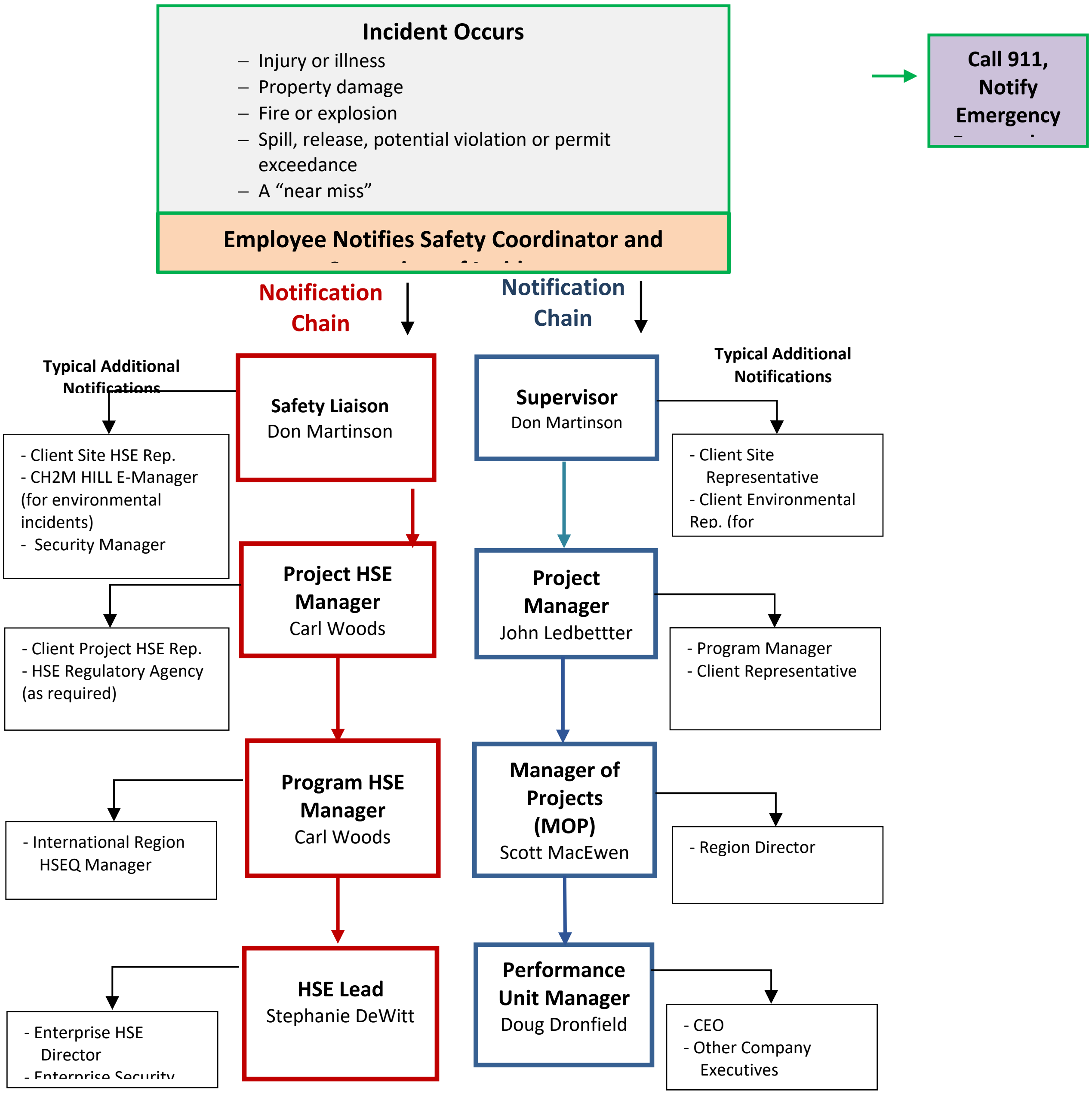
INCIDENT NOTIFICATION PROCEDURE

***Verbal Incident Notification** – to be implemented as soon as possible after an incident.*

Verbal incident notification is made to **both the HSE and the Operations chains** to the indicated group depending on the severity, and any project, geographic, or client specific notification and reporting requirements as shown below *(Refer to SOP HSE-111 for additional information).* After verbal notification, complete a HITS report.



For "Serious Incidents" call the Global Assistance and Response Hotline 443 221-6281

(e.g., work related death, kidnapping terrorism, property damage in excess of $500,000, spill with significant threat, etc. ***Refer to SOP HSE-111 for additional information.*)**

Third Party Incidents –
Incidents outside of our contractual obligations do not need to be reported UNLESS they are serious and may affect CH2M HILL or our work. The Project and Sector HSE Managers will determine the level of communication necessary for third party incidents.

19 Inspections

19.1 Management HSSE Inspection Checklists

The Management Inspection Checklist (see form in attachments to this plan) is intended to facilitate PM leadership, to provide an opportunity for PMs to mentor field staff on HSE, and to identify any big picture actions that need to be addressed. This checklist does not take the place of a formal HSE audit. The PM shall do the following:

- Complete one checklist per month during field work at their site. The PM may delegate completion to the task lead, field team leader, or construction manager if the project is of short duration and a visit is not planned for.
- Complete applicable sections of the checklist (can by typed or handwritten). PM shall address issues with the field team, taking the opportunity to mentor staff by identifying the "root cause" of observation (e.g., Why are SBOs not being completed? Had this hazard been noted by any other team members?).
- Send completed form to the overall program manager and RHSM for tracking and review. Original should be kept in the project files.

19.2 Project Activity Self-Assessment Checklists

The following self-assessment checklists are required when the task or exposure is initiated and weekly thereafter. The checklists shall be completed by the SC or other CH2M HILL representative and maintained in project files.

Drilling
Groundwater Sampling/Water Level Measurements
Hazardous Materials Handling
PPE

19.3 BeyondZero Observation (BZO) Reports

(Reference Jacobs Business Management System Work Instruction, JJ-HS-WI-0306-JJ,Beyond Zero Observation Report [BZO])

BZOs are a tool:

- that can be used for both a planned or an unplanned observation of behaviors or conditions in the work area.
- for improving leadership, workforce behaviors, and peer to peer communication.
- to provide positive reinforcement, correct unsafe behaviors or unsafe conditions.
- to document something you witness outside of work hours that others can learn from.

BZOss are a required element of our BeyondZero Culture of Caring. Performing an BZO is something that everyone should consider both in the workplace and outside of the workplace as often as possible. The SC or designee shall perform at least two BZOs per week per major definable feature of work for each field crew for any fieldwork performed by subcontractors or when there are at least two Jacobs personnel performing fieldwork. Everyone is asked to participate: all office staff, management, PMs, supervisors, SCs, and field staff whether in an office, traveling, at a project site or anywhere in between.

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After you've discussed the observation with the affected parties (see **note*** below), use the BZO app on your phone or tablet, or use your computer to log onto JacobsConnect and enter the BZO into the system. Once submitted, parts of the BZO cannot be changed, so reach out to your RHSM/EM if you need help entering an Observation. Once submitted, the BZO will be routed to your supervisor (and PM if you entered the project number). A feature to this system is you can attach photos.

*** Note**: Entering the correct Worst Potential Severity (WPS) code is important! The WPS code is a way of rating an event based on the likelihood of what could have happened versus what actually happened. **When a WPS of 3, 4, or 5 is indicated, the BZO form is elevated to higher levels of management so please be sure you've notified your RHSM, Supervisor, and/or PM of the event prior to submitting an BZO with a WPS of 3 or greater. Likewise, if any follow-up action is needed, regardless of WPS, notify the RHSM and/or PM and supervisor.**

Worst Potential Severity Table

WPS	Injury -Illness	Environment	Property Damage
5	Fatality or total permanent disability	Serious offsite impact, significant remediation required	USD$> 3 million
4	Partial disability; life changing; intensive care	Significant offsite impact, some remediation required	USD$ 300K-3 million
3	Urgent treatment, surgery	Release significantly above reportable limit of some local impact	USD$ 30K-300K
2	Medical treatment to prevent deterioration	Release above reportable limit or minor impact	USD$ 3K-30k
1	Simple, immediate treatment	Small release contained onsite and no impact	USD$ less than 3K

How do I complete an BZO?

- Access Intelex: Beginning February 17th all Jacobs' employees can access the system through the Intelex portal with Single Sign On (SSO) capability. Additional instructions, including off network access, can be found in the Intelex Getting Started Guide.
- Close Active SORs: On February 17th, 2020, you will no longer be able to create a new observation in the current SOR tool. You will still have access to the SOR tool in order to close out active SORs. The window to close out active SORs is still being determined but will be at least 60 days.
- Visit the Intelex Jacobs Connect Space for training materials including Quick Reference Guides, videos that will be made available at the time of the launch and additional details on the Intelex project and more. For general questions, please email jacobsintelexsupport@jacobs.com .
- Use the hard copy form attached to this plan.
- BZOs can be chosen by the Center of Excellence (COE) as a winner of the "BZO of the Month."

19.4 Agency Inspections

If a Federal or local agency (e.g., OSHA, local water board, EPA) announces it will be performing inspection, either announced or unannounced, refer to Attachment entitled Target Zero Bulletin on Agency Inspections. Contact the PM, RHSM and EM as soon as you receive notice.

20 Records and Reports

Refer to the Handbook, Section 19, "Records and Reports," for a complete description of HSE recordkeeping requirements. Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), SDSs, exposure modeling results
- Training records
- Respiratory fit test records
- Incident reports, investigations and associated back-up information
- Federal or state agency inspection records
- HSE audits and assessments
- Confined space entry permits
- Waste profiles
- Agency submittals
- Equipment inspections
- Equipment maintenance
- Emergency equipment inspection records
- SBOs
- Self-assessment checklists
- Daily Safety Meeting Sign-In forms/PTSPs
- Waste analytical data
- Manifests
- Reports and certifications

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21 Employee Signoff Form

EMPLOYEE SIGNOFF FORM
Health and Safety Plan

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: Basewide Per- and Polyfluoroalkyl Substances (PFAS) at Webster Field **Project Number:** 663482

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Figures

\\Brookside\gis_share\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\663482_AFFF_Report\PFAS_Report\Figure 1 - Naval Air Station Patuxent River Location Map.mxd CG021858 5/30/2017

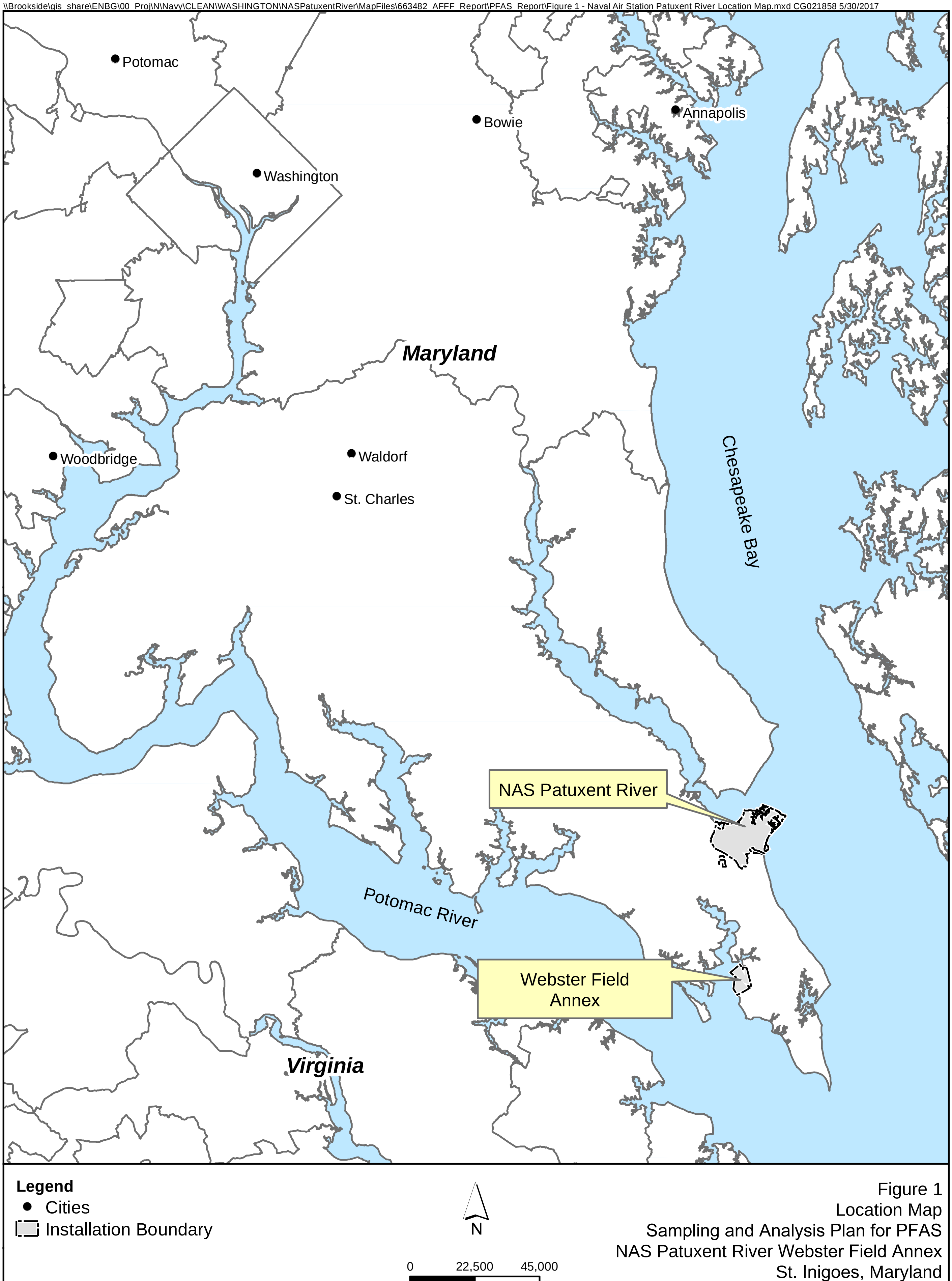


Figure 1
Location Map
Sampling and Analysis Plan for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m.

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\WASHINGTON\NASPatuxentRiver\MapFiles\PFAS\703334_WebsterField_SAP\Figure 2 - Potential Source Area for PFAS Supply Wells.mxd beresl 7/10/2019

Legend

- Supply Well
- Estimated Shallow Groundwater Flow Direction
- Fire Station 3, Building 8076
- AFFF Crash Truck Maintenance Check Area
- Nearest Residential Homes with Private Wells
- Installation Boundary
- Storm Sewer Discharge Point
- Catch Basin
- Storm Sewer Manhole
- Storm Sewer Valve Point
- Storm Sewer Culvert
- Storm Sewer Headwall
- Storm Sewer Line
- Storm Sewer Open Drainage Ditch

N

0 500 1,000 Feet

Imagery Source: ©2015 Google
Modifications have been made

Figure 2
Potential Source Area for PFAS
NAS Patuxent River Webster Field Annex
St. Inigoes, Maryland

ch2m

Attachment 1
CH2M HSE Field Handbook

Attachment 2
Chemical Inventory/Register Form

Chemical Inventory/Register Form

Refer to SOP HSE-107, Attachment 1, for instructions on completing this form.

Location:

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☐ Project:

Project No.:

Regulated Product	Location	Container labeled (✓if yes)	SDS available (✓if yes)

SDS for the listed products will be maintained at:

Attachment 3
Chemical-Specific Training Form

Chemical-Specific Training Form

Refer to SOP HSE-107 Attachment 1 for instructions on completing this form.

Location:	Project #:
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product SDS to provide the following information concerning each of the products listed above.

- ☐ Physical and health hazards
- ☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)
- ☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of SDSs, chemical inventories, and CH2M's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

Attachment 4
Project Activity Self-Assessment Checklists/Permits/Forms

Field Documentation, Readiness, and Implementation		Comments
Health and Safety Plan(s)		
☐	Jacobs plan signed by HSM and PM; plan and Handbook at site	
☐	Jacobs plan approved (within last year)	
☐	Sub HSP, if applicable, accepted by HSM and on site	
☐	All field workers signed both Jacobs and, if applicable, Sub plan	
AHAs		
☐	All field tasks covered by AHA	
☐	Jacobs AHAs present and approved by HSM	
☐	Sub AHAs present and accepted by HSM	
Training and Medical Certs		
☐	Jacobs training verified current	
☐	Sub training verified current	
☐	Specialized training certs verified (CSE, fall protection, forklift)	
Safety Meeting/PTSP Documentation		
☐	PTSP form available per safety plan	
HazCom-required paperwork		
☐	Inventory developed (safety plan attachment)	
☐	SDSs available	
☐	Training documented (safety plan Attachment)	
Project Self-Assessment Checklists		
☐	Checklists available per the safety plan	
☐	Corrective actions to be taken tracked and closed out	
SORs or SWOs	(formerly SBOs)	
☐	Forms available per the safety plan	
☐	SOR submitted and HSM/PM notified once a week or as designated	
Incident/Injury reporting process/paperwork		
☐	Notification and Intelex entry process known and paperwork available	
Air monitoring instrumentation and documentation		
☐	Correct equipment per HSP (correct PID lamp, if applicable) available	
☐	Calibration gas, if applicable, ordered and onsite	
☐	Action levels known	
☐	Calibration documented prior to use	
☐	Breathing zone readings documented	
☐	Completed air monitoring documentation sent to SPA	
Physiological monitoring paperwork		
☐	Action levels known	

☐	WBGT, thermometer, or watch available	
☐	Form available	
Special permits (Hot Work, CSE, etc.)		
☐	Required forms and permits available	
Specific/specialized plans and postings (Lone Worker, Critical Lift, asbestos)		
☐	Lone worker protocol established (if applicable)	
☐	Lead or asbestos plans in place (if applicable)	
☐	Critical lift plan necessary?	
Emergency Planning		
☐	Emergency Contacts and route to hospital posted	
☐	Emergency plan rehearsed (table top at minimum)	
Equipment Inspections		
☐	Equipment inspected as brought on site	
☐	Regular heavy equipment inspections documented	
Personal Protective Equipment		
☐	PPE verified per HSP/AHAs and on site	
Environmental Considerations		
☐	Waste drums on-site	
☐	Erosion control devices on site	
☐	Labels available and crew knows how to fill out?	
Decon		
☐	Any special equipment needed? (Tubs, brushes, waste drums?)	
SC REMINDERS		
DAILY		
☐	PTSP, Daily Safety Meeting, review observations from previous day's work with project team/subs	
☐	Informal site inspections (documented in logbook along with any corrective actions taken)	
☐	Air monitoring calibration documented on daily site monitoring form or in logbook	
☐	Air monitoring readings documented on daily site monitoring (or equivalent) form and kept in project files	
☐	Heat stress monitoring conducted if specified in plan	
☐	Incident reporting/assist with investigations	
☐	Filling out field logbook	
☐	Ensure SDSs for new chemicals brought onsite are inventoried and added to SDS book, training is given to Jacobs personnel or subs are giving training to their workers	
☐	Briefing on Jacobs HSP for any new personnel coming onsite, including subcontractor personnel and verifying training	
☐	Project file maintenance for H&S documentation	

WEEKLY	
☐	SORs/SWOs – send to HSM/PM (more frequently if indicated in safety plan)
☐	Complete self-assessment checklists (applicable to type of work going on and as specified in safety plan)
MONTHLY	
☐	Fire extinguisher inspections (document on fire extinguisher tags)
☐	First aid kit/eyewash inspections (documented—for eyewash on tag—first aid kit in logbook)
MANDATORY POSTINGS	
☐	State and Federal required postings including minimum wage, OSHA “It’s the Law,” fair employment, worker’s compensation, etc. (Vendor for all-in-one poster is *Compliance Poster Company* 1-800-817-7678)
☐	Evacuation routes and rally points
☐	Tornado shelter (as applicable)
☐	OSHA 300 log (February thru April of every year)
☐	Emergency phone numbers
☐	Route to Hospital map and phone number

Pre-task Safety Plan (PTSP) and Safety Meeting Sign-in Sheet

Project:____________________________ Location: _______________ Date:___________________

Supervisor: _________________________________ Job: ____

Activity:____

Attendees: Print Name Sign Name

____

____

____

____

____

____

List Tasks and verify that applicable AHAs have been reviewed:

____

____

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

____

____

Potential Health and Safety Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition
__Underground Utilities	__ Security	__ Poor communications

Other Potential Hazards (Describe):

____

____

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device __ Hard Hat __ Safety-Toed Boots	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections __ Entry Permits/notification	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected __ Overhead line clearance __ Underground utilities ID'd
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ No visible dust __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in confined space entry __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ First-aid-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Drill rigs/geoprobe rigs __ Cranes and rigging __ Utilities marked	Training: __ Hazwaste (current) __ Construction __ Competent person __ Task-specific __ First-aid/CPR __ Confined Space __ Hazcom
Underground Utilities __Dig alert called __3rd Party locater __As-builts reviewed __Interview site staff __Client review __soft locate necessary?	Incident Communications __Work stops until cleared by TM/CM __Immediate calls to TM/CM __Client notification __24 hour notification setup __Clear communications	AHA' s __reviewed and approved by HSM __onsite and current __applicable for this day's work __Communication and incident processes included?	
Field Notes (including observations from prior day, etc.): ______________________________ ______________________________ ______________________________			

Name (Print): ________________________________

Signature:________________________________ Date:__________________

JACOBS

StepBack

BEYOND ZERO
Our Culture of Caring

What are the hazards?
What is the risk?
What can we do about it?

StepBack Risk Questions.	**YES**	**NO**
Is there enough time to complete the task safely and are people focused (not fatigued, distracted)?		
Is the right person(s) completing the task? (experience/training)		
Are adequate support and resources available?		
Are the correct tools, equipment, and PPE in place and are they in good operating condition?		
Are control measures in place to protect people/the environment (barriers, LOTO, adjacent activities)?		
Have environmental issues (waste, hazardous materials, stormwater) been identified and mitigated?		
Are there safe access and egress to and from the work area?		
Are emergency planning/response measures adequate, including spills/releases?		
Are conditions the same since the task was last assessed?		
Is there a pre-task plan developed and approved for the task?		
If you answer ‘**NO**’ to any of the above, **STOP** work, and contact your HSM or EM.		

Project Observation Information			
Project Name:		**Project Manager:**	
Project #:		**Health & Safety Mgr.:**	

Office Observation Information			
Office:			

Observation Information					
Observer Name:		**Company:**		**Date & Time:**	
Position/Title of worker observed:		**Company:**			
Observation Type:	☐ Safe Behavior ☐ Safe Condition ☐ Unsafe Behavior ☐ Unsafe Condition ☐ Opportunity for Improvement ☐ Other (specify):				
Work or Task Observed:					
Describe Observation:					
Type of incident prevented?					
WPS (*see table below):	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5				
Remedial Action Taken?	☐ Not Applicable ☐ No ☐ Yes (describe):				
Further Action Needed?	☐ No Action ☐ Outstanding Action ☐ Urgent Action (describe action needed):				

***For any incident with a WPS greater than 3, or when futher action is necessary, notify your HSM/EM and PM/Supervisor as soon as possible.**

Worst Potential Severity Table

WPS	Injury -Illness	Environment	Property Damage
5	Fatality or total permanent disability	Serious offsite impact, significant remediation required	USD$> 3 million
4	Partial disability; life changing; intensive care	Significant offsite impact, some remediation required	USD$ 300K-3 million
3	Urgent treatment, surgery	Release significantly above reportable limit of some local impact	USD$ 30K-300K
2	Medical treatment to prevent deterioration	Release above reportable limit or minor impact	USD$ 3K-30k
1	Simple, immediate treatment	Small release contained onsite and no impact	USD$ less than 3K

Activity Hazard Analysis (AHA)

ACTIVITY/WORK TASK:		Overall Risk Assessment Code (RAC) (Use highest code)					
	SIGNATURES	Activity #		AHA #			
PWD/OICC/ROICC OFFICE		**Risk Assessment Code (RAC) Matrix**					
NAME & DATE ACCEPTED BY GDA:							
CONTRACT NUMBER:		**Severity**	**Probability**				
TASK ORDER/DELIVERY #:							
PRIME CONTRACTOR:			Frequent	Likely	Occasional	Seldom	Unlikely
SUBCONTRACTOR:							
DATE OF PREPARATORY MEETING:		Catastrophic	E	E	H	H	M
DATE OF INITIAL INSPECTION:		Critical	E	H	H	M	L
CONTRACTOR COMPETENT PERSON:		Marginal	H	M	M	L	L
SITE SAFETY and HEALTH OFFICER		Negligible	M	L	L	L	L
ACCEPTANCE BY GOVERNMENT DESIGNATED AUTHORITY (GDA)		Review each **"Hazard"** with identified safety **"Controls"** and determine (RAC)					
E = EXTREMELY HIGH (PWO/OICC/ROICC)		Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" .Place the highest RAC at the top of AHA. This is the overall risk assessment code for this activity					
H = HIGH RISK (FEAD DIRECTOR)		**"Severity"** is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible after controls are in place					
M = MODERATE RISK (CM or ET or PAR)							
L = LOW RISK (ET or PAR)		**"Probability"** is the likelihood to cause an incident, near miss, or accident did occur and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely after controls are put in place.					

Job Steps	Hazards	Controls	RAC

Equipment to be Used	Training Requirements and Competent or Qualified Personnel name(s)	Inspection Requirements	RAC

DAILY SITE MONITORING REPORT

Project:	Date:
Task Name:	Subcontractor(s):
Description of Activities:	Description of Potential Contaminant(s) and Source:

1. Monitoring Instrumentation

Instrumentation Description: Instrument ID Number:	Calibration gas and lot number: Time & Date Calibrated: Calibration Results:

2. Site Monitoring Results

Time(s)	Monitoring Location (note distance from source, upwind/downwind, etc.)	Sample Type (source, breathing zone, area, etc.)	Instrument Reading (Units)	Comments or list name and company of person if reading is a Breathing Zone sample,*

Review

Sampler:	Signature:	Date:

DAILY SITE MONITORING REPORT

Page ___ of ___

3. Site Monitoring Results

Time(s)	Monitoring Location (note distance from source, upwind/downwind, etc.)	Sample Type (source, breathing zone, area, etc.)	Instrument Reading (Units)	Comments or list name and company of person if reading is a Breathing Zone sample,*

Review

Sampler:	Signature:	Date:

Heat Stress Physiological Monitoring Form

Project:	
Date:	Company:

1. Take and record measurement of temperature or pulse at the frequency indicated in the safety plan.
2. Follow the Physiological Monitoring Protocol in the safety plan. Typically:
   - Monitoring pulse every hour when it is 90-105 deg on heat index. Over 105 deg, monitor every 30 min and contact HSM.
   - The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g., 180 – 40 year old person = 140 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.
   - The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
   - If the heart rate is higher than 120 bpm after the FIRST minute into the rest period, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. **E.g. work 40 minutes, rest 20 minutes.**
   - If the pulse rate still exceeds 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. **E.g. work 20 minutes, rest 40 minutes.**
   - Continue this procedure until the rate is maintained below 120 bpm after the FIRST minute into the rest period.
3. Never continue work if your body temperature is more than 100.4° F/38° C, or if you are experiencing sudden and severe fatigue, nausea, dizziness, or lightheadedness.

Employee:
Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee:
Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee:
Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee:
Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Underground Utility Verification

Project No.:		**Project Name:**	
Site Address:			
Date:		**PM:**	
Utility Locator:		**Field Personnel:**	
Ground Disturbance Scope and Equipment (drill rig, backhoe, or other):			

	Description	Yes	No*	NA/Notes
1	Obtained and reviewed available utility diagrams or as-built drawings for facility.			
2	A facility contact with knowledge of utility locations was met onsite. Facility contact reviewed and approved proposed locations of intrusive work. Facility Contact: ________________________________ Phone Number: __________________________			
3	Proposed ground disturbance areas are “white lined” by project team. White-lined areas should be a 20-foot minimum radius around the proposed ground disturbance location, unless buildings or hazards prohibit marking a 20-foot radius. White paint or pin flags should be used.			
4	Contacted the designated local utility notification service (such as 811) and notification ticket is current (according to state/provincial law, typically 10 to 15 days).			
5	Public utility companies have been contacted and utilities located and marked. Present / Not present / Response method (mark, phone, email) & notes High-Voltage Electric ☐ ☐ ______________________________________ Low-voltage Electric ☐ ☐ ______________________________________ Gas ☐ ☐ ______________________________________ Process/Fuel ☐ ☐ ______________________________________ Water ☐ ☐ ______________________________________ Storm ☐ ☐ ______________________________________ Sewer ☐ ☐ ______________________________________ Telecommunication ☐ ☐ ______________________________________ Irrigation ☐ ☐ ______________________________________			
6	Client- or facility-specific permit or procedure complete (such as dig permit).			
7	A qualified, independent field survey provider performed a field survey to identify, locate, and mark potential subsurface utilities in the work area.			
8	Independent field survey provider used appropriate instrumentation and geophysical technologies (for example, radio frequency [RF], electromagnetic [EM], ground-penetrating radar [GPR]). Describe methods: ____ RF, EM, and GPR are typically necessary. If one of these is not used, mark “No” and explain rationale in Utility SOP Deviation Request at the bottom of Page 2.			
9	Oversight staff were present during independent utility survey.			
10	A “360-degree” assessment has been performed, including walking the area and inspecting for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, light standards, drains, and vent risers.			
11	Utilities have been properly identified and marked. Utilities are marked within a minimum 20-foot radius around the proposed drilling or excavation location, anticipating step-out locations.			
12	Utility marks are the appropriate color (red – electrical; yellow – gas; green – sewer; blue – water; orange – communication; purple – irrigation). Pink should be used for unknown/temporary.			

	Description	Yes	No*	NA/Notes
13	Utility marks can be protected and preserved until no longer required (use whiskers or pin flags if necessary). If the utility location markings are destroyed or removed before intrusive work commences or is completed, the Project Manager (PM), Safety Coordinator, or designee must notify the independent field survey provider or the designated utility locating service to resurvey and remark the area.			
14	Utility clearances are provided in writing and signed by the party conducting the clearance on the Buried Utility Tracking Form. See Page 3.			
15	Private or public utilities within 5 feet of proposed locations are documented on the Buried Utility Tracking Form. See Page 3.			
16	Documentation of the utility survey (report, updated utility site map, photo log) is complete.			
17	When aggressive intrusive activities will be conducted within 5 feet, either laterally or vertically, of an underground utility, or when there is uncertainty about utility locations, drilling locations must be physically verified by non-aggressive means such as air or water knifing or hand digging. Describe planned clearance method and depth: ____			
18	For drilling, non-aggressive clearance will be greater than the outside diameter of drill tooling.			
19	When underground utility is within 5 feet of intrusive work, then non-aggressive means must be used to physically locate (daylight) the utility before a drill rig, backhoe, excavator, or other aggressive method is used. This step of daylighting is in addition to clearance of the borehole.			
20	When an underground utility is within 5 feet of intrusive work, check to see if the utility can be isolated (locked out/tagged out and de-energized [purged as necessary] or blocked) during the subsurface activity. Hazardous utilities (gas, electrical) will be de-energized whenever possible. Verify with facility contact that isolation is completed according to the Lock Out Tag Out Standard Operating Procedure (SOP).			
21	Only non-aggressive means may be used within 2 feet of an identified utility.			
22	The following documentation will be available onsite during ground disturbance: • Available utility diagrams or as-built drawings • 811 notification • Facility-specific permit or procedure (dig permit) • Utility survey information (e.g. report, updated utility site map, photo log)			

Prepared by: ________________________________ **Verified by:** ________________________________

Field Personnel PM

Instructions:

1) Complete and submit Underground Utility Verification Checklist to Health and Safety Manager (HSM) and PM.
2) Ensure that documentation is communicated to other field staff and available at the site during ground disturbance activities.
3) For items marked No" above, complete the following utility SOP deviation request. Approvals may be provided via email or phone.

Utility SOP Deviation Request

Items Marked "No" above: ____

Rationale for Deviation: ____

____

PM Approval: ________________________________ Approved Date: ______________

HSM Approval: ________________________________ Approved Date: ______________

Buried Utility Tracking Form

Check each box using an "X" if a buried utility is present within 5 feet of a marked location identification (ID).

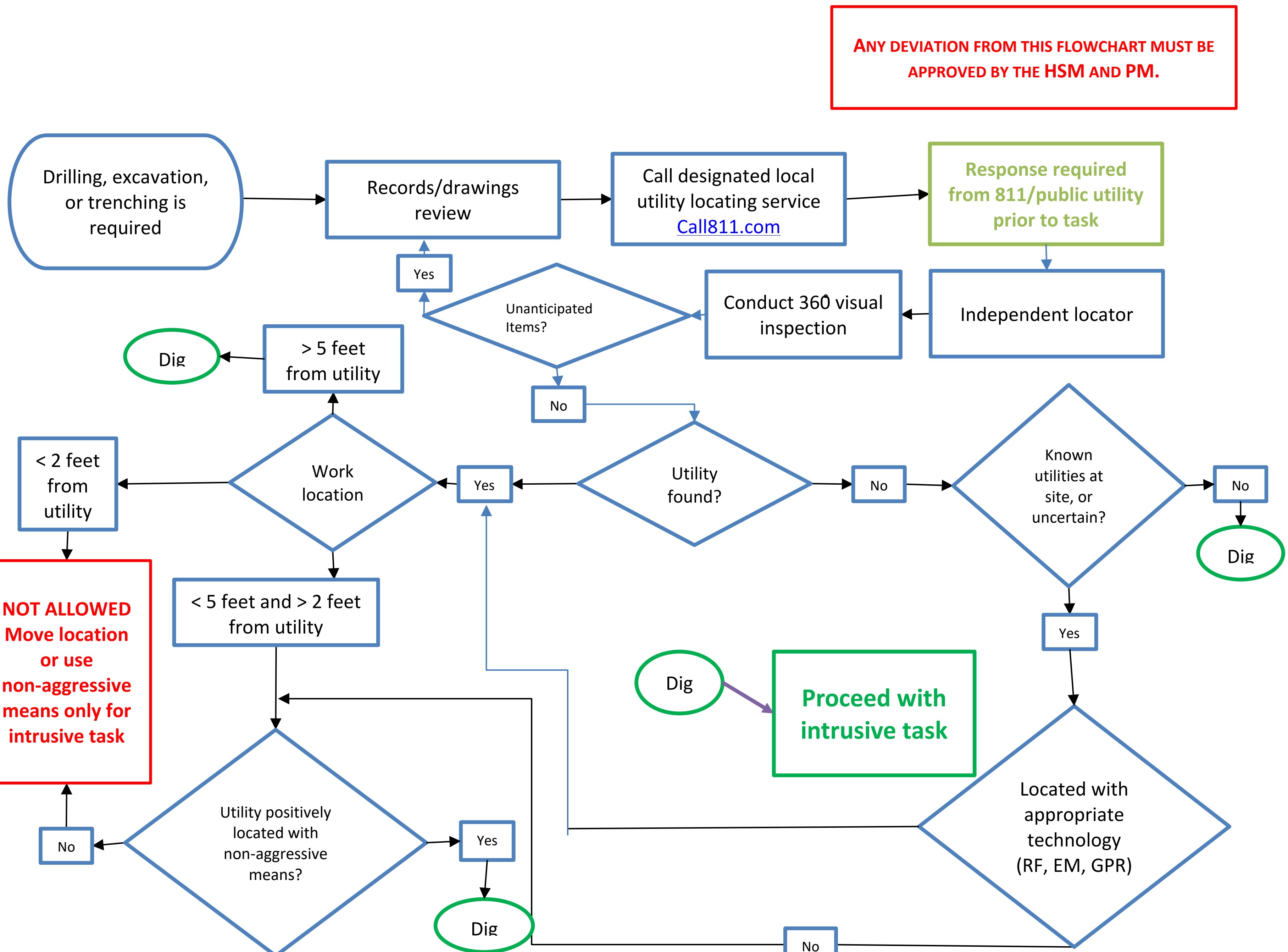
Location ID	Gas (Yellow)	Electric (Red)	Fiber optic (Orange)	Cable (Orange)	Water (Blue)	Sanitary Sewer (Green)	Storm Sewer (Green)	Steam (Yellow)	Petroleum (Yellow)	Compressed Air (Yellow)	Other ____	Other ____

The findings of the buried utility location activities summarized herein were conducted in accordance with the scope of work.

______________________________________ ____________

Utility Locate Subcontractor's Signature

Date


ANY DEVIATION FROM THIS FLOWCHART MUST BE APPROVED BY THE HSM AND PM.
Drilling, excavation, or trenching is required
Records/drawings review
Call designated local utility locating service Call811.com
Response required from 811/public utility prior to task
Independent locator
Conduct 360 visual inspection
Unanticipated Items?
Yes
No
Dig
> 5 feet from utility
< 2 feet from utility
Work location
Yes
Utility found?
No
Known utilities at site, or uncertain?
No
Dig
NOT ALLOWED Move location or use non-aggressive means only for intrusive task
< 5 feet and > 2 feet from utility
Yes
Dig
Proceed with intrusive task
Located with appropriate technology (RF, EM, GPR)
Utility positively located with non-aggressive means?
No
Yes
Dig
No

Incident Report Hardcopy (Phase 1 – Initial Entry)

Phase 1 – Initial Entry

Type of Incident (May select more than one)

- ☐ Injury/Illness
- ☐ Property Damage
- ☐ Spill/Release
- ☐ Environment/Permit
- ☐ Near Miss
- ☐ Other

General Information Section

Preparer's Name: ______________________________ **Preparer's Phone Number:** ________________________

Date of Incident: __________________ **Time of Incident**: ______________ AM / PM

What Business Unit is accountable for this incident:

____

What Performance Unit is accountable for this incident:

____

What Jacobs Company is accountable for this incident:

____

Where did the Incident occur?

- ☐ United States, Geographic Region: _____________________________________
- ☐ Canada, Province/Territory: ____
- ☐ International, County: ____

Location of Incident?

- ☐ Company Premises, Jacobs Office (use 3 letter office code if available):

____

- ☐ Project, Project name:

____

- ☐ In Transit

  Traveling from: ____

  Traveling to: ____

- ☐ At Home
- ☐ Other, Specify:

____

Describe the incident:

____

Describe how this event could have been prevented:

____

Provide Witness Information:

Name: ____Phone: _______________________________

Name: ____Phone: _______________________________

Name: ____Phone: _______________________________

Personnel Notified of Incident (Provide name, date and time):

Jacobs Personnel:

____

Client Personnel:

____

Additional Comments:

____

Injury/Illness Section **[Complete only if Injury/Illness Incident type selected]**

Who was injured?

- ☐ Jacobs Employee or Jacobs Temp Employee
- ☐ Subcontractor to Jacobs (Non-LLC Joint Venture Project)
- ☐ LLC Joint Venture Partner Employee
- ☐ LLC Joint Venture Project Subcontractor/Contractor
- ☐ Other

Name of Injured: ______________________________ **Job Title:** ___________________________

Employer Name: ______________________________ **Supervisor of Employee:** _______________

Complete for Jacobs Employee Injuries

Business Group of Injured Employee:

____

Has the employee called the WorkCare (888-449-7787)?

☐ Yes ☐ No ☐ Not Sure

Has the injured employee's supervisor been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Complete for Non-Jacobs Employee Injuries

Has the project safety coordinator been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Project Safety Coordinator:

____

Body Part Affected: ____

Injury/Illness (Result):

____

Describe treatment provided (if medication provided, identify whether over-the-counter or prescription):

____

Describe any work restriction prescribed (include dates and number of days):

____

Physician/Health Care Provider Information

Name: ____ Phone: ____________________

Was treatment provided away from the worksite?

☐ No

☐ Yes

Facility Name:

____

Address:

____

City: ________________________________ Phone Number: ____________________

Was injured treated in an emergency room?

☐ No ☐ Yes

Was injured hospitalized overnight as an in-patient?

☐ No ☐ Yes

General Information Environmental Section **[Complete only if Environment/Permit or Spill/Release Incident type selected]**

Who had control of the area during the incident?

☐ Jacobs, Company:

____

☐ Subcontractor, Company:

____

☐ Joint Venture Partner/Contractor/Subcontractor, Company:

____

☐ Other, Company:

____

Relationship to Jacobs: ____

Property Damage Section **[Complete only if Property Damage Incident type selected]**

Property Damaged:

____

Property Owner:

____

Damage Description:

____

Estimated US Dollar Amount:

____

Spill or Release Section **[Complete only if Spill/Release Incident type selected]**

Substance:____

Estimated Quantity: ____

Did the spill/release move off the property?

____

Spill/Release From:

____

Spill/Release To:

____

Environment/Permit Section **[Complete only if Environment/Permit Incident type selected]**

Describe Environmental or Permit Issue:

____

Permit Type: ____

Permitted Level or Criteria (for example, discharge limit):

____

Permit Name and Number (for example, NPDES No. ST1234): __________________________________

Substance and Estimated Quantity: ____

Duration of Permit Exceedance: ____

Health, Safety and Environment

Lessons Learned **[Date] GES LL-20-xx**

TITLE:

Subject:	Insert response
Situation:	Insert response (pictures are helpful)
Lesson(s) Learned:	Insert response
Recommendation(s) and/or Comment(s)	Insert response

Submitted by:

Date submitted:

Send draft Lessons Learned to the project HSM and/or EM for review, and then to Stephanie DeWitt/DEN and Sandy Wise/DEN for final review, posting and distribution.

Health and Safety Field Change Request (FCR)			
Date of Change: 3/17/2020			
FCR No. (assigned by RHSM): Varies by project			
Applicable Health and Safety Plan Title: Varies, Navy CLEAN program wide change to all project safety plans			
Project Number: Navy CLEAN Program Wide	**Project Location:** Varies		
Subject of Change: Adding hazards, controls and awareness information for COVID-19			

Recommended Changes:

A. Review and follow Jacobs Global Security Companywide Travel Restriction, Preparedness Pamphlet and FAQ
B. Review signs and symptoms of Coronavirus with all field staff. Utilize CDC guidance document to review COVID-19 awareness information.
C. If project team member has specific COVID-19 concerns (e.g. in high risk category, high risk locations), speak with PM and supervisor. Accommodations shall be made by the PM and supervisor.
D. If showing signs of COVID-19 (fever, dry cough, shortness of breath) in CDC guidance (attached); do not report to project site for work. Contact project Safety Liaison, Workcare, supervisor, PM, HSM.
E. Contact personal care physician and/or WorkCare for COVID-19 symptom reporting. See attached WorkCare guidance. Rather than phone notification, WorkCare request the following link be used for reporting.

Additional COVID-19 field project control measures:

F. Monitor local public health agencies communications. Follow all local agency guidance and restrictions.
G. Ensure Field Team Lead and Safety Liaison has cell phone number of all field staff for communication to project teams.
H. Identify project specific telework opportunities where feasible (e.g. work from hotel room).
I. Frequent hand washing is required. Hand wash facilities are typically required at temporary job locations (e.g. at portapotty at field office). If a handwashing sink is not feasible (e.g. mobile staff), utilize disinfectant hand wipes.
J. Provide hand sanitizer at all field project locations.
K. Be familiar with cough and sneeze etiquette and avoid touching eyes, nose, mouth.
L. Avoid sharing personal items with co-workers (e.g. cups).
M. Use disinfectant to frequently clean shared surfaces including, but not limited to rental cars; hotel room touch points; temporary office trailer touch points (e.g. door handles, workstations).
N. At temporary office entry points, post CDC Stop the Spread, Social Distancing and Hand Washing Notice Posters (attached).
O. If entering residential project site locations – ask occupants if they have signs of illness prior to entry. Do not enter residential locations with occupants that have signs/symptoms.

Note: All references are frequently updated. Check Jacobs and CDC COVID-19 webpages frequently for updates.

Reason for Change: Adding additional COVID-19 hazard and control information			
Submitted by:	**Company**: CH2M	**Date:** 3/17/20	
Review & Acceptance:			
Manager of Projects:	Scott MacEwen	**Date:** 3/17/20	
Health & Safety Mgr:	Carl Woods	**Date:** 3/17/20	
Distribution:			
1. Field Staff	2. PM/SL	3.	4.
5.	6.	7.	8.

File Copies: Project File

Attachments:

- Jacobs COVID-19 Preparedness Pamphlet
- CDC Factsheet – What You Need to Know about COVID-19
- WorkCare COVID-19 Employer Instructions
- CDC Poster – Stop the Spread, Hand Wash Notice, Social Distancing

Leadership HSE Site Visit Form

Participant(s):	**Date:**
Project, Program or Office Name:	
Whom Did I Engage (Who did I talk with and what are their roles? Make it personal.):	
What I Heard (Highlight the feedback you received, especially best practices and ideas for improvement.):	
What I Observed (What safe work behaviors and best practices did you observe? What did you review to verify HSE program implementation?):	
What I Felt (i.e. How was morale? Were employees positive, engaging, detailed in their explanation of what they were working on or planning to do, how was the culture?, etc.):	
What did I do or will I do to make a difference (here and elsewhere)? (This is most important. Please elaborate and define what actions you are taking to make improvements and follow-up. Take ownership of your recommendations and improvement actions.	

Program/Project Name: ______________________ **Work Being Performed:** ______________________

Management Inspector: ______________________ **Project Number:** ______________________

Date: ______________________ **Sector:** ______________________

1. Job Information/Postings	**A**	**C**	**I**	**N/A**	**Comments/Corrective Action(s)**
a. Required postings in place (OSHA/State/Country)					
b. Emergency Contacts and Phone list posted					
c. Directions and map to hospital posted					
d. Incident Reporting Flow Chart posted					
2. HSSE Documentation					
a. HASP current (within 1 year), onsite, and signed					
b. AHAs available for all work and reviewed/signed					
c. Daily Pre-Task Safety Plan/Meeting completed					
d. SWO's completed weekly and emailed					
e. Self-Assessment checklists completed per HASP					
f. Environmental Plan available					
g. Emergency drill completed and documented					
h. E Permit compliance assurance measures documented					
i. HSE training up to date and documented					
3. Housekeeping/First Aid					
a. Work areas clean and organized					
b. Fire extinguisher, eye wash, 1st aid/BBP kit in place					
c. Materials and waste labeled and in closed containers					
4. PPE and Air Monitoring					
a. PPE being worn as specified in HASP/AHA					
b. Air monitoring done per HASP and documented					
5. Heavy Equipment and Construction Operations					
a. Documentation of Competent/Qualified Operators					
b. Back-up alarms audible & no cell phone use					
c. High-visibility vests on ground personnel					
d. Daily inspections completed and documented					
e. Windshields/mirrors OK and seat belts worn					
6. Excavation, Trenching, and Land Disturbing Activities					
a. Competent person identified					
b. Daily inspection completed prior to entry					
c. Proper setup (sloping, shoring, exits, spoils)					
d. 3rd party Utility Locate service used					
d. Storm water PPP and inspections/sampling conducted					
d. Erosion/sediment controls and dust controls in place					
7. Hand Tools					
a. Hand tools inspected prior to use					
b. Guards in place on tools					
c. Right tool for the job at hand					
8. Electrical					
a. All electrical cords, prongs, receptacles OK					
b. GFCI used on all circuits					
c. No energized electrical work incl. voltage testing					
d. Written Lockout Tagout system in use					

(Column - A=Adequate, C=Needs Consideration, I=Needs Immediate Action, N/A= Not Applicable or Not Assessed)

9. Ladders and Scaffolds	A	C	I	N/A	Comments/Corrective Action(s)
a. Ladders extend 36” above the landing and secured					
b. Ladders selected and used properly					
c. Scaffold planked, unaltered, and in good condition					
d. Scaffold/ladder users trained in inspection and use					
10. Hot Work					
a. Gas cylinders stored upright and secured					
b. Minimum 20’ distance between fuels and oxygen					
c. PPE in use per HASP/AHA					
d. Fire watch in place w/adequate fire extinguishers					
11. Cranes					
a. Outriggers extended, swing radius protected					
b. Operator CCO licensed, competent person for rigging					
c. Annual certified crane inspection					
d. Chains and slings inspected, have rating tag					
e. Suspended load tag lines - no one underneath					
12. Drill Rigs					
a. Overhead electrical clearance adequate					
b. Daily inspections completed and available					
c. Emergency shut off functioning					
d. 3rd party Utility Locate service used					
13. Hazard Communication and Chemical Use					
a. MSDS’s present for all chemicals					
b. Chemical Inventory current and in HSP or on file					
c. Hazard communication briefing for all chemicals					
d. All chemicals labeled/stored as required					
e. SPCC Plan implemented for >1320 gals fuels/oils on site					
14. Fall Protection					
a. Full body harness worn properly, workers tied off over 6’					
b. Guard rails 42” high					
15. Material Handling					
a. Proper body positioning					
b. Objects less than 40 lbs. for one person lift					
16. Site Control					
a. Work Zones delineated, necessary signage in place					
b. Decontamination method is adequate					
17. Waste and Hazardous Materials Management					
a. Waste Tracking Log					
b. Hazardous waste onsite for <90 days					
c. Containers labeled, inspections conducted/documented					
d. HW manifests signed, tracked, copies kept on site					
e. HW Transporters trained and licensed, placards used					
18. Security and Emergency Planning					
a. Emergency coordinator designated					
b. Severe weather plans/controls in place					
c. Security plan/measures adequate					
19. Demolition					
a. ACM and Hazardous Materials Survey					
b. Asbestos/Lead based paint work approved per policy					

(Column - A=Adequate, C=Needs Consideration, I=Needs Immediate Action, N/A= Not Applicable or Not Assessed)

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: __________

This specific checklist has been completed to:

- ☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
- ☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
- ☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
  Subcontractors Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-204.

SECTION 1 - SAFE WORK PRACTICES (5.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	☐	☐	☐	☐
2. Personnel clear while mast is being raised	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Smoking is prohibited around drilling operation	☐	☐	☐	☐
7. Personnel wearing appropriate personal protective equipment (PPE), per written plan	☐	☐	☐	☐
8. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS (5.2)

AQUIFER DESIGNATIONS (5.2.1)

9. Aquifer designations determined and BGEM consulted when required.	☐	☐	☐	☐

LOCATION OF UTILITIES (5.2.2)

10. Location of underground utilities and structures identified	☐	☐	☐	☐
11. Power lines de-energized and grounded when safe distances cannot be maintained	☐	☐	☐	☐

SECTION 2 (Continued)

WASTE MANAGEMENT (5.2.3)	Yes	No	N/A	N/O
12. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
13. Wastes generated evaluated for proper disposal	☐	☐	☐	☐
14. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT ORDNANCE EXPLOSIVES OR UNEXPLODED ORDNANCE SITES (5.2.4)				
15. MEC plan prepared and approved	☐	☐	☐	☐
16. MEC avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
17. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
18. Personnel remain inside cleared areas	☐	☐	☐	☐

SECTION 3 - DRILLING SAFETY REQUIREMENTS (5.3)

GENERAL (5.3.1)				
19. Only authorized personnel operating drill rigs	☐	☐	☐	☐
20. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
21. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
22. Good housekeeping maintained on and around rig	☐	☐	☐	☐
SAFETY EQUIPMENT (5.3.2)				
23. Safety-toed shoes/boots, hardhats, safety glasses, gloves and hearing protection are worn	☐	☐	☐	☐
24. Drill rig equipped with fire extinguisher	☐	☐	☐	☐
25. Air monitoring instruments provided when required	☐	☐	☐	☐
26. PPE for protection from chemical hazards is worn if required				
DRILL RIG PLACEMENT (5.3.3)				
27. Location of underground utilities and structures identified	☐	☐	☐	☐
28. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
29. Drilling pad established, when necessary	☐	☐	☐	☐
30. Drill rig leveled and stabilized	☐	☐	☐	☐
31. Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (5.3.4)				
28. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
32. Spotter used when backing rig in tight or confined areas or when low clearances exist	☐	☐	☐	☐
33. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
EMERGENCY – CONTACT WITH OVERHEAD OR UNDERGROUND ELECTRICAL LINES (5.3.5)				
34. Personnel understand emergency procedures in the event of contact with overhead or underground electrical lines	☐	☐	☐	☐
DRILL RIG OPERATION (5.3.6)				
35. Kill switch clearly identified and operational	☐	☐	☐	☐
36. All machine guards are in place	☐	☐	☐	☐
37. Rig ropes never wrapped around any part of the body	☐	☐	☐	☐
38. Pressurized lines and hoses secured to prevent whipping hazards	☐	☐	☐	☐
39. Drilling operation stopped during inclement weather	☐	☐	☐	☐
40. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
41. Rig gear boxes placed in neutral when operator not at controls	☐	☐	☐	☐
42. Operator shuts rig engine down prior to leaving the drill rig vicinity	☐	☐	☐	☐

DRILL RIG SITE CLOSURE (5.3.7)

43. Ground openings/holes filled or barricaded ☐ ☐ ☐ ☐
44. Equipment and tools properly stored ☐ ☐ ☐ ☐
45. All vehicles locked and keys removed ☐ ☐ ☐ ☐

DRILL RIG MAINTENANCE (5.3.8)

46. Rig properly maintained per drilling company's maintenance program ☐ ☐ ☐ ☐
47. Defective components repaired immediately ☐ ☐ ☐ ☐
48. Lockout/tagout procedures used prior to maintenance ☐ ☐ ☐ ☐
49. Cathead in clean, sound condition ☐ ☐ ☐ ☐
50. Drill rig ropes in clean, sound condition ☐ ☐ ☐ ☐
51. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater ☐ ☐ ☐ ☐
52. Rig in neutral and augers stopped rotating before cleaning ☐ ☐ ☐ ☐
53. Good housekeeping maintained on and around rig ☐ ☐ ☐ ☐

FORMS/PERMITS AND CHECKLISTS (7.0)

54. Driller license/certification obtained ☐ ☐ ☐ ☐
55. Well development/abandonment notifications and logs submitted and in project files ☐ ☐ ☐ ☐
56. Groundwater withdrawal permit obtained where required ☐ ☐ ☐ ☐
57. Dig permit obtained where required ☐ ☐ ☐ ☐

SECTION 4

Complete this section for all items checked "No" in previous sections. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

CH2MHILL

HSE Self-Assessment Checklist—Groundwater Monitoring/Sampling

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees or subcontractors conduct groundwater sampling.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: ________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employees conducting GW sampling

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

SECTION 1

	Yes	No	N/A	N/O
GENERAL GW Monitoring				
1. AHA/THA includes precautions for moving heavy coolers and they are followed.	☐	☐	☐	☐
2. Well Head Space is monitored in accordance with the HSP (PID)	☐	☐	☐	☐
3. Well enclosures are evaluated for biological hazards before opening (spiders, wasps)	☐	☐	☐	☐
4. Correct lifting procedures are used unloading equipment at each sampling location.	☐	☐	☐	☐
5. Well casing is evaluated for sharp edges and precautions are taken before opening	☐	☐	☐	☐
6. Place all purge water in containers and manage in accordance with site plans	☐	☐	☐	☐
GENERAL - PPE				
7. PPE available for use by employees.	☐	☐	☐	☐
8. PPE stored appropriately to prevent deformation or distortion.	☐	☐	☐	☐
EYEWEAR (Glasses/Goggles/Face Shields)				
9 Eyewear cleaning supplies available.	☐	☐	☐	☐
10 Safety glasses in good condition and lenses free of scratches.	☐	☐	☐	☐
11 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched.	☐	☐	☐	☐
12 Face shields in good condition, including adjustment band, and free of scratches or chips.	☐	☐	☐	☐
HEAD PROTECTION				
13. Hard hat bill and suspension attached as allowed by manufacturer.	☐	☐	☐	☐
14. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	☐	☐	☐	☐
15. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	☐	☐	☐	☐
HAND PROTECTION				
16. Available in sizes matched to employee.	☐	☐	☐	☐
17. Gloves free of rips tears, abrasions, or holes.	☐	☐	☐	☐
18. Matched to manufacturer's specification for chemicals used onsite.	☐	☐	☐	☐
19. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐

HSE Self-Assessment Checklist—Groundwater Monitoring/Sampling

BODY PROTECTION

20. Available in sizes matched to employee. ☐ ☐ ☐ ☐
21. Maintained in a clean and sanitary condition, decontaminated or disposed properly. ☐ ☐ ☐ ☐
22. Flame-resistant clothing matched to electrical hazard and arc flash rating and site requirements. ☐ ☐ ☐ ☐
23 Welding gear matched to degree of hazard and free of cuts, tears or burn holes. ☐ ☐ ☐ ☐
24 Flotation gear available for work near or on water and in good condition. ☐ ☐ ☐ ☐

HOT AND COLD BODY PROTECTION

25 Cooling gear available based on degree of heat stress hazard. ☐ ☐ ☐ ☐
26 Cooling gear in operable, clean, and sanitary condition. ☐ ☐ ☐ ☐
27 Cold-weather gear provided based on needs assessment. ☐ ☐ ☐ ☐
28 Cold-weather gear available in sizes to match employees. ☐ ☐ ☐ ☐
29 Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition. ☐ ☐ ☐ ☐

GENERAL - Tools

30. Fixed open blade knives are not used. ☐ ☐ ☐ ☐
31. All tools operated according to manufacturer's instructions and design limitations. ☐ ☐ ☐ ☐
32. All hand and power tools maintained in a safe condition and inspected and tested before use. ☐ ☐ ☐ ☐
33. Defective tools are tagged and removed from service until repaired. ☐ ☐ ☐ ☐
34. PPE is selected and used according to tool-specific hazards anticipated. ☐ ☐ ☐ ☐
35. Power tools are not carried or lowered by their cord or hose. ☐ ☐ ☐ ☐
36. Tools are disconnected from energy sources when not in use, servicing, cleaning, etc. ☐ ☐ ☐ ☐
37. Safety guards remain installed or are promptly replaced after repair. ☐ ☐ ☐ ☐
38. Tools are stored properly. ☐ ☐ ☐ ☐
39 Cordless tools and recharging units both conform to electrical standards and specifications. ☐ ☐ ☐ ☐
40. Tools used in explosive environments are rated for such use. ☐ ☐ ☐ ☐
41 Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors. ☐ ☐ ☐ ☐

ELECTRIC-POWERED TOOLS (5.2.3)

42. Electric tools are approved double insulated or grounded and used according to instructions. ☐ ☐ ☐ ☐
43. Electric cords are not used for hoisting or lowering tools. ☐ ☐ ☐ ☐
44. Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed. ☐ ☐ ☐ ☐
45. Hand-held tools are equipped with appropriate on/off controls appropriate for the tool. ☐ ☐ ☐ ☐
46. Portable, power-driven circular saws are equipped with proper guards. ☐ ☐ ☐ ☐

HAND TOOLS (5.2.9)

47 Wrenches/Spanners are not used when jaws are sprung to the point of slippage. ☐ ☐ ☐ ☐
48 Impact tools are kept free of mushroomed heads. ☐ ☐ ☐ ☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

Attachment 5
Fact Sheets

Tick-Borne Pathogens — A Fact Sheet

Most of us have heard of Lyme disease or Rocky Mountain Spotted Fever (RMSF), but there are several notifiable tick-borne pathogens that present a significant field hazard. In some areas, these account for more than half of our serious field incidents. The following procedures should be applied during any field activity, even in places that are predominantly paved with bordering vegetation.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs and symptoms of tick-borne illnesses.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page. See also the 'TickEncounter' Resource Center website for photos of each variety of tick including photos of larvae, nymph, adult male and female, and partially fed and fully fed females ticks. It also shows the geographic location, their activity cycle over the year, and what diseases they can carry.

Tick Habitat

In eastern states, ticks are associated with deciduous forest, grasslands, and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture.

On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. For this region, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

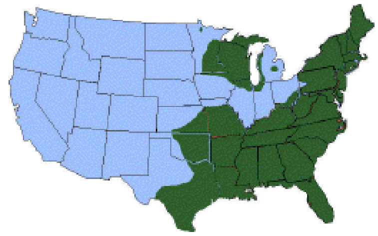
Illnesses and Signs & Symptoms

There are several notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite—normally hours after attachment. The illnesses include:

- Lyme (bacteria)
- RMSF (bacteria)
- Colorado Tick Fever (virus)
- Powassan (virus)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

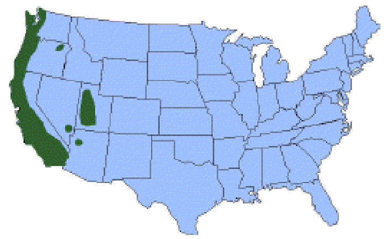
Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. For Lyme disease, the bite area will sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

Deer Tick



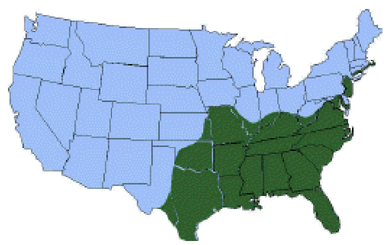
Distribution of Deer Tick (dark green)

From Left: adult female, adult male, nymph, and larvae
Deer Tick (cm scale)



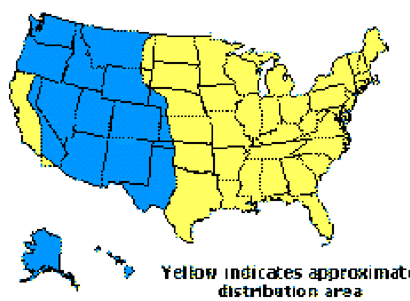
Distribution of Pacific Deer Tick (dark green)

Lone Star Tick

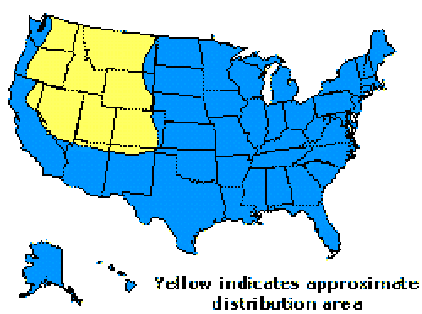


Distribution of Lone Star Tick (Green)

Dog Tick



Rocky Mountain Wood Tick



Hazard Control

The methods for controlling exposure to ticks include, in order of most- to least-preferred:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants—tick-borne pathogens present risk of serious illness!

In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and/or direct population reduction using tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative reduction such as removing leaf litter and trimming grass and brush. Trim/clear walking paths and specific work locations or request facility mow areas prior to field work. Often, projects schedule subcontractors to assist with vegetation reduction tasks prior to field work. Tick populations can be reduced by between 72 and 100 percent when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant or to a licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary to control exposure to ticks. Personal protection must include all of the following steps:

- So that ticks may be easily seen, wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used.
- To prevent ticks from getting underneath clothing tuck pant legs into socks or tape to boots and/or use tick gaiters (available through the warehouses). Tuck shirt into pants.
- Wear long-sleeved shirts, a hat, and high boots. Carry a tick removal kit (available through the warehouses).
- Apply DEET or Picradin repellent to exposed skin or clothing per product label. CDC recommended natural repellents may be used on a case-by-case basis for project staff sensitive to DEET or Picradin. Repellant is required when walking in vegetated areas with potential tick habitat.
- Apply permethrin repellent to the outside of boots, clothing and cloth field equipment (e.g. backpacks, snake chaps) before wearing, per product label. Consult this video, SDS, FAQ and label instructions for information on one of the available permethrin products that includes how to properly treat clothing and gear. Reapply Permethrin spray per the instructions (typically every six washings or six weeks). Insect Shield clothing is an alternative to spray Permethrin, and lasts up to sixty washes. Permethrin treated or Insect Shield clothing is required when walking in vegetated areas with potential tick habitat.
- Carry a lint roller. Frequently check for ticks and remove from clothing. Use lint roller, especially in the areas you can't see (back, back of the legs), the white roller body of the lint roller makes it much easier to identify and remove the very small ticks.

- At the end of the day, search your entire body for ticks (particularly groin, armpits, neck, and head) and shower.
- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves any time ticks are handled.

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid situations such as hand-to-face contact, eating, drinking, and smoking when applying or using repellents. Remove and wash clothes per repellent product label.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ Lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician.

In summary, if vegetation removal or insecticide to eliminate ticks is not feasible, the requirements are broken down into "**the three I's": Insecticide** (apply permethrin on clothing, DEET/repellant on skin), **Isolation** (wear long pants/sleeves, taping/tucking) and **Inspection** (frequent lint roller and visual checks, before entering vehicle checks, end of day check). You need all three I's to successfully protect yourself from ticks.

Tick Check

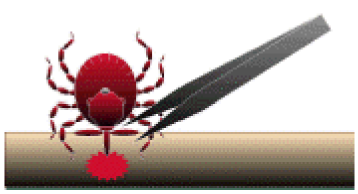
A tick check should be performed after field survey and each time before entering the field vehicle (you do not want to infest your field vehicle with ticks). Use a lint roller to check your clothes, small ticks are much easier to see on the white lint roller body, or if you don't have a lint roller, have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thorough as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self-check. Notify the Responsible Health and Safety Manager (RHSM), Project Manager (PM), and you supervisor if ticks are found on clothing and alert the entire field crew.

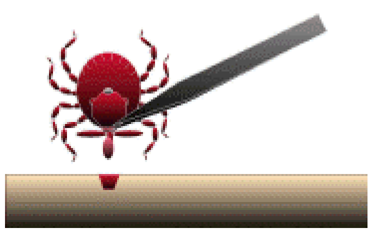
If a tick has embedded itself into the skin, remove the tick as described below and notify the RHSM, PM and your supervisor.

Tick Removal

1. Use a tick removal kit (obtained through one of the CH2M warehouses), or a fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. If this happens, remove mouthparts with tweezers. Notify the PM, RHSM, and your supervisor if a tick bite is experienced.





3. Avoid squeezing, crushing or puncturing the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. Should you wish to save the tick for identification, place it in a plastic bag, with the date of the tick bite, and place in your freezer. It may be used at a later date to assist a physician with making an accurate diagnosis (if you become ill).

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, many tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Individuals previously infected with Lyme disease does not confer immunity—re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

If you experience a tick bite, be sure to:

- ✓ **Notify your supervisor, PM, and RHSM**
- ✓ **Call WorkCare (U.S. including, Puerto Rico, Hawaii and AK) at 1-888-449-7787**

  For all other locations:

  - Canada, contact your supervisor and your HSE representative and call the Nurse Triage number at 1-877-424-5256
  - For International, contact your supervisor, HSE representative and HR
  - HKA (contingent) workers use the WorkCare number above

2020 Vehicle Accident Guidance

Insurance Cards

Fleet Vehicles: Please download, print and place in your vehicle
https://jacobsconnect.jacobs.com/community/company/grm/americas-grm
(choose the state where the vehicle is garaged)
Rental Vehicles: Insurance cards from the VO for rental cars are no longer required. When you use the preferred rental car company (Hertz or Enterprise) and reserve using the Jacobs code and corporate travel card, the insurance has been negotiated as part of the contract; therefore, your Hertz contract paperwork is the insurance documentation (keep in glove compartment with the rental's registration).

NOTE: ALL Rental Vehicles should be rented through **the Corporate Travel Agency, the online booking tool** or by using the **Jacobs Corporate Code** to obtain the corporate rental rate as well as the Loss Damage Waiver. If the vehicle is not rented through proper channels with the appropriate Jacobs Corporate Code, the **entire cost of the auto accident could be charged to your Project.**

Rental Company	Jacobs Corporate Code
Hertz (preferred)	37806
Enterprise	XZ32VJE
Enterprise	TK00442 (trucks)

When an Incident Occurs

In case of emergency – call 911
Notify your supervisor, PM, and RHSM
For non-emergency injuries, call WorkCare (U.S. including, Puerto Rico, Hawaii and AK) at 1-888-449-7787
For all other locations:

- For Canada, contact your supervisor and your HSE representative and call the Nurse Triage number at 1-877-424-5256
- For International, contact your supervisor, HSE representative and HR
- HKA (contingent) workers use the WorkCare number above

At the scene of the accident:

- ✓ Call the Police, note whether it is state or local police, the responding officer's name and badge number
- ✓ Take precautions to protect the scene of the accident from further accidents
- ✓ Provide emergency care for injured persons
- ✓ Request medical assistance
- ✓ Do not provide transportation
- ✓ Gather as much information as possible
- ✓ Take pictures
- ✓ Obtain witness names and addresses

Never admit liability. If asked, state that the claim will be or has been reported to your insurance carrier and an adjuster will contact them. Don't make any statement concerning who was at fault. Give out only that information required by authorities. Do not sign any statement except for an authorized authority.

Complete the appropriate vehicle accident report link to site **and sent to** AutoClaims@jacobs.com **and copy the PM, supervisor and RHSM.**

Working Alone Protocol

Call-In Contact Form

Date of site work:_______________ Expected start time:___________________
Name of Jacobs employee in the field:____
Name of Jacobs employee responsible to receive contact: _______________________________
Client Emergency Contact (if any): ____
Jacobs employee's contact numbers:
Radio #__________________________
Cell Phone #______________________
Address and Location of work:____
Directions/Map:

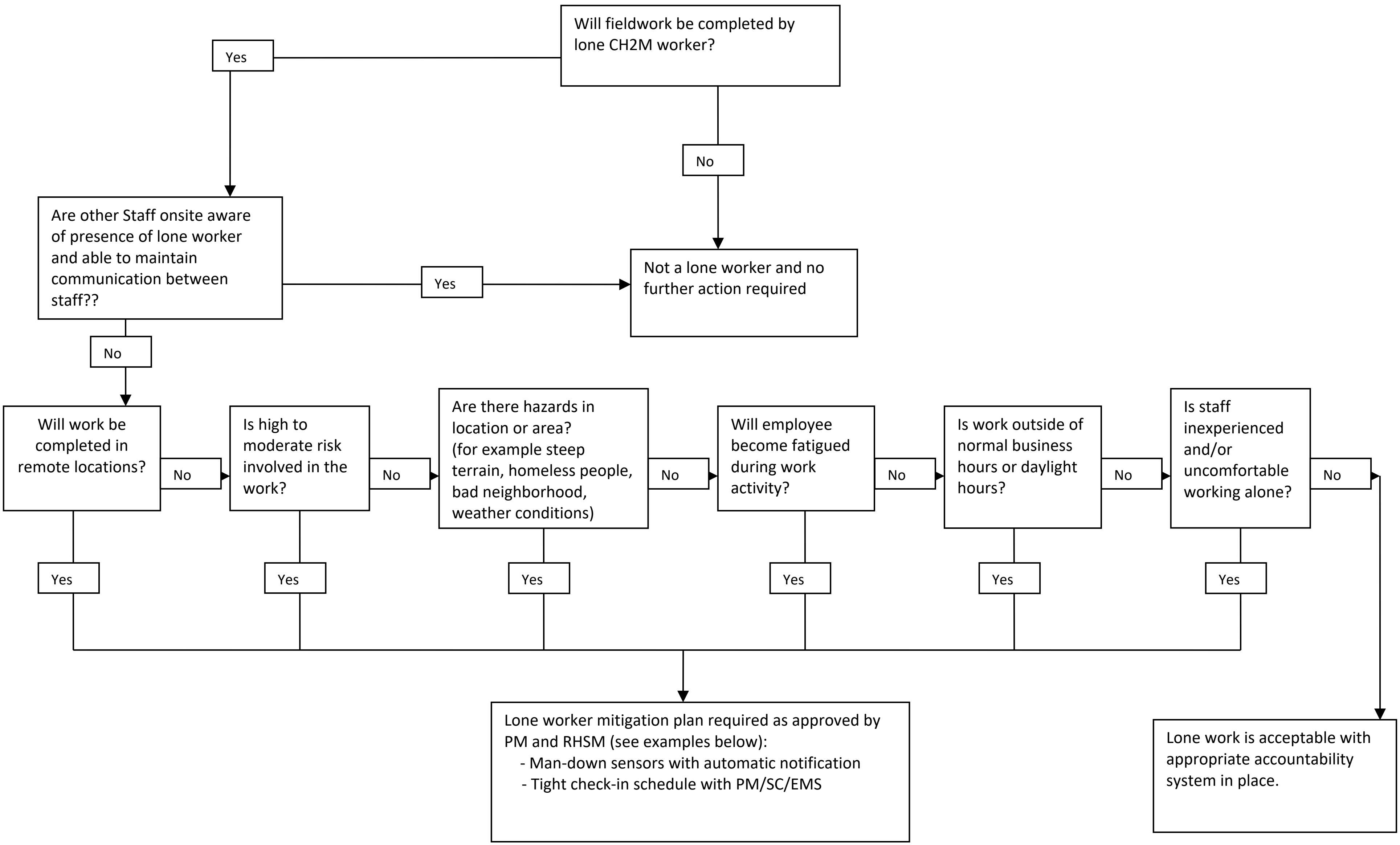
Planned Activity:____
Specified Frequency and time for call in:____

Time	Verified	Location

If lone worker fails to call in at specified frequency/time:

1. Call worker's radio and cell to determine if an emergency exists.
2. If no reply, immediately call client security/emergency service if there is one at the site.
3. If there is no client security, call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency onsite. Provide the lone worker's name, their last known location, and your contact information.
4. After Emergency Services have been contacted, call the other emergency contacts, PM, and Responsible Health and Safety Manager.

Lone Worker Protocol



HSE Agency Inspections (OSHA, EPA, DOT, State Health Department)

Do you know what YOU would do if an agency inspector arrived at your site unannounced?

Recently, a State Occupational Safety and Health Administration (OSHA) inspector made an unannounced visit to one of our Federal project sites. OSHA, U.S. Environmental Protection Agency (EPA), and authorized state or local agencies have authority to inspect any facility that is subject to health, safety, and environmental legislation. Inspections may be announced or unannounced. This particular inspector indicated that the project was targeted for an inspection because the work was funded by the American Recovery and Reinvestment Act (ARRA).

Enterprise Standard Operating Procedure (SOP) HSE-201, *Agency Inspections and Communications,* describes the responsibilities, procedures, and requirements associated with inspections conducted by external regulatory agencies, as well as the methods for communicating information to key individuals. This Target Zero Bulletin is a brief summary of what to do in the event of an agency inspection at your site. Refer to the SOP for more specific guidance.

Notification of Inspections

- If the inspection is an announced regulatory agency inspection, the Project Manager (PM) should notify the Responsible Health and Safety Manager (RHSM) and Responsible Environmental Manager (REM) well in advance of the inspection.
- If an unannounced agency inspector visits one of our projects, Field personnel must immediately notify the project Emergency Response Coordinator (ERC). Typically the ERC is the Safety Coordinator (SC).
- The ERC must immediately notify the RHSM/REM, as appropriate, of unannounced inspections, or designate someone to call the RHSM/REM. The RHSM/REMs can provide guidance to the field staff and PM.

Inspector Credential Verification

- Upon arrival, the ERC must request the inspector to provide official credentials. Record the inspector's name and office phone number or obtain the inspector's business card.
- The inspector shall sign the visitors log and be given a site-specific health, safety, and environmental protection briefing.
- The inspector shall meet any site access requirements associated with security clearances, specialized training, and medical monitoring. The Jacobs representative shall verify that the inspector possesses these requirements; access will only be granted to those areas where appropriate access requirements are met. Some inspectors have the authority to gain access to any work area at any time, such as an inspector with a search warrant. In these cases, we can stop work operations as necessary to protect the safety of the inspector(s).

Opening Conference

- The Jacobs Project Manager, SC, RHSM, or EM, and the inspector shall determine attendees for the opening conference. The RHSM (for OSHA and other worker health and safety inspections) or REM (for environmental inspections) shall join the opening conference via conference call.
- The inspector shall inform Jacobs of the purpose of the inspection and provide a copy of the complaint, if applicable.
- The inspector shall outline the scope of the inspection, including employee interviews conducted in private, physical inspection of the workplace and records, possible referrals, discrimination complaints, and the closing conference(s).

Requests for OSHA Logs

- An OSHA inspector may request to review the project OSHA Injury/Illness log, better known as the OSHA 300 Log. Contact your RHSM for assistance in obtaining the OSHA 300 Log.
- Field projects with a continuous duration of one year or longer are considered to be separate establishments and are required to maintain an OSHA 300 log specific to the project. The project OSHA 300 log should be maintained onsite and kept current.
- Recordable injuries and illnesses sustained on field projects less than one year in duration are maintained on the Jacobs office log where the injured employee is based.

The Inspection

- The scope of the inspection shall be limited to that indicated by the inspector in the opening conference. The inspector shall be escorted to relevant areas only. The ERC or other designated by the RHSM or REM must accompany the inspector during the inspection.

- Ensure that the inspection is limited to the scope that the inspector disclosed during the opening conference. The ERC should always take notes which identify: areas inspected, machinery or equipment and materials examined, employees or other persons interviewed, and photographs taken by the inspector.
- The inspector will observe safety, health, and environmental conditions and practices and document the inspection process. The inspector may also take photos and instrument readings, examine records, collect air samples, measure noise levels, survey existing engineering controls, and monitor employee exposure to toxic vapors, gases, and dusts.
- Jacobs should gather duplicate information (photographs, readings, samples) in the same manner and condition as the inspector. If the equipment needed to take duplicate samples is not onsite, ask the inspector if the sampling can wait until the equipment is available. If samples are taken, request a description of the tests that the agency intends to perform on the samples and request results as soon as they are available.
- Employees may be questioned during the inspection tour. The employee can refuse to speak to an inspector, can speak to the inspector with a company representative (including management) present, or can speak to the inspector privately. It is Jacobs policy that employees who wish to speak to the inspector are not discriminated against, intimidated, or otherwise mistreated for exercising their rights during compliance inspections.
- Copies of documents should not be provided to the inspector without the approval of the RHSM or REM or Legal Insurance Department (LID). **DO NOT** voluntarily release documents. Respond only to inspection team requests.
- During the course of the inspection, the inspector may point out violations. For each violation, the Jacobs representative should ask the inspector to discuss possible corrective action. Where possible, violations detected by the inspector should be corrected immediately and noted by the inspector as corrected.
- For those items which cannot be corrected immediately, an action plan shall be formulated for timely correction. In any instance, employees exposed to hazards shall be removed from the area.

Closing Conference

After the inspection, a closing conference is normally held as follows:

- The Jacobs PM, SC, RHSM or EM shall be involved via conference call in the closing conference, at a minimum;
- The inspector shall describe the apparent violations found during the inspection and other pertinent issues as deemed necessary by the inspector. Jacobs shall be advised of their rights to participate in any subsequent conferences, meetings or discussions. Any unusual circumstances noted during the closing conference shall be documented by the ERC;
- The inspector shall discuss violations observed during the inspection and indicate for which violations a citation and a proposed penalty may be issued or recommended;
- The ERC shall request receipts for all samples and approved documents photocopied by the inspector, request a photocopy of the inspector's photograph log, and request a copy of the final inspection report; and
- Any documentation from an agency inspection must be transmitted immediately to the RHSM or REM, and LID.

Unannounced regulatory agency inspections may happen at any time on our projects
Get your RHSM/REM and PM involved immediately if an Inspector arrives.

COVID 19 CORONAVIRUS DISEASE

What you need to know about coronavirus disease 2019 (COVID-19)

What is coronavirus disease 2019 (COVID-19)?

Coronavirus disease 2019 (COVID-19) is a respiratory illness that can spread from person to person. The virus that causes COVID-19 is a novel coronavirus that was first identified during an investigation into an outbreak in Wuhan, China.

Can people in the U.S. get COVID-19?

Yes. COVID-19 is spreading from person to person in parts of the United States. Risk of infection with COVID-19 is higher for people who are close contacts of someone known to have COVID-19, for example healthcare workers, or household members. Other people at higher risk for infection are those who live in or have recently been in an area with ongoing spread of COVID-19. Learn more about places with ongoing spread at https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html#geographic.

Have there been cases of COVID-19 in the U.S.?

Yes. The first case of COVID-19 in the United States was reported on January 21, 2020. The current count of cases of COVID-19 in the United States is available on CDC's webpage at https://www.cdc.gov/coronavirus/2019-ncov/cases-in-us.html.

How does COVID-19 spread?

The virus that causes COVID-19 probably emerged from an animal source, but is now spreading from person to person. The virus is thought to spread mainly between people who are in close contact with one another (within about 6 feet) through respiratory droplets produced when an infected person coughs or sneezes. It also may be possible that a person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes, but this is not thought to be the main way the virus spreads. Learn what is known about the spread of newly emerged coronaviruses at https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html.

What are the symptoms of COVID-19?

Patients with COVID-19 have had mild to severe respiratory illness with symptoms of

- fever
- cough
- shortness of breath

What are severe complications from this virus?

Some patients have pneumonia in both lungs, multi-organ failure and in some cases death.

How can I help protect myself?

People can help protect themselves from respiratory illness with everyday preventive actions.

- Avoid close contact with people who are sick.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Wash your hands often with soap and water for at least 20 seconds. Use an alcohol-based hand sanitizer that contains at least 60% alcohol if soap and water are not available.

If you are sick, to keep from spreading respiratory illness to others, you should

- Stay home when you are sick.
- Cover your cough or sneeze with a tissue, then throw the tissue in the trash.
- Clean and disinfect frequently touched objects and surfaces.

What should I do if I recently traveled from an area with ongoing spread of COVID-19?

If you have traveled from an affected area, there may be restrictions on your movements for up to 2 weeks. If you develop symptoms during that period (fever, cough, trouble breathing), seek medical advice. Call the office of your health care provider before you go, and tell them about your travel and your symptoms. They will give you instructions on how to get care without exposing other people to your illness. While sick, avoid contact with people, don't go out and delay any travel to reduce the possibility of spreading illness to others.

Is there a vaccine?

There is currently no vaccine to protect against COVID-19. The best way to prevent infection is to take everyday preventive actions, like avoiding close contact with people who are sick and washing your hands often.

Is there a treatment?

There is no specific antiviral treatment for COVID-19. People with COVID-19 can seek medical care to help relieve symptoms.

DEPARTMENT OF HEALTH & HUMAN SERVICES USA CDC

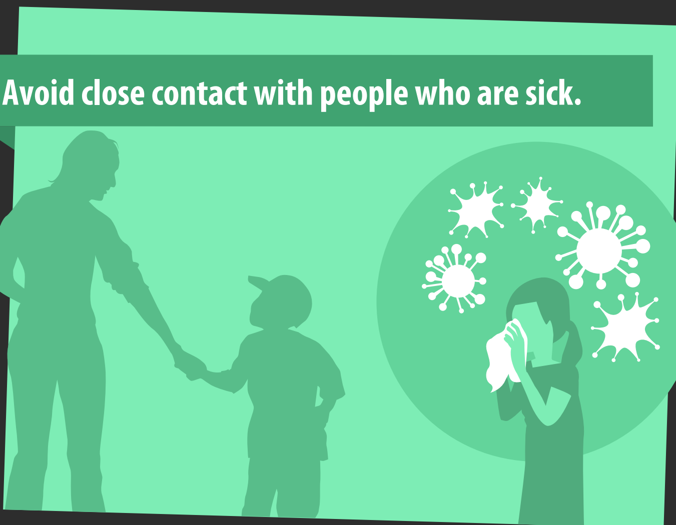
For more information: **www.cdc.gov/COVID19**

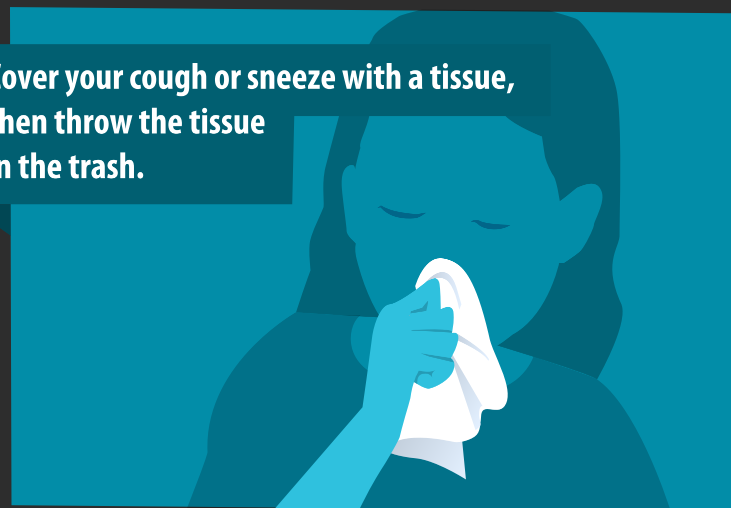
CS 314937-A 03/03/2020

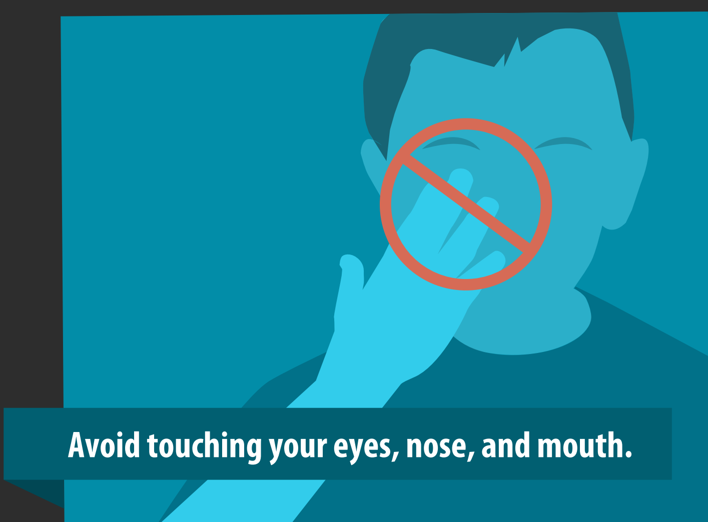
COVID 19 CORONAVIRUS DISEASE

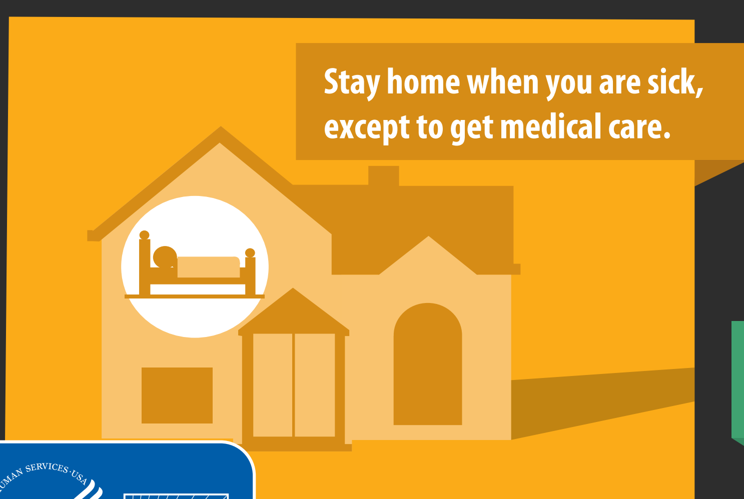
STOP THE SPREAD OF GERMS

Help prevent the spread of respiratory diseases like COVID-19.









DEPARTMENT OF HEALTH & HUMAN SERVICES·USA CDC

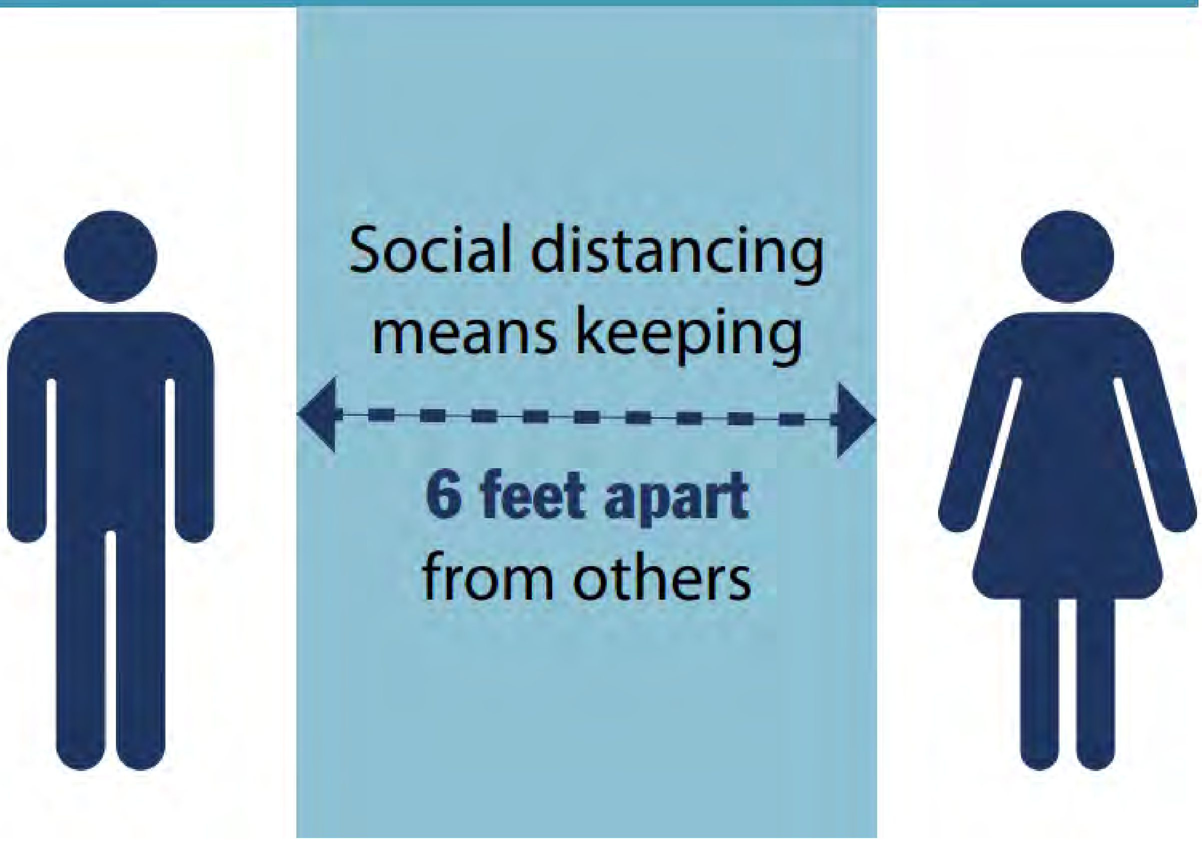
For more information: **www.cdc.gov/COVID19**

CS314915-A

NOTICE

Please Wash
Hands Prior
To Entering Office

Please keep your social distance.



Jacobs Novel Coronavirus (2019-nCoV) Preparedness

Jacobs has a pandemic preparedness guide within our Emergency Response Plan which includes specified actions at certain trigger points (phases). As the situation progresses, we will keep you informed via email, JacobsConnect, office HSE and facilities communications.

Our travel locator service allows us to identify business travellers in affected regions and to provide them with specific advice.

If you are not feeling well, stay home and seek medical care. For further guidance, employee can also contact the Global Assistance & Response hotline at **+1-443-221-6281**.

For additional information, reach out to the Operational Centers of Excellence HSE or Global Security & Resilience contacts at global.security@jacobs.com.

BeyondZero℠

Jacobs

What is a Coronavirus?

The 2019 novel (new) coronoavirus (2019-nCoV) is an ongoing outbreak of pneumonia first identified in Wuhan, China and can spread from person-to-person. Common signs of infection include:

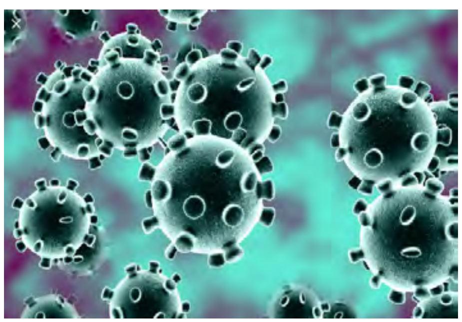
Healthy adults can infect others beginning three days after exposure to the virus, one day before symptoms develop, and up to five days after becoming sick. The total incubation period can be up to 14 days. This means you can pass the disease to someone
else before you know you are sick, as well as while you are sick.

Currently, there is no specific treatment or vaccine to protect against 2019-nCoV.

Pandemic influenza phases

The World Health Organisation (WHO) uses the following classifications:

Phases 1 - 3	Predominantly animal infections. Few human infections.
Phase 4	Sustained human to human transmission.
Phases 5 – 6 PANDEMIC	Widespread human infection
Post Peak	Possibility of recurrent events
Post Pandemic	Disease activity at seasonal level



Healthy people either inhale the virus or pick it up by touching contaminated surfaces, then touching their nose, eyes, or mouth. Reduce transmission by covering your cough or sneeze.

What you can do

- Practice good personal hygiene – cover your mouth and nose with a tissue while coughing or sneezing.
- Wash hands frequently with soap and water or hand sanitizer that contains at least 60% alcohol – especially after coughing or sneeze.
- Avoid crowds and stay at least one to two meters away from obviously sick people. Stay at least one to two meters away from them.
- Avoid contact with wild animals or farm animals (live or dead) and their environment. This includes "wet markets" with live animals.
- Clean your environment often.
- Do not touch surfaces that may be contaminated with animal droppings.
- Avoid touching your face. If you must touch, ensure your hands are clean first.
- Do not travel if you are sick.
- Always check travel advisories before travelling.
- If travelling from an affected area or after contact with anyone from an affected area, monitor your health for at least fourteen days after your return and seek medical attention immediately if you become ill.
- Thoroughly cook meat and eggs to the recommended temperatures.

Up-to-date information on the 2019-nCoV can be found through the following:

- World Health Organization (WHO) Novel Coronvirus
- Center for Disease Control and Prevention (CDC)

Keeping your hands clean can reduce the spread of infection and protect yourself and others from getting sick.

Workplace Measures & Frequently Asked Questions

To protect our employees, Jacobs has deployed several measures:

- We are providing timely communications and guidance through JacobsConnect, network groups and HSE and real estate partners.
- Each country has specific guidelines around time off and time recording. Reach out to your local HR and line manager for guidance.
- Inform your manager if you are feeling unwell and discuss time off decisions.
- Visit your local doctor for further assessment and treatment.
- Local offices should look to procure containment kits which may include nitrile gloves, surgical masks, and hand sanitizers containing at least 60% alcohol.
- The Global Security & Resilience (GS&R) and Health, Safety and Environmental (HSE) team will continue to monitor the situation closely and provide updates as they develop.

Travel is temporarily banned to Mainland China at this time (excluding Hong Kong). Exceptions will require completion of TRiP consultation with and assessment by Global Security & Resilience team and final approval by the President, COO and/or CFO.

Reference: Global Security & Resilience JacobsConnect page for the latest travel status

- Global Assistance and Response World Cue Planner
- The Center for Systems Science and Engineering (CSSE) – Mapping the Wuhan Coronavirus

The use of surgical face masks can help protect you and others. If you are ill, face masks also help prevent the spread of disease.

Emergency preparedness

Circulate the pamphlet to your teams, direct any employee inquiry or travel concerns to GS&R, and refer employees to the Coronavirus mitigation protocol.

All Emergency Management Teams (EMTs) should continue to monitor the situation and follow guidance from the Operational Centers of Excellence.

All EMTs should review and update their Emergency Response Plan (ERP) and refer to the Pandemic guide to action for response advice on Page 95.

The EMT Incident Commander or Coordinator should seek guidance and coordinate with the GS&R team and Operational Centers of Excellence HSE leads as needed.

Educate yourself and your family. Learn about possible dangers and become familiar with your local office emergency plan for handling pandemics and your local community health response plan.

GLOBAL ASSISTANCE & RESPONSE

Jacobs Global Assistance & Response is available 24/7 for any security or medical enquiries.

COVID-19: EMPLOYER INSTRUCTIONS

WorkCare Will:

- Speak with employee (EE) and review Centers for Disease Control and Prevention (CDC) determination for risk levels
- Notify the employer (ER) of EE's risk level
- Suggest EE follow CDC guidelines for possible infectious disease:
    - For EEs identified as High Risk by the CDC:
        - Instruct EE on CDC guidelines regarding self-elected isolation
            - NOTE: EE will be responsible for contacting their primary or local healthcare provider (Do not visit the clinic/office)
                - Healthcare provider will determine the next steps, including whether testing and reporting to local health department is required and how EE should obtain testing
- WorkCare will conference EE and supervisor/manager to discuss CDC suggestions
    - ER and EE will determine if EE should report to work
- WorkCare physician will, upon ER request, consult with ER / EE to ensure that best practice criteria have been met for an EE to return to work (RTW):
    - Self-Directed Quarantine x 14 days at minimum completed
    - EE is asymptomatic
    - EE has communicated with primary care provider (PCP) EE has obtained a clearance letter from PCP with approval to RTW

WorkCare Will Not:

- Diagnose the employee (EE)
- Remove EE from work
- Provide a release for work or determine fitness for duty
- Answer general questions about COVID-19
- Call the local health department
- Identify an EE as a patient under investigation (PUI). This must be done by the EE's personal or local healthcare provider.
- Follow-up with the employee to determine health status after the initial call
- WorkCare will not assume care as the primary or local treating provider

Definitions

Low Risk: Symptomatic OR Asymptomatic & No Known Exposure

Moderate Risk: Asymptomatic & Positive Exposure

High Risk: Symptomatic & Positive Exposure

Isolation: Used to separate ill people that have a communicable disease from those that are healthy (HHS.gov)

Quarantine: Used to separate and restrict the movement of well people who may have been exposed to a communicable disease to see if they become ill (HHS.gov)

WorkCare™
WORK MATTERS. HEALTH COUNTS.

Approvals

	Name	Title	Signature	Date
Authors	Michael Talbot RN	Process Lead		3/10/2020
	Karen O'Hara	Director, Marketing, Communications		3/10/2020
Reviewer	John Longphre MD MPH	Senior VP		3/10/2020
Authorized by	Anthony Harris MD	Corona Project Lead		3/10/2020

Change Log

Document	Effective Date	Significant Changes	Prior Document
Corona Do / Don't – ER distribution	3/10/2020	Change to ER documentation	03.06.2020
	Click or tap to enter a date.		
	Click or tap to enter a date.		
	Click or tap to enter a date.		

Attachment 6
Observed Hazard Form

Observed Hazard Form

Name/Company of Observer (*optional*):
____

Date reported**:**___________________ | Time reported**:**_____________________

Contractor/s performing unsafe act or creating unsafe condition**:**

1. ____

2. ____

3. ____

Unsafe Act or Condition**:**

____
____
____
____
____
____
____
____
____

Location of Unsafe Act or Condition**:**

Name of Jaocbs Representative:
____

Corrective Actions Taken**:** Date: ___________

____
____
____
____
____

Project Safety Committee Evaluation: Date: ___________

____
____
____
____

Attachment 7
Stop Work Order Form

Stop Work Order

REPORT PREPARED BY:

Name:	**Title:**	**Signature:**	**Date:**

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:
	_________________

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	**Title:**	**Signature:**	**Date:**

**** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by Jacobs Representative,***

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:
	_________________

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	**Title:**	**Signature:**	**Date:**

Attachment 8
Completed Jacobs AHAs

ACTIVITY HAZARD ANALYSIS

Date: 3/17/2020	Task Risk Assessment Code: Low
Project Location: Basewide PFAS Investigation at NAS Patuxent River, Webster Field Annex	L = Low Risk
Project Manager: Carrie Saunders/AUS	M = Moderate Risk
Site Safety Liaison/Site Safety and Health Officer: Don Martinson	H = High Risk
Health and Safety Manager Review/Approval: Carl Woods	E = Extremely High Risk
Quality Control Manager Review/Approval: N/A	
Contract Number: N62470-16-D-9000	
Job/Activity: Groundwater Sampling	

		Probability				
		Frequent	**Likely**	**Occasional**	**Seldom**	**Unlikely**
Severity	**Catastrophic**	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY									
									
1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATURE

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? cut, struck, exposed, or other.)	**Potential Energy Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer the HSE Handbook for required controls.)	**Risk Assessment Code**
General site work	**See Site Reconnaissance and General Site Work Activity Hazard Analysis (AHA) For General Site Hazards and Controls (driving, biological, weather, traffic, lifting hazards, security)**			**L**
Accessing and opening well	Over tightened bolts, rusty locks/slipping causing cuts/abrasions to hands Pinch points Exposure to contaminants Contact with potentially contaminated water Traffic, struck by vehicles Personal security Biological hazards	Mechanical Gravity Chemical	• Know the limitations of all hand tools. Use socket wrench and, if necessary, bolt cutters to remove old, rusty locks. Never use shop or homemade tools. • Do not open large manholes without appropriately designed lifting equipment. • Watch hand placement when removing well lid to access monitoring well. Do not place hands around lip or well head where well lid could pinch. Use pry bar to lift well lid if possible. • Stand upwind of well when opening lid. Allow well to vent, use air monitoring equipment to follow action levels in the Accident Prevention Plan (APP) and contact health and safety manager if readings exceed action levels. • Review constituents of potential concern (COPCs) listed in APP and be aware of site health hazards. • Do not eat or drink onsite, except in designated areas. • Wear leather gloves if necessary to avoid sharp edges or pinch points; wear nitrile gloves when there is a potential for contact with water • Set up an exclusion area around well. Use site control as specified in APP. • Use appropriate traffic control, including delineators and caution tape. Never conduct sampling in parking areas or roadways without traffic control. • Do not work alone. Always use buddy system when sampling. Review security requirements in Site Reconnaissance AHA. • Inspect well head for biological hazards, such as spiders. Wear gloves and long-sleeve shirts. Use a stick to clear the location of webs and insects. Review biological hazards and control measures in Site Reconnaissance AHA.	L
Using generator/ batteries	Electrical hazards/shock from generator or battery Carbon monoxide Generator/noise hazard	Electrical Noise	• Use GFCI and grounding rods or ground to vehicle. Place generator at extension cord length distance downwind of site. • Verify all cords are in good condition. Ensure ground is present on extension cord. • Cords should be heavy duty and designed for exterior use. • Ensure cords are not laying in water. • Do not use gas powered generator in an enclosed area. • Use equipment in compliance with manufacturer's guidelines and only for applications for which they were designed. Do not remove guards. • If vehicle batteries are used, care must be taken when using 12-volt DC batteries. Follow manufacturer instructions for maintenance of batteries. Follow equipment manufacturer's instructions for battery use in that equipment and or for charging. • Using hearing protection or move the generator away from work area.	L

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? cut, struck, exposed, or other.)	**Potential Energy Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer the HSE Handbook for required controls.)	**Risk Assessment Code**
Water level measurement	Probe recoiling too quickly striking personnel, hunching over well (back fatigue) Contact with potentially contaminated groundwater Slip/fall	Motion Mechanical Chemical	• Recoil meter slowly as the probe reaches meter. • Maintain good posture while standing at well, and take breaks as necessary to stretch out back muscles. • Use knee pad, chair or other supports to minimize strain. • Wear personal protective equipment (PPE), including nitrile gloves and safety glasses to prevent dermal contact • Avoid contact with transducer or contaminated groundwater. • Keep cords out of walking path and maintain good housekeeping.	L
Sample Collection (groundwater)	Placing or removing pump from well/pinch points, muscle strain Sample preservatives/vapors released once water is added or splashing of preservative/groundwater on skin Broken glass and tape gun, sharp edges Entering private houses to collect drinking water sample (people hazards, dog hazards)	Motion Mechanical Chemical Biological	• Be aware of hands as pump is lowered and recoiled, do not allow pump head to fly out of well. • Stand upwind when adding sample preservatives (if outside); do not hold sample containers on your lap when adding preservative. • Review Safety Data Sheet (SDS)/labels of preservatives, may be corrosive. • Hold sample containers away from face when filling and wear proper PPE including nitrile gloves and safety glasses • Do not overtighten caps. Carefully handle so containers do not break. Wear cut resistant gloves if glass breaks. • To extent possible, prepare tape strips separately and apply to sample bottles by hand; break tape by pushing tape gun away from you.	L
Preparation of sample containers	Handling of chemicals/spilling of chemicals on skin, clothes or eyes.	Motion Chemical	• Never leave open chemicals unattended. • Know location of nearest eyewash kit. • Wear proper PPE. • Keep prep and pack area well ventilated. • Know location of SDS and absorbent spill cloth. • Make sure all caps are secure. • Do not hold sample containers on your lap when adding preservative. • If using glass sample containers, use caution not to drop, and use caution if you have to clean up broken glass (wear leather gloves under nitrile, if necessary).	L
Receiving pre-preserved bottles	Glass containers/broken glass, cuts to hands Packaging material / acid leak Accumulation of preservatives	Motion Chemical	• Use caution when opening package. • Ensure containers are labeled and marked with hazard information. • Wear proper PPE (nitrile gloves, safety glasses; if cleaning up broken glass, wear leather gloves under nitriles, if necessary)	L
Receiving coolers from the field	Heavy coolers/back injury Insects, spider bites and stings	Biological	• Bend at knees, ask for assistance. • Use hand truck or two people to lift coolers. • Use caution when taking contents out of cooler. Inspect coolers for insects.	L
Preparing coolers for delivery	Strapping machine/ tripping over unrolled tape. Tape gun/cuts to hands	Gravity	• Make sure strapping machine is properly rolled.	L

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? cut, struck, exposed, or other.)	**Potential Energy Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer the HSE Handbook for required controls.)	**Risk Assessment Code**
	Heavy coolers/back injury Slipping on ice/pools of water from melted ice	Motion	• Use caution, be aware of cutting edge; To extent possible, break tape by pushing tape gun away from you; ensure hands and legs are not in the path of the tape gun • Bend at knees, ask for assistance. Use two people or hand truck to lift loaded coolers. • Minimize distance coolers must be carried. • Avoid spilling ice, pick up any spilled ice. Wipe up wet areas with a towel to avoid slips.	
Decontamination	Contaminant exposure	Chemical	• Ensure equipment is decontaminated prior to reuse or leaving exclusion area. • Use Alconox or appropriate decontamination solution to wash equipment. Review Alconox SDS. • Do not leave exclusion area with PPE on. • Be aware of cross-contamination, do not take items that have had ground water to other locations or vehicle. • Dispose of PPE and decontamination solution in appropriate area. • Wash hands and face after performing task.	L

Equipment to Be Used (List equipment to be used in the work activity.)	**Inspection Requirements** (List inspection requirements for the work activity.)	**Training Requirements** (List training requirements, including hazard communication.)
• Standard PPE (safety glasses, hard hat, safety boots, high-visibility clothing) • Gloves suitable for the task • Field vehicle • Miscellaneous field equipment • Ground water sampling equipment (such as coolers, glassware, pump, tubing) • Gauging equipment • Hand and power tools (such as socket set, screwdriver) • Small portable generator/battery • GFCI and power cords • Fire extinguisher • Eye wash (small portable type) • First aid/bloodborne pathogen kit • Traffic and site control equipment (such as delineators, caution tape) • Spill Kit • Decontamination equipment (such as spray bottle, Alconox, trash bags) • Communication devices • Personal Protective Equipment • Heat stress control measures (shade tent, suitably cool water, sunscreen) • Tick and insect control measures if walking in vegetation (such as DEET, permethrin) • Snake chaps if walking in vegetation	• Daily inspections of PPE by user. Replaced as necessary. • General inspection of vehicle by CH2M HILL, Inc. (CH2M) personnel. Maintained regularly. • Daily inspections of tools by user. Replaced as necessary. • Daily inspections of safety equipment by user. Replaced as necessary. Follow equipment manual instructions.	• State-issued driver's license • First aid/cardiopulmonary resuscitation • Fire extinguisher • Virtual office training modules as indicated in APP/SSHP (such as for noise, traffic) • Hazard Communication training • HAZWOPER (as indicated in APP) • PPE training • Training on CH2M APP and Subcontractor's APP (and applicable AHAs) • Documented training on SDSs for any chemicals used • Safety Coordinator Hazardous Waste • Heat stress training (review signs and symptoms presented in SSHP)

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________________	Date/Time:___________________________________
SC/SSHO Name:	______________________	______________________________	Date/Time:___________________________________
Employee Names:	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
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CH2MHILL

Activity Hazard Analysis

Date: March 17, 2020	Task Risk Assessment Code (RAC):		Moderate				
Job/Activity: Observe drilling subcontractor (including direct push drilling/sampling, well installation)	L = Low						
Project: Basewide PFAS Investigation at NAS Patuxent River, Webster Field Annex	E = Extremely High Risk				**Probability**		
Prepared by: Carl Woods, CSP	H = High Risk						
Reviewed by (PM/Site Supervisor): Don Martinson	M = Moderate Risk		**Frequent**	**Likely**	**Occasional**	**Seldom**	**Unlikely**
Description of the work: This AHA is for use by CH2M HILL personnel providing oversight of subcontractors performing work, including drilling operations and groundwater samples.	**Severity**	**Catastrophic**	E	E	H	H	M
NOTE: Many hazard controls listed are aimed at the drilling contractor but are listed here as an aide for the Oversight crew. CH2M HILL personnel should not perform work associated with the drilling activities, outside of oversight. The drilling contractor will have their own H&S procedures that they follow.		**Critical**	E	H	H	M	L
Minimum PPE during site visits: Hard hat, safety glasses, safety-toed boots, long pants, sleeved shirt.		**Marginal**	H	M	M	L	L
		Negligible	M	L	L	L	L

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
General preparation	Forgotten safety equipment, no cell phone coverage, lack of emergency preparedness, untimely reporting of an injury or other incident	• Check for cell phone coverage. • Designate rally point and evacuation point (daily if working in new locations each day). • Check daily weather report and plan activities around severe weather. • Review, inspect and locate safety equipment including fire extinguisher, first aid kit, insect repellant/bug-out suits, PPE as specified in HSP, water, spill kits, thermometer or stop watch for heat stress monitoring, access to shade, etc. • Be sure to review the requirements for incident notification, reporting and investigation section of the HSP. Report all injuries, no matter how minor. If you are unsure whether an event should be reported, contact your RHSM. Be sure to report near misses.

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
A. Arrive on site		
Complete HSP, AHA review Complete Pre-Task Safety Plan	Vehicle congestion, traffic flow/control, access difficulties, visibility hazards working around heavy equipment	• Wear proper PPE as specified in HSP including safety glasses with side shields, hard hat, hearing protection, safety boots, work gloves, and high visibility traffic vest. • Determine appropriate locations for drill rig and support vehicles and ensure that roadways are clear for travel, inspect areas for overhead obstructions or utilities. • Check area for rig accessibility (i.e. clearances, solid ground). Verify a minimum of 4 feet of clearance during transit for 50kV line, check drill protocol for clearances. • Use cones or barricades as necessary to identify and control site boundaries and access.
Confirm list of wells to be installed, determine locations and route to be taken.	Biohazards associated with wells in remote areas. Weather related issues (heat and/or cold stress).	• Watch for animal hazards in wooded and high grassy areas (i.e. snakes, rabid raccoons, etc.). • Follow the biological hazard precautions, guidelines, and fact sheets in the HSP for ticks, spiders, snakes, hazardous plants, etc. • Wear and use proper clothing and sprays to protect against ticks, mosquitoes, poison ivy, and other biological hazards—follow the controls in the HSP for specific requirements. • Personnel should dress appropriately for ambient temperatures which would include but not limited to dry layered clothing. • For cold weather, work schedules should be adjusted to provide sufficient break periods in a heated area • For hot weather, work schedules may need to be adjusted to provide time intervals for replenishing fluids and which is free of contamination. • Review/Inspect safety equipment prior to starting work. Ensure fire extinguisher, spill kit, eye wash unit, and first aid kits are at the location. • Check the fire extinguisher on drill rig to verify inspection and charge.

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
	Temperature Extremes **(cold)**	• Read and follow cold stress precautions specified in the HSP. • Wear layers and ensure you're dressed adequately for site conditions. • Takes breaks in a warm location as necessary and stay hydrated with warm fluids (avoid caffeine). • Monitor your co-workers for signs of cold stress. • Persons who experience signs of heat or cold stress should contact the SC, PM and RHSM. Call the occupational nurse first if symptoms are severe.
	Wasps	• Keep exposed skin to a minimum. • Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. When working at a remote location, ensure that first-aid kits contain over-the-counter allergy and itch medication (e.g., Benadryl, Claritin, etc) as well as other over-the-counter medications that may not be available to aid in symptom treatment. • If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in brushy areas. • Consider if heavy-weight clothing or tyvek, or head netting would provide additional protection in areas where wasps/bees are known or suspected. Be aware of heat stress conditions additional clothing may cause. • Use insect repellent on clothing. Wear light-colored clothing and remove bright reflective safety-colored clothing if not working near a roadway as these may attract the wasps. • Wear fragrance-free or lightly-scented sunscreen, and body lotions. Bees are attracted to sweet scents. Avoid using floral scented soaps, shampoos, or conditioners. • If you encounter a wasp, back away slowly and calmly, do not run or swat at the insect. Wait for it to leave, or gently move or brush it off gently with a piece of paper or other light object. Do not use your

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		hand. • If you are stung, contact the occupational nurse no matter how minor it may seem. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe. • Use wasp/bee spray if necessary in accordance with manufacturer's labeling and direction for use.
	Other biological hazards	• Refer to the HSP for controls on other biological hazards possibly present dependent on season/location, including Valley Black Gnats, snakes, spiders, and poisonous plants.
B. Mobilize to drilling/DPT location, drill set up, set up decon area for augers/cores, set up sampling logging table.	Driving hazards, contact, caught, and fall hazards.	• Inspect the vehicle prior to departure. • If driving a rental car, become familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles. • Drivers shall not use cellular phones, or other two-way communication devices while driving (including hands-free devices). Pull over and park the car to make or take phone calls, text, or e-mail. • Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you. • If vehicle is malfunctioning, don't pull over off the road suddenly. Give the traffic behind you notice that you are pulling off. • Always wear seatbelt in vehicle, regardless of length of drive. • Apply Get Out and Look (GOAL) when returning to the vehicle to prevent property damage and injury by looking for obstructions, personnel or other items.

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		Back slowly and use a spotter when view is obstructed. • Personnel should stay out of the operator's blind spots while equipment if being moved and set up between borings. • Wear high visibility traffic vests. • Ensure that all heavy equipment has reverse alarms. • Remain alert and attentive to location of and movement of all drilling equipment. • Inspect immediate work area—remove slip, trip fall hazards as feasible or mark to warn of a hazard.
	Exertion-heavy lifting	• Utilize proper lifting procedure when loading and unloading vehicles and equipment (i.e. augers, sand bags, and bentonite). Use mechanical means when available or necessary. • Bend down at the knees and lift with your legs rather than bending and lifting with your back. Do not lift and twist. • CH2M HILL personnel shall not lift more than 40 pounds. Get a buddy or use mechanical lifting/handling devices.
	Struck by components of drill rig, tools or samples, strains/sprains from lifting	• Set up sample logging table facing the drill rig and at least one mast length (or greater if pipe is strung higher than the mast) away from the rig (to keep away from drilling "line of fire" hazards) • Have driller helper or driller bring core samples over to geologist. Discuss this with drillers prior to commencement of drilling. • If CH2M HILL personnel must handle cores and/or coolers, use a four-wheeled platform or similar type cart (or other similar material handling device) or use two people to move.
	Striking or coming into contact with buried or overhead utilities Pinch points Injury from improper or unlevel rig set-up	• Check well locations for underground and overhead utilities. • Check sample locations for underground utilities. Follow the "Utilities (underground)" section of the HSP. Any deviation from the HSP must be discussed with the HSM prior to intrusive activities. • Know where the kill switch is located on the drill rig in

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		case an emergency shut-down is necessary. • Observe rig mast set up, so no contact with overhead obstacles. • Know voltage of overhead electrical lines so that the minimum safe distance can be determined in accordance with the overhead utilities section of the HSP. • Proper rig set up and leveling. • Remind everyone never to leave hand tools on rig.
	Fire/explosion/Spill Hazards associated with drill rig	• Use non-sparking tools as potential to contact free product (gasoline) is possible. • Ensure drill rig is grounded. • Have spill materials and 20-lb ABC fire extinguisher in the area. When feasible, drillers should use best practices such as placing visqueen or other secondary type containment under rig to catch hydraulic leaks. • Have fire extinguisher accessible within work area. Where exposure to free product is possible, use non-sparking tools. Monitor work area and breathing zone with CGI. If CGI indicates LEL of 5% or greater (or oxygen contact below 19.5% or greater than 23.5%), suspend work. If readings are sustained, contact HSM. • Eliminate static electricity by grounding, where applicable/feasible. • Keep ignition sources away from the work area. • No smoking in the area and set-up zones large enough to keep public at safe distance.
Open or cut concrete, asphalt, or soil at soil boring or well location.	Contact, Caught, Fall Hazards.	• Wear proper PPE as specified in HSP including safety glasses with side shields, hard hat, hearing protection, safety boots, work gloves, high visibility traffic vest. • Proper use of equipment (i.e. concrete saw, core drill, etc.) - make sure all kill switches, blade guards, are functioning properly and correctly positioned. • During cutting activities be aware of flying debris; wear a face shield if necessary. • Bend down at the knees and lift with your legs rather than bending and lifting with your back.

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
Hand clear soil boring location to assure no underground improvements (if appropriate and necessary). (Hand dig to 5 feet bgs in areas where suspected utilities may be but not showing on utility surveys.)	Contact, Exposure, Exertion Hazards Striking or coming into contact with buried or overhead utilities may potentially expose personnel to hazards including high voltage, electricity, natural gas, industrial wastewater, and raw sewage.	• Hand clear slowly, do not force through soil may contact/break underground lines ("soft dig" technologies recommended). • If an obstruction is encountered, suspend work and determine what it is. If it cannot be determined, contact client or project representative—location may have to be moved. • Wear proper PPE: safety glasses with side shields, hard hat, safety boots, leather gloves, high visibility traffic vest, chemical resistant over-gloves, if necessary. • Slowly hand clear and use a balanced stance with feet shoulder width apart to avoid back, neck, and wrist strain. • Take turns to avoid fatigue • Drink plenty of water (hot, warm, and cold weather).
C. Begin Drilling	Exposure to loud noise, flying debris, dust, chemical contamination, and entanglement with rotating equipment. Exposure to overhead suspended loads	• Do not allow the drill rig to be running when the driller is not present. • If an obstruction is encountered, suspend work and determine what it is. If it cannot be determined, contact client or project representative—location may have to be moved. • Stay away from moving rotating parts (i.e. augers, drill drive shaft) • Personnel shall not wear loose fitting clothing to avoid the potential for entanglement with rotating equipment. • Do not attempt to operate drill unless emergency shut-down is necessary. • Air monitoring will be performed in breathing zone in accordance with site HSP. Action levels will be followed in site HSP. • Wear proper PPE: safety glasses with side shields, hard hat, safety boots, high visibility safety vest, leather and/or chemical resistant gloves, hearing protection, if necessary, and coveralls or tyvek if there is potential for contacting potentially contaminated soil. • Personnel conducting oversight duties shall wear hearing protection if it is not possible to communicate

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		with another person standing next to you using your normal voice. Stay away from drilling operations while drilling in place (overhead hazards, line of fire) • If necessary to keep personal clothing clean, or if in areas with potential contamination, personnel shall wear Tyvek to minimize contact with contaminated dust/soil that may be generated during drilling activities. • Use good housekeeping practices, keeping the work area clear of trip hazards • Ensure water does not accumulate in the drilling area. Designate a specific area to place all soil cuttings, try to place the cuttings in a location that is outside of the general work flow • Do NOT stand beneath suspended loads.
Receiving sample containers (possibly preserved)	Glass containers/broken glass, cuts to hands Packaging material / acid leak	• Use caution when opening package and removing containers – Wear proper PPE including safety glasses with sideshields or goggles, Nitrile gloves, and splash protection as necessary (apron or tyvek).
Preparation of sample containers	Handling of chemicals/spilling of chemicals on skin, clothes or eyes.	• Never leave open chemicals unattended. • Know location of nearest eyewash station. • Wear proper PPE including safety glasses with sideshields or goggles, Nitrile gloves, and splash protection as necessary (apron or tyvek). • Keep prep and pack area well ventilated (open window) • Read MSDS for preservation material • Know location of MSDS, absorbent spill cloth, Hazmat spill kit • Do not hold sample containers on your lap when adding preservative • Make sure all caps are secure

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
Collect Surface and Subsurface Soil Samples	Exposure, Contact, Slips, Trips, Falls	• Wear proper PPE: safety glasses with side shields, hard hat, safety boots, chemical resistant gloves. • Stay alert while logging soil samples of all drilling activities. • Maintain clean work area, keep walkways clean and clear, tools picked up, and soil in drums. • Use dedicated pen for logging information into field book to prevent potential contact with contaminants. STAY ALERT. • Handle sample containers safely, if a container is broken make sure leather work gloves are used during clean up. • Place sample collection equipment near the top of the split spoon, sample barrel, or the hydropunch to minimize handling contaminated media. • Utilize appropriate nonreactive tools (plastic spoons, stainless steel trowels, etc.) to collect media from the collection equipment. • Air monitoring will be performed in breathing zone in accordance with site HSP. Action levels will be followed in site HSP. • Monitor discharge from soil gas sampling pump with PID.
D. Preparation to mob to next drilling location or leave site.	Contact, Caught, Exposure, Exertion Hazards	• Ensure an observer is watching the lowering of the drill rig mast so no lines or overhead obstacles are contacted. • Prior to lowering rig off of outriggers make sure all tools and personnel are clear of the drill rig. • Bend down at the knees and lift with your legs rather than bending and lifting with your back while loading tools. • Wear proper PPE (hard hat, safety glasses with side shield, hearing protection (while rig is operational) steel toe boots, leather work gloves. • Prior to driving to next location make sure auger racks are in.

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		• While rig is moving on site have spotters verify clearance so no overhead obstacles are contacted and no obstacles are hit while backing. • Properly remove PPE and wash hands and face, no smoking, drinking, eating in the work area.
Decontamination of drill rig, augers, bits, sampling equipment (as necessary, based on site contaminants)	High noise levels Injury from high water pressure Slip, trip, & fall Muscle strains – heavy lifting Ergonomic - awkward positions (bending down to pressure wash); fatigue Wet and/or cold stress	• Hearing protection required if noise levels may exceed 85 dBa • Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum. • Inspect pressure washer before use and confirm deadman switch fully operational • Operator will maintain a firm grip on the wand assembly when operating the unit. The trigger will not be tied down or blocked open and the operator will not leave the equipment unattended. • The operator will ensure that hands and other body parts are never placed in front of the wand while in operation and that the wand is never directed towards people or electrical components. Wand extension used to prevent awkward positions. • Be aware of potential slip and trip hazards such as wet surfaces and hoses. • Ergonomic concerns such as muscle fatigue and heat stress (from wearing rain gear) may exist. • Contain all decon water and dispose of properly • When deconning the rotary hammer drill for Gore Sorber work, disconnect the drill from the power source before beginning decontamination. Power sources must be in direct control of the person performing the decontamination (e.g., within arms' reach). • Properly dispose of decontamination water and PPE is designated areas. • Become familiarized with the detergent (i.e. Alconox) MSDS before beginning decontamination.
Load Truck	Back strain - Improper lifting technique	• Utilize proper lifting procedure when loading coolers

Activity Hazard Analysis

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
		and equipment back into truck. (to avoid lifting heavy/awkward coolers leave cooler on tailgate to load samples and ice into). • Bend down at the knees and lift with your legs rather than bending and lifting with your back.
Take down work area (cones, flags, barricades)	Traffic which includes being struck by pedestrian or other vehicles. Pedestrian traffic trying to cross work area-slips, trips, falls Damage to equipment. Injury to other personnel. Slips, trips, falls. Back strain - Improper lifting technique	• Wear highly visible clothing such as orange reflective traffic vests or clothing. • Stay alert to surroundings and traffic (if possible move truck over to work area to reduce take down time and loading, use flashing light and truck hazard lights for added safety). • Load all equipment into truck neatly. • Keep work area clear of caution tape and cords during removal of traffic control. • Utilize proper lifting procedure when loading traffic control equipment back into truck.
E. Depart From Site	Traffic, pedestrian, and obstacle hazards	• Ensure site is clean and nothing is left behind. • Drive defensively, wear your seatbelt, obey all traffic laws, and know the route to site prior to trip.

Activity Hazard Analysis

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)
• Hand and power tools • Drill rig, heavy equipment • Sampling equipment/containers • Well installation supplies • Fire extinguisher(s) • Fuel storage/equipment • Portable eye wash • First Aid/Bloodborne pathogen/CPR kit • Sunscreen • MSDS for any chemicals used onsite	• Inspect all vehicles, equipment, tools, and PPE prior to each use (remove from service any defective equipment) • Visual Inspections of work area daily • Use of applicable project self-assessment checklists • Ensure cell phone has coverage and have fully charged. • Determine daily rally point/evacuation route.	• OSHA 40-hour HAZWOPER initial training, current refresher, 3-day OJT, and medical clearance. • Hazard Communication training, as appropriate • Training on CH2M HILL HSP and third party and their subcontractors' HSP • Documented training on MSDSs for any chemicals used. • Qualified SC-HW

CH2MHILL

Activity Hazard Analysis

PRINT NAME		SIGNATURE	
Supervisor Name:	____________________	____________________	Date/Time:____________________
Safety Officer Name:	____________________	____________________	Date/Time:____________________
Employee Name(s):	____________________	____________________	Date/Time:____________________
	____________________	____________________	Date/Time:____________________
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CH2MHILL

ACTIVITY HAZARD ANALYSIS

Date: March 17, 2020	Task Risk Assessment Code (RAC): L
Project: Basewide PFAS Investigation at NAS Patuxent River, Webster Field Annex	L = Low
Site Supervisor: John Ledbetter/WDC	E = Extremely High Risk
Site Safety Liaison: Don Martinson/WDC	H = High Risk
HSM Review/Approval: Carl Woods, CSP	M = Moderate Risk
Job/Activity: General Site Work, Site Inspection Note: Review this AHA first, as this information might not be repeated on other AHAs	

Severity		Probability				
		Frequent	**Likely**	**Occasional**	**Seldom**	**Unlikely**
	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY:									
1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATURE

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
General preparation Review, inspect and locate safety equipment including fire extinguisher, first aid kit, PPE, etc.	Forgotten safety equipment, lack of emergency preparedness, untimely reporting of an injury or other incident	None	• Complete HSP, AHA review • Complete PTSP, daily safety meeting. • Review rally point and evacuation plan. • Check daily weather report and plan activities around severe weather. • Review, inspect and locate safety equipment including fire extinguisher, first aid kit, PPE as specified in HSP, water, etc. Check cell phone coverage. Ensure communication devices are functional. • Be sure to review the requirements for incident notification, reporting and investigation section of the HSP. Report all injuries, no matter how minor. If you are unsure whether an event should be reported, contact your RHSM. Be sure to report near misses.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
Hazards and controls applicable to all steps of field work.	Temperature Extremes (heat)	Temperature, radiation	• Acclimatize to work in hot weather by working in heat and taking more frequent breaks, systematically building up tolerance to heat • Conduct field activities in the early morning if possible during hot weather to avoid heat or inclement weather. • Having enough water onsite so that each worker can consume, at a minimum, one quart per hour per shift. • Frequent reminders and/or water breaks shall be taken so that each person can consume enough water. • Access to shade (i.e., blockage from direct sunlight) shall be provided at all times and shall be reasonably close to the work area. Keep in mind that a vehicle or other enclosed are with no air conditioning is NOT considered shade. Must be a well ventilated area or have air conditioning. • Workers suffering from heat illness-related symptoms OR if needed for preventative recovery shall be provided access to shade for at least 5 minutes, or longer, for recovery. (if heat related symptoms are occurring, contact the RHSM). • Training on risk factors, signs and symptoms of heat illness, importance of hydration and acclimatization, and importance of reporting symptoms and what to do in case of heat illness emergency, and contacting emergency medical services. • Read and follow heat stress precautions specified in the HSP/HSE Handbook, document on the heat stress physiological monitoring form if necessary. • Be conscious of your individual tolerance to work in hot weather and monitor yourself and co-workers for signs and symptoms of heat stress. • Take regular breaks in an air-conditioned truck or trailer during warm weather. Use a wide-brim hat or an umbrella or have a place where shade has been set up (tent or other temporary structure) when working under direct sun for extended periods. • Persons who experience signs of heat or cold stress should contact the SC, PM and RHSM. Call the occupational nurse first if symptoms are severe.
	Temperature Extremes (cold)	Temperature	• Read and follow cold stress precautions specified in the HSP. • Wear layers and ensure you're dressed adequately for site conditions. • Takes breaks in a warm location as necessary and stay hydrated with warm fluids (avoid caffeine). • Avoid direct contact with metal objects that have been exposed to the cold for long periods of time. Wear leather gloves when handling cold metal tools. • Monitor your co-workers for signs of cold stress. • Persons who experience signs of heat or cold stress should contact the SC, PM and RHSM. Call the occupational nurse first if symptoms are severe.
	Stinging Insects	Biological	• Keep exposed skin to a minimum. • Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. When working at a remote location, ensure that

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			first-aid kits contain over-the-counter allergy and itch medication (e.g., Benadryl, Claritin, etc) as well as other over-the-counter medications that may not be available to aid in symptom treatment. • If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in brushy areas. • Use insect repellent on clothing. Wear light-colored clothing and remove bright reflective safety-colored clothing if not working near a roadway as these may attract the wasps. • Wear fragrance-free or lightly-scented sunscreen, and body lotions. Bees are attracted to sweet scents. Avoid using floral scented soaps, shampoos, or conditioners. • If you encounter a wasp, back away slowly and calmly, do not run or swat at the insect. Wait for it to leave, or gently move or brush it off gently with a piece of paper or other light object. Do not use your hand. • If you are stung, contact the occupational nurse, no matter how minor it may seem. Call 911 if the reaction is severe. • Use wasp/bee spray if necessary in accordance with manufacturer's labeling and direction for use.
	Other Biological Hazards	Biological	<u>Spiders – Black Widow & Brown Recluse</u> -Spiders may be present in well boxes, on the underside of ledges, rocks, plants, and debris. -Cold weather may drive these spiders indoors. -Workers will wear gloves when working in areas where webs may be strung. -Tuck pants into socks. -Wear long sleeves. <u>Biting Insects –Fleas, & Mosquitoes</u> -Use insect repellent when threat is greatest. -Wear long sleeve shirts. -Complete tick checks after hiking through areas known for ticks (i.e. deer trails, deer bedding areas, trees, high brush). -Mosquitoes can carry the West Nile Virus. Monitor health after being bitten. -Fleas can carry Bubonic Plague. Monitor health after being bitten. <u>Poisonous Reptiles – Rattlesnakes</u> -Avoid tall vegetation -Snake gaiters are to worn when working in areas of tall vegetation -Always give snakes the right-of-way. -If a snake is encountered contact WNY Emergency Services to handle the removal/relocation of the reptile. <u>Poisonous Plants – Poison Ivy, Oak, or Sumac</u> -If entering area infested with poisonous vegetation don a full body Tyvek.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			-Immediately wash any areas that come into contact with poisonous plants with special oil eliminating products. -Wear protective clothing (long sleeves, pants) if necessary to enter area. -Put affected clothing into plastic garbage bags, segregating them from contaminating other contact surfaces and materials. -Do not attempt to clear area with fire or pollen/dust producing operations such as weed whacking. <u>Mammals – Deer, Mountain Lions, Coyotes, Bobcats Raccoons, & Mice and Bird Droppings</u> -Stay calm and hold your ground. -Make noise. -Slowly back away while facing the animal. -Respect the wildlife, it is their home, not yours! -Mice and bird droppings can carry the Hantavirus. Monitor health after being exposed.
	Inclement Weather	Electrical, Motion	• Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Carry clothing appropriate for inclement weather. • Take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed. • Work will halt during thunderstorms. • Heavy rain, snow, and extreme cold can make heavy machinery especially dangerous. Therefore extra caution must be taken around heavy machinery during these conditions. • If caught in a thunder storm, seek shelter. The nearest shelter will likely be the field vehicles. • Avoid lone trees as shelter and open, bare areas. • If caught in open area, place feet close together and crouch down as small as possible, without lying on the ground. • Avoid low lying areas such as washes after rain as they can flood. • Take time to review where the closest structure that can be used when severe weather occurs and what route will be used to get there. Listen to weather reports and plan for severe weather. Designate an emergency evacuation assembly area and evacuation routes for non-weather related emergencies (fire, etc.).
	Personal Security, Violence	Motion	• Trust your intuition; if a situation appears strange or wrong, it probably is. • Be confident in your walk or stride; do not give the appearance you are new in town. • Avoid carrying and displaying large sums of cash.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			• If you sense or see dangerous situations along your route, change your route and depart the area quickly. If you feel that you are being followed, go to the nearest police station or safe location and file a complaint with the police. Provide a description of the person, their vehicle, license plate number and any other useful information. • If you feel your life is in danger, call 911. Be sure to speak clearly, concisely and give the dispatcher a good description of where you are physically located. • Quickly check your car before entering it to determine damage or presence of an intruder. • Vulnerable times can be stopping to find your keys to enter your vehicle or stepping out of your vehicle in an isolated area. Be aware of your surroundings before you perform these activities. • Always keep your doors locked during transit and when the vehicle is parked. • Carry mobile communication devices (e.g., cell phone or walkie talkie); • Wear iridescent orange vests and construction apparel (i.e., appear as a construction worker and avoid misidentification to the extent possible); • Have an awareness of your surroundings; • Avoid passing through problem areas or streets if possible; • Do not leave valuables in field vehicle. Be sure to only bring what's needed for oversight of construction activities (i.e., leave laptop in office or at home); • Do not perform any night work inspections.
Operating Work Vehicle	Traffic accidents	Motion, Mechanical, Pressure,	• Inspect the vehicle prior to departure. • If driving a rental car, become familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles. • Drivers shall not use cellular phones, including hands-free devices, or other two-way communication devices while driving (including hands-free devices). Pull over and park the car to make or take phone calls, text, or e-mail. • Be sure to take adequate rest breaks when driving, especially on long distance trips. Do not drive fatigued. • Obey speed limits; follow the rules of the road. • Be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you. • If vehicle is malfunctioning, don't pull over off the road suddenly. Give the traffic behind you notice that you are pulling off. • Always wear seatbelt in vehicle, regardless of length of drive. • Apply Get Out and Look (GOAL) when returning to the vehicle to prevent property damage and injury by looking for obstructions, personnel or other items. Back slowly and use a spotter when view is obstructed.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			• All traffic signs, temporary signs, and site-specific warnings including barricades, lights, and sirens will be obeyed.
Vehicle Parking	Pedestrian accidents and vehicle fires	Motion, Fires	• Vehicles should be parked off road in areas where access to from vehicles is safe and avoids active roadways. • Park on gravel or paved areas whenever possible. Avoid parking in newly compacted backfill or newly excavated dirt whenever possible. • Do not block any property access roads, driveways, or gates. • Set parking brake when parking. • Wear reflective orange vests when near traffic. Delineate the work zone with orange cones if the work zone will impact roadways. • Construction vehicles have the right-of-way. • Utilize 3 points of contact when getting on/off vehicle (e.g. truck beds). Do not jump.
Site walk, inspection of area	Slips, trips, and falls	Mechanical, Pressure, Motion, Gravity	• Inspect area for slip, trip, and fall hazards. Remove hazard, if possible, or mark it. Designate foot traffic around trip hazards. • Wear steel toed work boots, with good tread. Wear gloves when walking on-site to protect hands in the event of a fall. • Pay attention and constantly observe the work area for hazards, changing weather conditions, biological hazards. • Step slowly and tentatively in tall grass where the ground can't be seen to avoid depressions or other obstacles that could cause ankle/knees sprains. • Survey work area and travel paths for slip/trip hazards that can be removed or marked. Avoid "distracted walking" (e.g., looking at mobile device while walking). • Utilize good housekeeping. Store tools and equipment properly. • Never approach another vehicle, truck or heavy equipment unless you have made contact with the operator and the equipment is appropriately deenergized.
Setting up work site	Unauthorized access by untrained personnel or visitors Traffic – Site and Public Health hazards Fire	Motion, Chemical, Fire	• Use cones or barricades and signage as necessary to identify and control site boundaries and access. • Work within a work zone. Use barricade tape to keep public or other site workers out. • Identify traffic flow patterns and traffic control requirements for the site. • Utilize appropriate signage and traffic control devices (e.g. delineators). Never work in the roadway without traffic control set-up. • When necessary, the field team will consist of 2 members. The member that is not physically working on the sampling task at hand will double as a 'look-out', to maintain site safety and security. • Identify site contaminants of concerns and action levels. Conduct air monitoring as described in HSP. • Smoking not permitted except in designated area.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			• Ensure fire extinguisher is near-by and accessible.
Handling/Loading Materials Loading Vehicle	Lifting hazards, back injury or strain. Tape gun – sharp edge.	Mechanical, Pressure, Motion	• Use partner to assist in lift of heavy equipment, be aware of pinch points when using truck lift gates, lift with legs not your back. • Tie down all loads securely (rope, ratchet straps, load bars) • Wear leather gloves, as necessary, when loading equipment • Utilize proper lifting procedure when loading equipment back into truck. • Use mechanical means or a buddy when available or necessary. Do not lift more than 40 lbs alone. • Bend down at the knees and lift with your legs rather than bending and lifting with your back. Do not lift and twist. • If a knife is needed to cut packaging tape, review, understand, and sign the AHA for knife use (provided separately).
Working Alone	No assistance immediately available in case of injury. Difficult to hear ringing cell-phone Miscommunication	All	• During field work, a copy of "The Lone Worker Call-In Contact Form" should be maintained by both the office-worker and the field-worker. • "Lone Worker" and "Office Contact" must both have cell phones and each others' phone number. • Field-worker should call the office worker when he has arrived on-site, before exiting his vehicle. On this phone call a time should be arranged for a "check-in" call to be made by the field worker (2 hours maximum, or more frequent if task or conditions are more hazardous). On each "check-in" call a time should be arranged for the next "check-in" call. Document this time on the form. • Worker should carry cell phone throughout the field event and put the ringer on its loudest setting as wind is strong and can muffle the sound. If, for any reason the phone becomes inoperable, the field-worker should immediately stop work, leave the site, and use the nearest phone to contact the office-worker to verify their safety and to inform them of the issue. • Work should not proceed in the field until the field-worker has a working device that provides communication with the office-worker. o *If office worker does not receive "check-in" call at scheduled time he should attempt to contact field-worker. If no contact is made then office worker should phone for emergency services inform them that there is a possible emergency and instruct them to go to the field location and assist worker. Provide the lone worker's name, their last known location, vehicle description and your contact information.* o *After Emergency Services have been contacted, immediately call the other emergency contacts, including Project Manager, and Health and Safety Manager.* o Upon completion of work activities, field-worker should pack up all materials and prepare to leave site. Then, before starting the engine of the vehicle to leave site, the field-worker should contact the office-worker and inform him or her that work

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			is complete and that he or she is leaving the site. Make contact again when field worker arrives at his/her final destination.

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)
• PPE	• Daily inspections of PPE by user. Replaced as necessary.	• State issued driver's license. • FA/CPR, fire extinguisher, eye wash • OSHA 40-hour HAZWOPER initial training, current refresher, 3-day OJT, and medical clearance. • VO training modules as indicated • Hazard Communication training • Training on CH2M HILL HSP and Subcontractor's HSP (and applicable AHAs) • Documented training on MSDSs for any chemicals used. • Qualified SHSO (with SC-HW training)
• Field Vehicle	• General inspection of vehicle by CH2M HILL personnel. Maintained regularly.	
• Hand and power tools	• Daily inspections by user. Replaced as necessary. • Check to ensure good working order and fully charged, calibrate each morning	
• Fire extinguisher(s)	• Monthly inspections by user. Replaced as necessary.	
• Portable eye wash • First Aid/Bloodborne pathogen/CPR kit	• Daily inspections by user. Replaced as necessary.	

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ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________________	Date/Time:___________________________________
Safety Coordinator Name:	______________________	______________________________	Date/Time:___________________________________
Employee Name(s):	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
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	______________________	______________________________	Date/Time:___________________________________

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ACTIVITY HAZARD ANALYSIS

Date: March 17, 2020	Task Risk Assessment Code (RAC):	L
Project: Basewide PFAS Investigation at NAS Patuxent River, Webster Field Annex	L = Low	
Site Supervisor: John Ledbetter/WDC	E = Extremely High Risk	
Site Safety Liaison: Don Martinson/WDC	H = High Risk	
HSM Review/Approval: Carl Woods, CSP	M = Moderate Risk	
Job/Activity: Utility Assessment and Utility Locate Oversight **Note:** Review General Site Work AHA first, as it contains general site hazard/control info (e.g. driving, biological, weather, lifting hazards)		

Probability

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY:

1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATURE

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
General Site Work	See General Site Work AHA For General Site Hazards/Controls (e.g. driving, biological, weather, lifting hazards)		
Background and Records Assessment	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure	• Conduct a background and records assessment of known utilities or other subsurface obstructions. • Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities • Obtain available utility diagrams and/or as-built drawings for the facility.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			• Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate. • Request that a facility contact (e.g. site owner, site manager) with knowledge of utility locations review and approve proposed locations of intrusive work. Meet contact on-site when feasible. • White line the proposed intrusive locations (drilling locations, trench or excavation) with white paint or similar methods. Never use red, orange or yellow paint for proposed locations.
Contact the Designated Utility Locate Service	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure	• Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call, 811) to identify and mark the location of utilities. Typically, this is at least 2 days before intrusive work. • Some states require that the entity performing the intrusive work be the responsible for contacting the local service. Where subcontractors are responsible for the intrusive work, CH2M personnel shall verify the subcontractor has contacted the designated local utility locating service • When on-site verify each public utility operator has responded by marking out utilities or via email/phone. Note all responses on utility notification form or project field book. • If a public utility operator has not responded to the utility locate submittal, s do not break ground. Contact the utility operator and/or 811. • For high risk utilities, request to meet the public utility operator at the site. Note some states require this meeting for work within 10' of "high priority" utilities, including pressure natural gas (>60 psi); petroleum pipelines; pressurized sewage lines; high voltage electrical (>60kV); and hazardous material pipelines. • Note that not all utility operators participate in 811 (e.g. some state DOTs, railways, pipelines). Notify these operators in writing/email.
Set Up Work Zone (Roadway or Shoulder Work)	Traffic	Motion	• Wear high visibility traffic vests near heavy equipment or traffic. • Contractor to utilize traffic control equipment (cones, delineators, etc.) to route traffic around work area, as needed. • Always remain aware of an escape route (e.g., behind an established barrier, parked vehicle, guardrail, etc). • Always pay attention to moving traffic – never assume drivers are looking out for you. • Work as far from traveled way as possible to avoid creating confusion for drivers. • When workers must face away from traffic or look down at equipment, a "buddy system" should be used, where one worker is looking towards traffic.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			• Understand TC subcontractor traffic plan if utilized. Note shoulder/sidewalk work may require TC. • <u>Never work in roadways without appropriate MUTCD compliant traffic control plan, signage and devices, even for short duration tasks.</u>
Independent Field Survey (Utility Locate)	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure	• Verify utility locator is qualified, trained and experienced. • Determine the most appropriate instrumentation/technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions. • In general, GPR, RF and Electromagnetic Detectors should be used. If one device is not used, discuss this with the PM. Contact the RSHM for guidance if necessary. • Ensure CH2M representative is present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. • Physically walk the area to verify the work location and identify, locate, and mark underground utility location. • Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.
Utility Visual Assessment	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure	• Perform a “360 degree” assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the proposed intrusive work area. • The visual survey shall include all surface landmarks, including manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants. • If a building is near-by, ensure typical building utilities are positively identified (e.g. electrical, gas, water, sewer, communication). • If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.
Use of GPR, RF, EM and other Locate Tools	Confined Space Hazards Lifting Electrical Wiring Slip, Trip, Fall	Chemical (asphyxiant, H2S), Gravity Biological	• Never enter (break plane) of a manhole or vault that is may be a confined space without appropriate confined space training, permit, air monitoring and control measures. • Use PVC extension rod for telephone and electric manholes if necessary. • Use manhole assist as feasible. Use proper lifting techniques. Do not lift more than 40 lbs alone. • Look for biological hazards in utility vaults, risers, well boxes, etc. Use insect repellant if necessary.

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
	Utility Strike by Project Team Biological Hazards in Utility Access Points	Fire, Electrical, Pressure Motion	• Never touch exposed electrical wires. Have qualified personnel test with voltmeter. • Ensure openings are closed before leaving hole unattended. Put up proper barricades when near roadways or sidewalks. • Before using GPR, EM or RF equipment, look at work area and identify, mark and/or correct potential trip hazards (e.g. holes, mounds, debris). • Use proper locating techniques. Be familiar with state utility notification/locate regulations and CGA Best Practices document. • Inspect locating equipment. Follow and be familiar with utility locating equipment manual. • Ensure locating equipment is calibrated. Records should be available on-site. • Ensure proper grounding of equipment. Use appropriate tool for placing stakes. Scan ground location with locating equipment prior placing grounding rod. Check connection points with a volt meter prior to connecting. Use properly insulated equipment leads. • Be cognizant of area for bleedoff and to minimize chance of ground rod striking nearby utilities. • Be aware of where cables are place to reduce trip hazards. Do not touch electrode stake while data collection is under way. • Ensure utility locator is aware of limitations of locating equipment and explains these to project team members (e.g. rebar in concrete, locating in clay). • Use direct connection and active/conductive techniques or similar methods to positively identify and mark utilities. • Snake/ferret storm drains, PVC or clay lines when necessary. Do not snake/ferret industrial waste lines or if lines are unknown.
Placing Utility Marks, Updating Records	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure Paint Exposure	• Ensure locator always follows the APWA color code marking requirements: • Use pink for temporary or unknown lines, never red, orange or yellow. • The markings from utility surveys must be protected and preserved until the markings are no longer required. Use whiskers or similar means if necessary. • If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or 

Work Task Sequence (List steps you need to take to complete the activity.)	**Potential Health and Safety Hazards** (How can you be harmed? Cut, struck, exposed…)	**Potential Energy(ies) Associated with Task**	**Hazard Controls** (List the **specific controls** for each potential hazard. Refer to the HSE Handbook for required controls)
			designee must notify the independent utility locate service and/or the designated local utility locating service to resurvey and remark the area. • Use only paint only in well ventilated areas. Minimize skin contact, wear gloves where necessary, do not inhale vapors. Paint may be combustible. Reference can label and MSDS sheet. • Update site map with all utilities found on-site. Take pictures of locations and near-by utility marks. Ensure site map is available and reviewed with excavator/driller prior to intrusive work.
Preparing For Intrusive Activities	Utility Strike by Project Team	Fire, Electrical, Chemical, Pressure	• Note marked utility tolerance zones (e.g. typically 18”-24”). Utilities may not be directly under utility marks. • When aggressive intrusive activities will be conducted within 5 feet (1.5 meters), either laterally or vertically, of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing, hand digging, or manual posthole digging. • Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Additionally, check to see if the utility can be isolated (locked out/tagged out and either de-energized [and purged as necessary] or blocked) during the subsurface activity • Use non-aggressive methods (hand digging, air-knifing, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible. • Consider moving proposed intrusive locations if utility conflicts exist. Discuss conflicts with the PM and site personnel. Contact the RSHM for guidance if necessary.

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)
• PPE	• Daily inspections of PPE by user. Replaced as necessary.	• State issued driver's license. • FA/CPR, fire extinguisher, eye wash • OSHA 40-hour HAZWOPER initial training, current refresher, 3-day OJT, and medical clearance. • VO training modules as indicated • Hazard Communication training • Training on CH2M HILL HSP and Subcontractor's HSP (and applicable AHAs) • Documented training on MSDSs for any chemicals used. • Qualified SHSO (with SC-HW training) • Qualified Traffic Control Personnel (if needed)
• Field Vehicle	• General inspection of vehicle by CH2M HILL personnel. Maintained regularly.	
• Misc. equipment such as air monitoring equipment	• Daily inspections by user. Replaced as necessary. • Check to ensure good working order and fully charged, calibrate each morning	
• Hand and power tools	• Daily inspections by user. Replaced as necessary. • Check to ensure good working order and fully charged, calibrate each morning	
• Fire extinguisher(s)	• Monthly inspections by user. Replaced as necessary.	
• Portable eye wash • First Aid/Bloodborne pathogen/CPR kit	• Daily inspections by user. Replaced as necessary.	
• Decon supplies	• Daily inspections by user. Replaced as necessary.	
• Traffic Control Equipment • Delineators, caution tape, signage	• Daily inspections.	
• Utility Locate Equipment • RF, GPR, Ferromagnetic Detectors • GPS • Paint, Whiskers	• Daily inspections.	

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ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________________	Date/Time:___________________________________
Safety Coordinator Name:	______________________	______________________________	Date/Time:___________________________________
Employee Name(s):	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
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	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________
	______________________	______________________________	Date/Time:___________________________________

Attachment 9
Safety Data Sheets
(to be added as items are obtained)

Appendix C
Field Standard Operating Procedures

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books (hard copy and electronic) during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities. Field notes may be recorded in field log books or electronically on computer tablets.

III. Equipment and Materials

- Log book
- Indelible pen
- Jacobs supplied electronic tablet or laptop with notebook software

IV. Procedures and Guidelines

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

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Rite in the Rain® or Sanford Sharpie® permanent markers. **Note:** for sites where PFC is being analyzed for, Rite-in-the-Rain®, Sanford Sharpie®, or anything water-resistant or with Teflon® cannot be used in the field. All field book materials must be “fluorine free”. Acceptable substitutes would be a sewn notebook

without a plastic cover, or loose-leaf notebook paper.

2. Alternatively, field notes may be recorded electronically in Jacobs provided field tablets or laptop computers. Notes are recorded in appropriate note collection software; e.g., Microsoft One Note. At the end of each day, the electronic notes must be digitally signed by the author and downloaded for electronic file storage. The notes may be converted to an Adobe pdf file prior to storage. It is important that the field notes be downloaded daily to ensure the electronic time stamp of the notes is the same as the day the notes were recorded.

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

   - Company name and address
   - Log-holders name if log book was assigned specifically to that person
   - Activity or location
   - Project name
   - Project manager's name
   - Phone numbers of the company, supervisors, emergency response, etc.

4. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

5. If field notes are recorded electronically, the author will not have any spaces between entries.

6. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

7. Daily entries will be made chronologically.

8. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

9. Each page of the log book will have the date of the work and the note takers initials.

10. The final page of each day's notes will include the note-takers

signature as well as the date.

11. Only information relevant to the subject project will be added to the log book.

12. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

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

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

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

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

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

11. Deviations from the Work Plan: Record any deviations from the work

plan and document why these were required and any communications authorizing these deviations.

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

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

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

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

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

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

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Draw a box around the sample ID so that it stands out in the field notes
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)

- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

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

V. Attachments

Example field notes.

(47) MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M HILL STAFF:
John Smith: FIELD TEAM LEADER
Bob Builder: SITE SAFETY COORD.
WEATHER: OVERCAST + Cool, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • Collect GROUNDWATER
SAMPLES for LTM work at SITE 14
• SUPERVISE SURVEY CREW
AT SITE 17

0725 BB ~~Cal~~ (JS) Calibrates
PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #

0730 BB Calibrates HORIBA METER
MODEL #, SERIAL #
→ List calibration Results

0738 Survey crew ARRIVES on Site
→ List NAMES

0745 BB Holds H+S TAlk on Slips, Trips, FAlls, Ticks + AIR Monitoring
JS + Survey Crew ATTEND
No H+S ISSUES IDENTIFIED as concerns. All work is in "Level D."

0755 JS Conducts site-wide Air Monitoring
All readings = 0.0 ppm in

JS 5-12-03

MAY 12, 2003 EXAMPLE (48)

SITE 14 LTM
BREATHING ZONE (BZ)

0805 Mobilize to well MW-22 to SAMPLE, surveyors setting up AT SITE 17

0815 PM (PAUL PAPER PUSHER) Calls AND INFORMS JS to collect GW SAMPLE AT well MW-44 today for 24 hour TAT ANALYSIS OF VOC'S

0820 Purging MW-22
→ RECORD WATER QUALITY DATA

JS 5-12-03

0843 Collect SAMPLE AT MW-22 for total TAL Metals AND VOC'S. No Dissolved Metals Needed per PM

0905 JS + BB Mobilize to Site 17 to show surveyors wells to Survey.

0942 Mobilize to well MW-22 to collect SAMPLE

0950 CAN not ACCESS well MW-22 due to BASE OPERATIONS; CONTACT PAUL PAPER PUSHER AND he STATED he will check on GAINING ACCESS with BASE contact.

0955 Mobilize to well MW-19

JS 5-12-03

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

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

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

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

II. Scope

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

Scenario 1

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

Scenario 2

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

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

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

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

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

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

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

III. Services and Equipment

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

Services

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

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

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

Equipment

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

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

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

IV. Procedures and Guidelines

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

Activity Notification and Dig Permit Procedures

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

Activity Specific: To be provided by Activity or Project Manager

CH2M Utility Clearance Procedures

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

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

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

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

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

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

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

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

IV. Attachments

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

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

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

Proposed Scope of Work

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

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

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

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

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

Field Marking and Documentation

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

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

Bid Sheet/Payment Units

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

Health and Safety Requirements

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

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

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

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

Security

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

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

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

Quality Assurance

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

Subcontractor Standby Time

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

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

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

Down Time

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

Schedule

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

Attachment B - Services Available for Identifying and Marking Underground Utilities

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

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

Each are discussed below.

Navy Public Works Department

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

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

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

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

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

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

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

Private Subcontractors

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

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

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

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

Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	▯	▯	▯	▯	▯	▯	▯	▯

Notes:

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

[1]Equipment types are:

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

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

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

Jacobs In-house Utility Location Experts

Steve Saville/KNV

Home Office Phone – 720-261-5367

Electromagnetic Induction (EMI) Methods

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

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

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

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

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

Ground Penetrating Radar (GPR)

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

Magnetic Field Methods

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

Optical Methods

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

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

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

White – Proposed excavations and borings

Pink – Temporary survey markings

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

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

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

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

PMS 219

PMS 1795*

PMS 108

PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

PMS 3415

APWA UNIFORM COLOR CODE

WHITE - Proposed Excavation

PINK - Temporary Survey Markings

RED - Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials

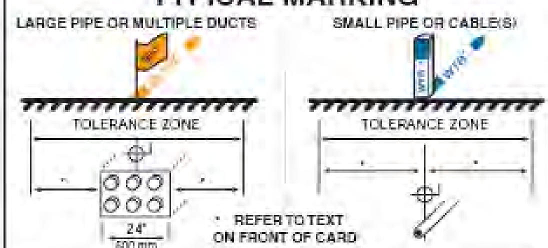
ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

BLUE - Potable Water

PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING



Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS
The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION
Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING
Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE
Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE
The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

STANDARD OPERATING PROCEDURE

Multi RAE Photoionization Detector (PID)

I. Purpose

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

II. Scope

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

III. Definitions

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

Volatile Organic Compound (VOC) – VOC concentration in ppm

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

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

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

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

IV. Procedures

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

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

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

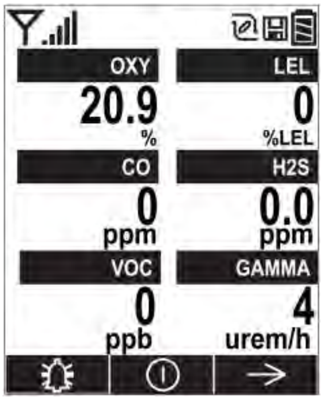
The following subsections will discuss Mini RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

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

Start up Instrument

- Press **Mode** button
- A RAE Systems logo (or a company name) should appear first. This is followed by a progression of screens that tell you the MultiRAE's current settings:
    - Product name and model number, air flow type, and serial number
    - Application firmware version, build date, and build time
    - Sensor firmware, build date, build time
    - Installed sensors (including serial number/production/expiration/calibration date and alarm limit settings)
    - Current date, time, temperature, and relative humidity
    - User mode and operation mode
    - Battery type, voltage, shutoff voltage
    - Alarm mode and alarm settings
    - Datalog period (if it is activated) and interval
    - Policy Enforcement settings (whether calibration and/or bump testing are enforced)
- Then the MultiRAE's main reading screen appears. It may take a few minutes for sensors to show a reading, so if any have not warmed up by the time the main screen is shown, you will see "- - -" instead of a numerical value until the sensor provides data (typically less than 2 minutes). Then it displays instantaneous readings similar to the following screen (depending on the sensors installed) and is ready for use.

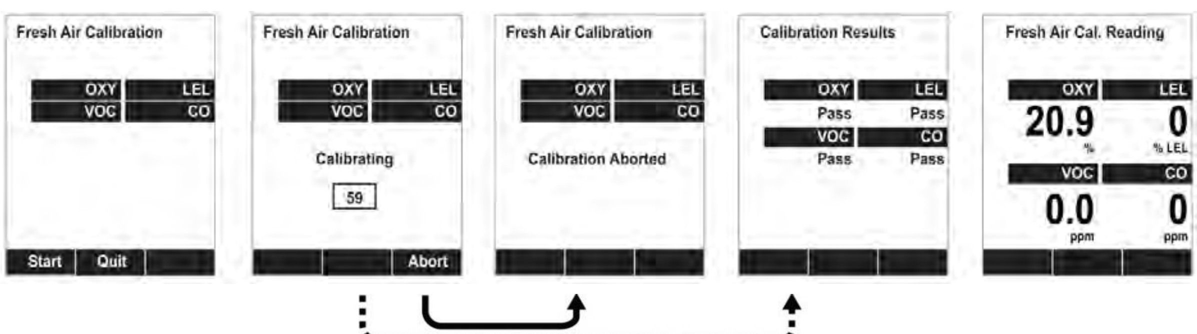


Calibration Check and Adjustment

Zero Calibration

- At the Calibration Menu, select “Fresh Air.” Press [Y/+] once to enter the fresh air calibration sub-menu.

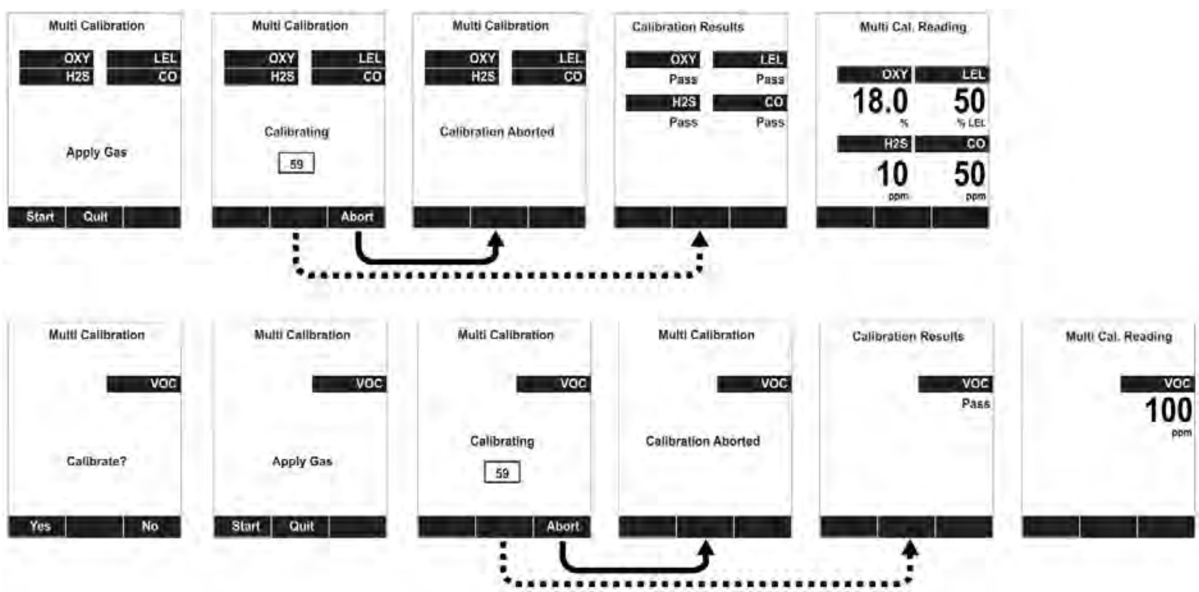
- Press **[Y/+]** to start fresh air calibration
- A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].



- Note: Dotted line indicates automatic progression
- If the calibration is not aborted, the display shows the sensor names and tells you whether the fresh air calibration passed or failed, followed by the sensors’ fresh air readings

Multi Sensor Span Calibration

- Depending on the configuration of your MultiRAE and span gas you have, you can perform a span calibration simultaneously on multiple sensors. You can define which sensors are calibrated together using the Multi Cal Select menu described in section 8.3.2.9.
- In case all sensors in the instrument cannot be calibrated with the same gas, the MultiRAE will intelligently split the span calibration process into several steps and will provide menu prompts accordingly.
- At the Calibration Menu, select “Multi Sensor Span.”
- Install the calibration adapter and connect it to a source of calibration gas.
- Start the flow of calibration gas.
- Press **[Y/+]** to start calibrating or wait for calibration to start automatically.
- A countdown screen is shown. You can abort the calibration at any time during the countdown by pressing **[N/-]**.



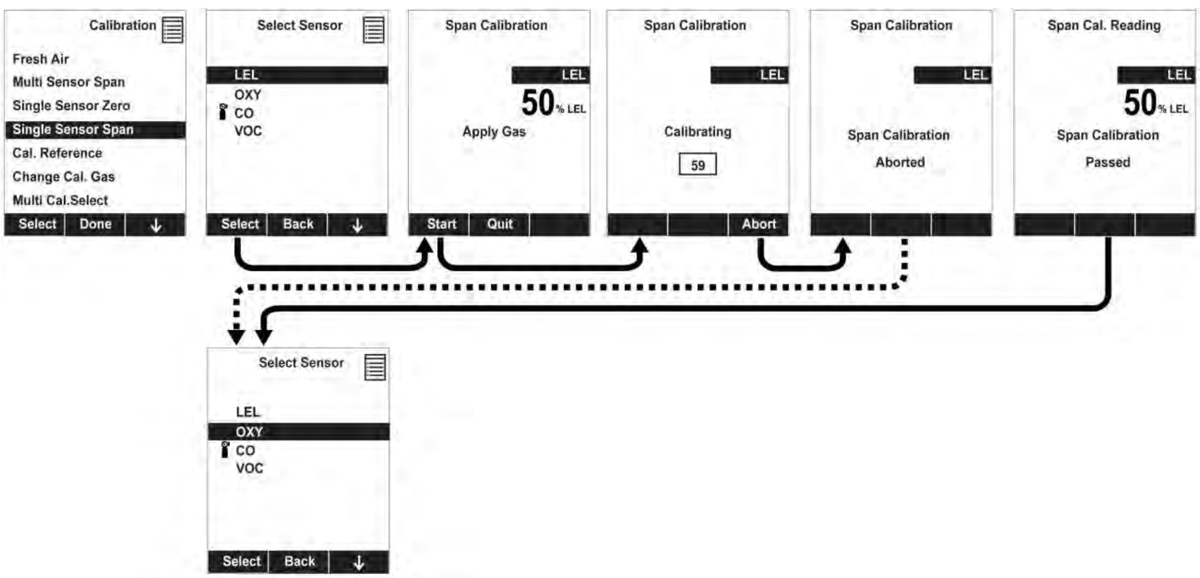
- Note: Dotted line indicates automatic progression
- If the calibration is not aborted, the display shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.

Single Sensor Span Calibration

- Instead of performing a span calibration on multiple sensors simultaneously, you can select a single sensor and perform a span calibration.
- To perform span calibration of an individual sensor, follow these steps:
- At the Calibration Menu, select “Single Sensor Span.”
- Select a sensor to calibrate from the list.
- Install the calibration adapter and connect it to a source of calibration gas.
- Verify that the displayed calibration value meets the concentration specified on the gas cylinder.

- Start the flow of calibration gas.

- Press [Y/+] to start calibrating or wait for calibration to start automatically.
- A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].



- Note: Dotted line indicates automatic progression
- Select the done button when calibration is complete.
- **CALIBRATION IS COMPLETE!**

B. Operation

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

C. Site Maintenance

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

D. Scheduled Maintenance

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

V. Quality Assurance Records

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

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

VI. References

Multi RAE User's Guide, RAE Systems, Revision C, May 2013.

STANDARD OPERATING PROCEDURE

Global Positioning System

I. Purpose

The procedure describes the calibration, operation, and functions associated with a Trimble® GeoExplorer® 6000 series. The GeoExplorer 6000 series includes the GeoXH™ and GeoXT™ handhelds. These handhelds combine a Trimble GNSS receiver with a field computer powered by Microsoft Windows Mobile version 6.5 operating system. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

II. Scope

This procedure provides information regarding the field operation and general maintenance of a Trimble® GeoExplorer® 6000 series. The information contained herein presents the operation procedures for this equipment. Review of the equipment's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the equipment.

III. Definitions

GPS: Global Positioning System - A system of satellites developed and operated by the US DOD. Continuous 3D coordinate information is broadcast free of charge on a worldwide basis enabling precise positional location. The GeoExplorer 6000 series handheld includes an integrated GNSS receiver that enables the collection of GPS and GLONASS data for incorporating into a GIS or for managing assets.

GPS (Global Positioning System) and GLONASS (GLObal NAvigation Satellite System) are Global Navigation Satellite Systems (GNSS). Each system consists of a constellation of satellites that orbit the earth. GNSS provides worldwide, all-weather, 24-hour time and position information.

IV. Procedures and Guidelines

The procedure for calibration, operation, and maintenance of the GPS unit is outlined below. Daily calibration and battery recharging is typical operating procedure; frequencies other than daily shall be noted in the logbook and reason for increased frequency recorded. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

The procedures described below include additional features pre-programmed into the GPS datalogger to aid the data collection process.

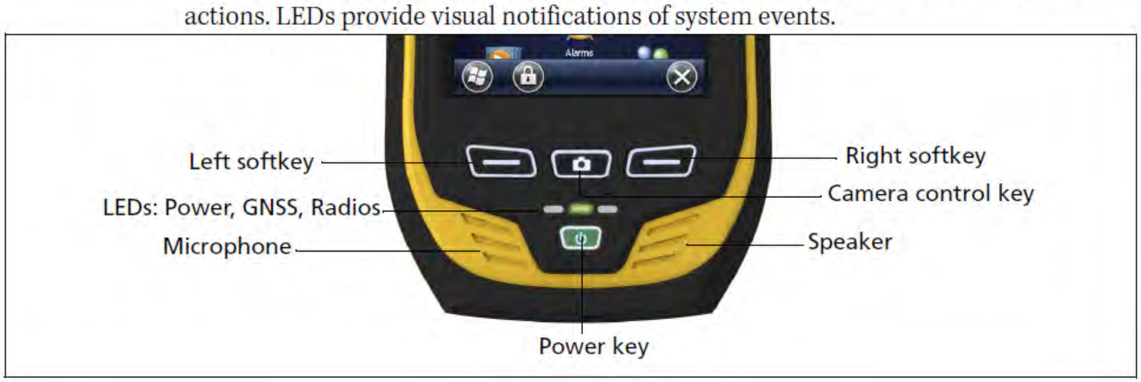
A. GeoExplorer 6000 Unit

Parts of the GeoExplorer 6000 series handheld

The following diagrams show the main parts of the handheld.

Keypad buttons

The GeoExplorer 6000 series handheld has a keypad for fast, easy access to common actions. LEDs provide visual notifications of system events.

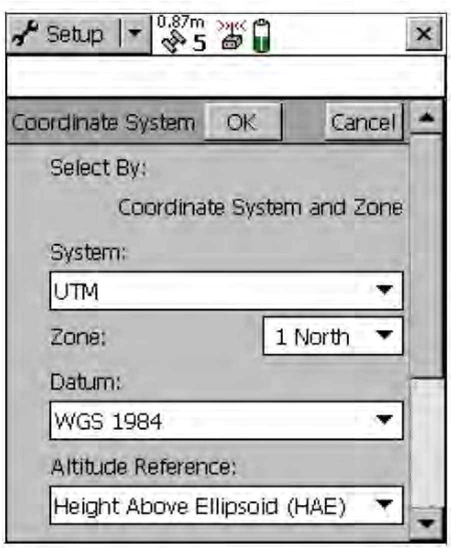


B. Operations for surveying coordinates of a location

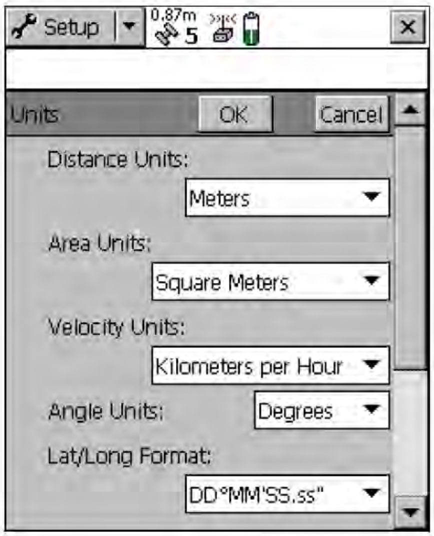
The TerraSync software consists of five sections as described below:

Use this section …	to …
Map	view features, background files, and the GPS trail graphically
Data	work with data files: • create a new data file or open an existing data file • log base station data to file or broadcast real-time corrections • collect new features or maintain existing features • move, copy, delete, or rename data and background files
Navigation	navigate to features using the *Direction Dial* and *Close-up* screens, or the graphical lightbar
Status	view information about: • the satellites the TerraSync software is tracking, their relative positions in the sky, and your current position • the predicted satellite constellation and position quality over the next 12 hours • communication ports that the TerraSync software is using • your GPS receiver and real-time correction source • the current UTC time • the TerraSync software version and trademark information
Setup	configure the TerraSync software

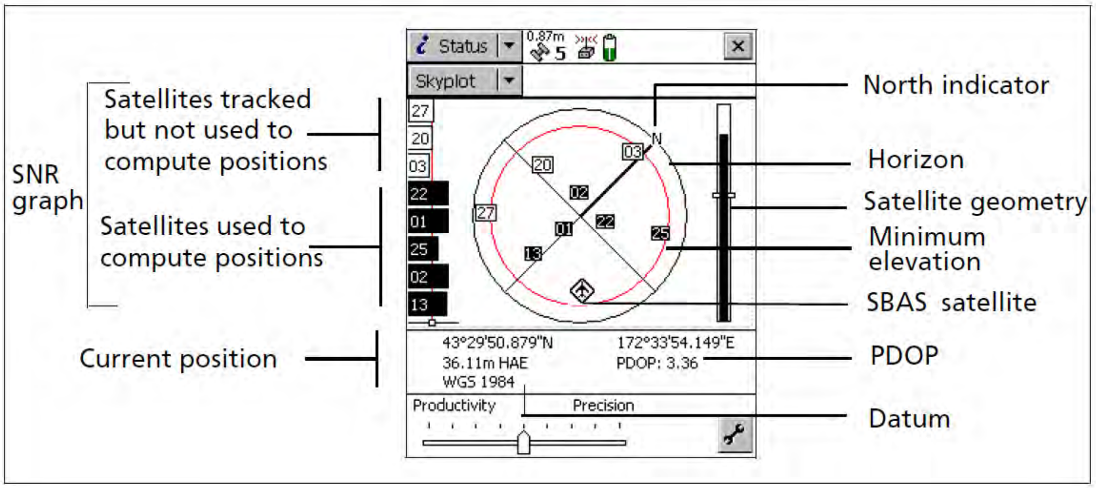
1. Configure coordinate settings: To open the **Coordinate System** form, tap Coordinate System in the Setup screen. Use this form to specify the coordinate system you want the TerraSync software to display foreground and background files.



2. Configure unit settings: To open Units form, tap **Units** in the Setup screen. Use this form to specify the units used for measurements and display.



3. Starting the TerraSync Software:
   - When you are outside and ready to begin, switch on your data collector and start the TerraSync software. The GPS receiver should activate automatically.
   - On the Microsoft Windows® or Windows Mobile® taskbar, tap the windows icon and the select Programs/TerraSync. While the software is loading, a Trimble identification screen appears.
4. Getting a clear view of the sky. Move to a location where the receiver has a clear view of the sky. Signals can be received from any direction. Satellite signals can be blocked by people, buildings, heavy tree cover, large vehicles, or powerful transmitters. GPS signals can go through leaves, plastic, and glass, but they will weaken the signal.
5. Checking the GPS status. When you start the TerraSync software, it automatically connects to the GPS receiver and begins to track visible satellites to calculate its current position. Use the satellite icon on the status bar to check whether the receiver is computing GPS positions.
6. To view the GPS status: The Skyplot screen appears when you first run the TerraSync software. If this screen is not visible, tap the Section button, select Status, tap the Subsection list button and then select Skyplot.

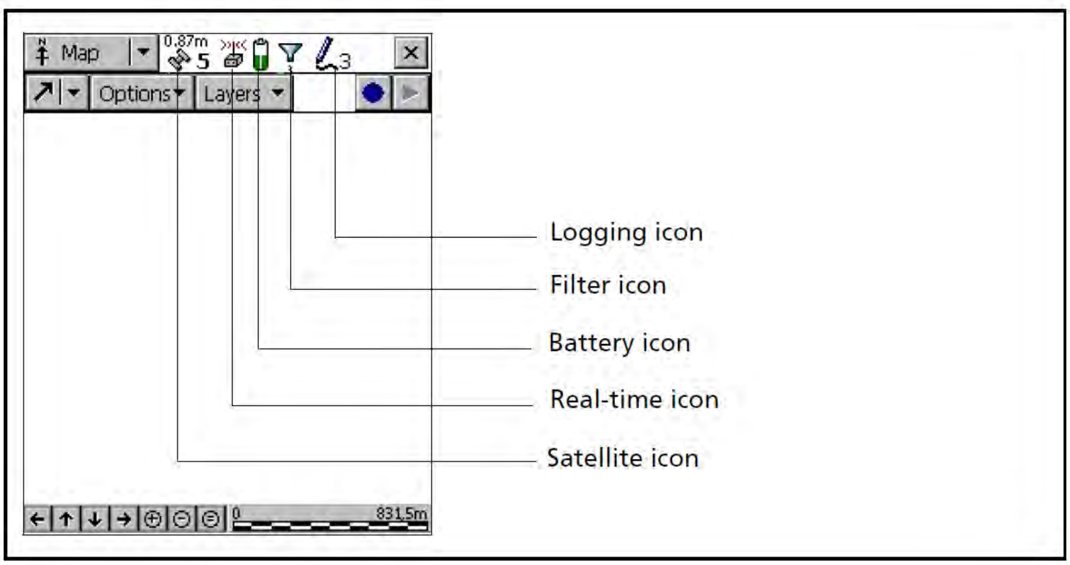


- Filled black boxes represent satellites that the receiver is using to compute its current GPS position.

- White boxes represent satellites that the receiver is getting signals from but is not using because the signals are too weak.

7. You need a minimum of four satellites with good geometry to computer a 3D GPS position.

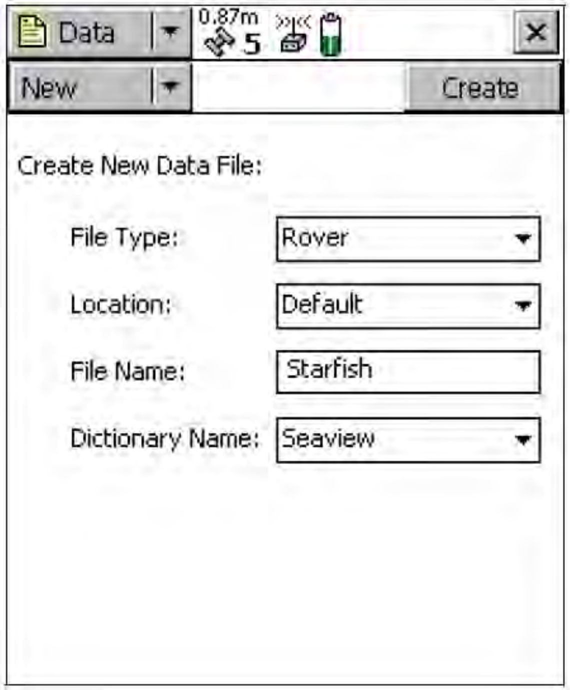
8. Status Bar: The status bar appears in the top row of the TerraSync screen. It is always visible, but the icons displayed depend on the current status of the TerraSync software.



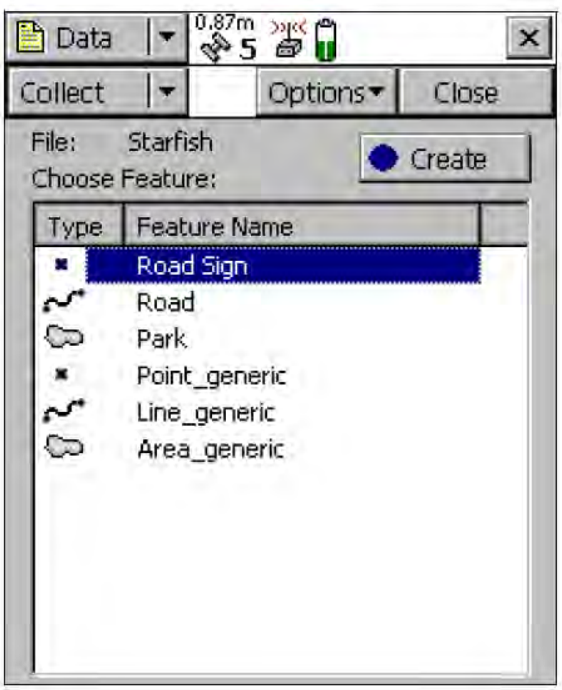
9. Creating a New Data File: Before starting the data collection session, you need t create a new data file to store the new features and attributes you collect. Use the Data section to do this.

- Tap the Section list button and then select Data

- Tap the Subsection list button and then select New.



- In the Dictionary Name field, select a data dictionary.
- Tap **Create**. The Collect Features screen appears:



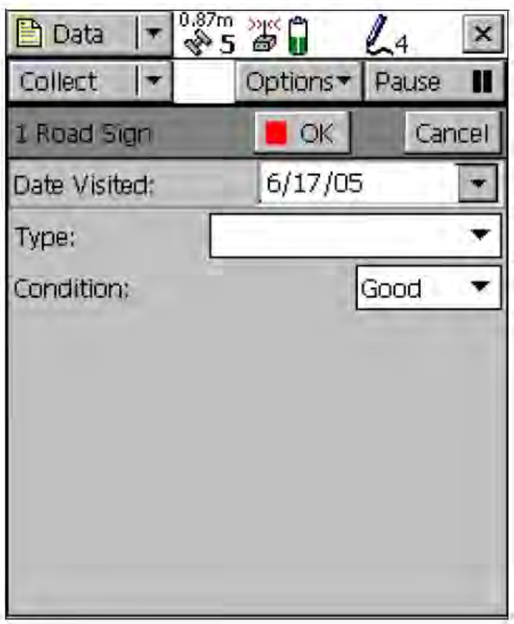
10. Collecting a Point Feature: When you record a point feature, you remain stationary for some time. The TerraSync software logs a number of GPS positions during this time.

These positions are averaged together to compute the final GPS position of the point feature.

When the TerraSync software is logging GPS positions, the logging icon appears in the status bar. The number beside the icon indicates how many positions have been logged for the selected feature. It is recommended that a minimum of 20 positions are logged prior to recording the feature.

To record a Point Feature:

- Ake sure the Collect Features screen is open.
- In the Choose Feature list, highlight an appropriate point feature and then tap **Create**. The attribute entry form for the feature type appears:
- Fill in the attribute field with appropriate values



- Once you have reached the desired amount of positions, tap OK to close the road sign feature. The attribute entry form closes and you are returned to the Collect Features screen.
- Refer to the TerraSync Orientation Guide for steps on how to collect other features.

11. Ending the data collection session: When the data collection session is complete, close the data file and then exit the Terra Sync software.

    - In the Collect Features screen, tap **Close**.
    - A message appears asking you to confirm that you want to close the open file. Tap **Yes** to close.

- Tap the X button in the top right corner of the screen.
- A message appears asking you to confirm that you want to close the TerraSync software. Tap **Yes** to close.

C. Preventive Maintenance

Data should be downloaded from the datalogger a minimum of once daily, twice daily is preferred. At the end of each day the receiver batteries should be recharged. For technical assistance call the rental company through which you acquired the Trimble® unit. Guidance is also provided in the manual and at http://www.trimble.com.

V. References

GeoExplorer® 6000 series, Trimble, February 2011.

TerraSync and GPS Pathfinder Office Software Guide, December 2006

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

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

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

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

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

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

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

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

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

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

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meter to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Air monitoring equipment
- Personal protective equipment
- Flow-through cell with inlet/outlet ports and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Purged water containers
- Sample containers
- Waste container labels
- In-line disposable 0.45μm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Aluminum foil
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.

2. Calibrate instruments according to manufacturer's instructions.

3. Record well number, site, date, and condition in the field logbook.

4. Place plastic sheeting on the ground surrounding well head. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. Do not let any downhole equipment touch the ground.

5. Open the well and begin screening breathing zone with air monitoring device until sampling is complete, in accordance with the HASP.

6. All sampling equipment and any other equipment to be placed in the well must cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

7. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the tubing to the pump. Lower the pump slowly into the well and set it at approximately the middle of the screen, or wetted screen interval, and at least two feet above the bottom of the well to avoid disturbance of sediment. Submersible pumps should be lowered by the suspension cable rather than the discharge tubing.

8. Insert the water quality measurement probes into the flow-through cell and place in a shaded area. The purged groundwater must enter the flow through the cell by the lower port and exit via the upper port. Wrap exposed tubing and the flow through cell in aluminum foil to minimize heat loss/gain due to environmental conditions.

9. Generators and fuel, if used, must be located at least 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Begin purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

11. Contain purged water for placement in labeled 55-gallon drum or tank, as appropriate.

12. The water level should be monitored frequently during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at

least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to minimize water level drawdown.

13. During purging, the field parameters must be measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

- pH: within 0.1 pH units
- Specific conductance: within 3 percent
- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- ORP: within 10 mV
- Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The pump should be allowed to operate at the same rate as the purge cycle until sampling begins, whereupon the discharge should be reduced to 0.1 L/m.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

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

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.

2. The sample is slowly poured so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.

3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus. VOC vials should be capped slowly to prevent introduction of air bubbles in the sample. Once capped, the VOC vial should be inverted and tapped to detect the presence of air bubbles.

5. Immediately upon collection, all samples for chemical analysis are to be labeled and placed on ice.

6. Re-usable equipment must be cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, must be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)

2. Sample source and source description

3. Field observations and measurements (appearance, field screening, field chemistry, sampling method), volume of water purged prior to sampling, and field parameter measurements

4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.

- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization. Submersible pumps used in large diameter wells should be equipped with a shroud to force water flow across the pump motor to dissipate heat build-up.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - ✓ Inspect sampling pump regularly and replace as warranted
    - ✓ Inspect quick-connects regularly and replace as warranted
    - ✓ Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

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

II Scope

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

III Definitions

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

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

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

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

IV. Procedures

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

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

Sample Identification

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

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

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

Measurements and observations shall be recorded using waterproof ink.

Sample Label

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

- Project – Name of project site.

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

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 05/21/17).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name or initials of the sampler.
- Remarks - Any pertinent additional information.

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

Chain-of-Custody Procedures

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

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include ***only*** the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample

locations in photographs, an easily read sign with the appropriate sample location number should be included.

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

Transfer of Custody and Shipment

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

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

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

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

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

V Quality Assurance Records

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

VI Attachments

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

VII References

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

Attachment A

Example Sample Label

QAL

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

Client ____________________

Sample No. ____________________

Location ____________________

Analysis ____________________

Preservative HCL

Date ____________ By ____________

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

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

SAMPLE TYPE

☐ Grab ☐ Composite ☐ Other ________

COLLECTED BY:

Attachment B

Example Chain-of-Custody Record

CH2M H[illegible]

APPLIED S[illegible]ENCES LABORATORY

CHAIN OF CUSTODY [illegible]CORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #	Purchase Order #
Project Name	
Company Name CH2M HILL Office	
Project Manager & Phone # Mr. [ ] Ms. [ ] Dr. [ ]	Report Copy to:
Requested Completion Date:	Sampling Requirements: SDWA NPDES RCRA OTHER; Sample Disposal: Dispose Return

OF CONTAINERS

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA– FOR LAB USE ONLY

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

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

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	QC Level: 1 2 3 Other:
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	COC Rec / ICE
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	Ana Req / TEMP; Cust Seal / Ph
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other	Shipping #	
Work Authorized By (Please sign and print name)	Remarks			

Instructions and Agreement Provisions on Reverse Side

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

REV 3/94 FORM 340

Attachment C

Example Custody Seal

CH2M HILL

CUSTODY SEAL

Date

Signature

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

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

II. Scope

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

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

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

III. Equipment and Materials

- Coolers
- Clear tape
- Strapping tape
- Contractor bags
- Absorbent pads or equivalent
- Resealable bags
- Bubble bags (for glass bottle ware)
- Bubble wrap (if needed)
- Ice

- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

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

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

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

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

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

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

G. Fill remaining spaces with bubble wrap if needed.

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

J Close lid and latch.

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

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

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

Medium- and High-Concentration Samples:

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

V. Attachments

None.

VI. Key Checks and Items

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

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

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

II. Equipment and Materials

A. Fluids

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

B. Solids

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

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or roll-offs or frac tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes (fill drum ¾, not to top), capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

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

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

B. Labels

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

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

C. Fluids

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

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

D. Solids

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

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

E. Storage and Disposal

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

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

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

STANDARD OPERATING PROCEDURE

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

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

A. General Parameters and Specifications:

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

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

B. Calibration:

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

C. Sample Measurement:

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

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

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

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

IV. Key Checks and Preventive Maintenance

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

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks and Drums

I. Scope and Application

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

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

II. Summary of Methods

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

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

III. Comments

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

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

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

IV. Required Equipment and Apparatus

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

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

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

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

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

V. Procedures

A. Drums

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

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

also be used to puncture the drum for sampling. See **Attachment D** for method of drum opening. Record air-quality monitoring results.

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

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

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

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

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

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

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

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

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

B. Underground Storage Tanks

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

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.

3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.

4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.

5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.

2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.

4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)

5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.

6. Sample each trailer compartment.

7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging,

labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

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

Drum

Glass tube	—	Procedure 1
COLIWASA	—	Procedure 2

Storage Tank and Tank Trailer

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

VI. Contamination Control

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

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

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

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

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X. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

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

Uses

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

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

Procedures for Use

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

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

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

Note:

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

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

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

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

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.
2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.

6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

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

<u>Uses</u>

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

<u>Procedures for Use</u>

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

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

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

Uses

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

Procedures for Use

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

Attachment E: Construction of a Typical COLIWASA

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

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

The sampler is assembled as follows:

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

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

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

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

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

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

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

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

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

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

II. Manual Drum Opening

A. Bung Wrench

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

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

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

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

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

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

III. Remote Opening

A. Backhoe Spike

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

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

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

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time-consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

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

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

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

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

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

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

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

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

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

IV. Attachments

None.

V. Key Checks

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

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

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

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

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

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

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

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

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

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

equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

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

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet

with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

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

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

F. HEAVY EQUIPMENT AND TOOLS

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

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

V. Attachments

None.

VI. Key Checks and Items

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

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

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

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- 2.5% (W/W) Liquinox® and water solution
- Buckets
- Brushes
- Isopropanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM–Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

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

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

B. Downhole Drilling Tools

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

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

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

C. Field Analytical Equipment

1. Water Level Indicators

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

   a. Rinse with Liquinox® and water solution
   b. Rinse with de-ionized water
   c. Solvent rinse with isopropanol (Optional)
   d. Rinse with de-ionized water

2. Probes

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

DRAFT FINAL STANDARD OPERATING PROCEDURE – NAVY CLEAN PROGRAM

Soil Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose

This SOP provides guidelines for soil sample collection and handling for samples that will be analyzed for per- and polyfluoroalkyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified at the time of analysis. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

Equipment and Materials Required

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

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

- Laboratory-prepared deionized, certified PFAS-free water for field blank collection

Equipment and Materials to Avoid During Sampling

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

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

Specifically, the following material should be avoided during sampling:

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

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

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

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

III. Procedures and Guidelines

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

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

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

   1. For samples on a grid:

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

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

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

d. Proceed to sample the points on the grid line as described in Section C below.

e. Make sure to stake location after sample collection in case professional surveying is to be completed.

f. Repeat 1c and 1e above until all samples are collected from the area.

g. Or, a GPS unit can be used to identify each location based on map coordinates, if available.

2. For non-grid samples:

a. Use measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Make sure to stake location after sample collection in case professional surveying is to be completed.

e. Repeat 2a through 2d above until all samples are collected from the area.

f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

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

D. To collect samples using hand tools:

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

2. If sampling:

a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

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

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

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

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

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

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

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

E. To collect Samples Using DPT Methods

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

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

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

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

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

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

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

Equipment Decontamination

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

References

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

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

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

Direct-Push Groundwater Sample Collection for Per- and Polyfluoroalkyl Substances

I. Purpose and Scope

This SOP provides guidelines for groundwater sample collection using direct-push (e.g., Geoprobe®) for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified at the time of analysis.

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

II. Equipment and Materials

Equipment and Materials Required

- Direct-push (e.g., Geoprobe®) sampling rods and retractable stainless-steel screen without PFAS-containing components (Avoid Teflon, Viton, PTFE and all other fluorinated compounds)
- PFAS-free tubing (avoid Teflon, Viton, PTFE and other fluorinated compounds) and stainless-steel foot valve
  - High density polyethylene tubing (unlined)
  - Masterflex tubing for peristaltic pumps, Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
- Peristaltic pump
- Pre-cleaned sample containers
- Air monitoring and water quality instruments (as needed)
- Personal protective equipment
- Groundwater sample containers (high density polyethylene [HDPE] with HDPE screw cap [no Teflon caps])
- PFAS-free shipping labels (if available[1]) materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard
- Pen (not Sharpie)
- Nitrile or Latex gloves
- Laboratory prepared deionized, certified PFAS-free water for field blank collection

Ensure the driller has not used and will not use drilling lube containing polytetrafluoroethylene (PFTE) or any other fluorine-containing substance. Biolube has been determined to be an acceptable substitute.

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

Equipment and Materials to Avoid During Sampling

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

Specifically, the following material should be avoided during sampling:

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

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

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

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

III. Procedures and Guidelines

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

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

1. Decontaminate slotted lead rod and other downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment* and this SOP.
2. Drive lead probe rod to the desired sampling depth, and withdraw rods 2 to 3 feet to expose the retractable screen to the aquifer formation. Ensure that the screened lead rod has been inserted to the desired sampling depth.
3. Insert the stainless-steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods or insert peristaltic pump tubing through rods, depending on which method is used.
4. Purge groundwater and monitor water quality parameters until stable prior to sampling.
5. Fill all sample containers. Samples should be collected in accordance with SOP *Groundwater Sampling when Analyzing for Per- and Polyfluoroalkyl Substances (PFAS)***.** Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling.

6. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required. Verify that the borehole made during sampling activities has been properly backfilled.

Equipment Decontamination

Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations. Do not use water from the facility (e.g. fire hydrants) if there is a possibility that the water available is contaminated with PFAS.

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

Use of Water Quality Equipment

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

References

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

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

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCL, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the soil boring log form (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for ASTM D1586 (attached), a standard soil boring log form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both sample jar labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as “approximate” or “estimated” as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger, sonic). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil consistency of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils (attached).

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density (coarse grained) or consistency (fine grained)
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see **Table 1** for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on **Table 2**.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in **Tables 3 and 4**.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch OD, and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch OD). A stiffer rod, such as an "N" rod (2-5/8-inch OD), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

Soil Boring Log Form with a completed example (Soil_Log_Examp.pdf)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

JACOBS

PROJECT NUMBER	BORING NUMBER

SOIL BORING LOG

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

ATD WATER LEVEL : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	SAMPLE #/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N')	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. DRILLING ACTIONS/DRILLER COMMENTS PID Readings: Breathing Zone: Above Hole:

CH2M HILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT ______ LOCATION ______

ELEVATION ______ DRILLING CONTRACTOR ______

DRILLING METHOD AND EQUIPMENT ______

WATER LEVELS ______ START ______ FINISH ______ LOGGER ______

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

Figure 1
SOIL BORING LOG, FORM D1586

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
DEN 22371.G5	BL-3	1 OF 3

SOIL BORING LOG

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Centennial, CO

ELEVATION 5136 Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan, Colorado

DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drill rig

WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michner

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
	2.5					
	4.0	1-S	1.5	2-3-4 (7)	POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 feet
5	5.0					Driller notes very soft drilling 4ft. dark grey, wet silty cuttings.
	6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft; strong H_2S odor, many fine roots up to about 1/4 inch	
	8.0					
	10.0	3-ST	1.3	—	ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10	11.5	4-S	1.3	2-2-2 (4)	SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet on 8/5/89 @ 0730 Driller notes rough drilling action and chatter @ 13ft
15	15.0 15.5	5-S	0.5	60/6"	SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
20	20.0 21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	Driller notes smoother, firm drilling @ 19 ft some angular rock chips @ bot tip of 6-S, poss boulders or rock Driller notes very hard, slow grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
	23.0 23.1	7-S	0	50/1"	NO RECOVERY	
					END SOIL BORING @ 23.1 FEET SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF COMPLETED LOG FORM

REV 11/89 FORM D1586

Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

*A Summary of Changes section appears at the end of this standard.

limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula.*

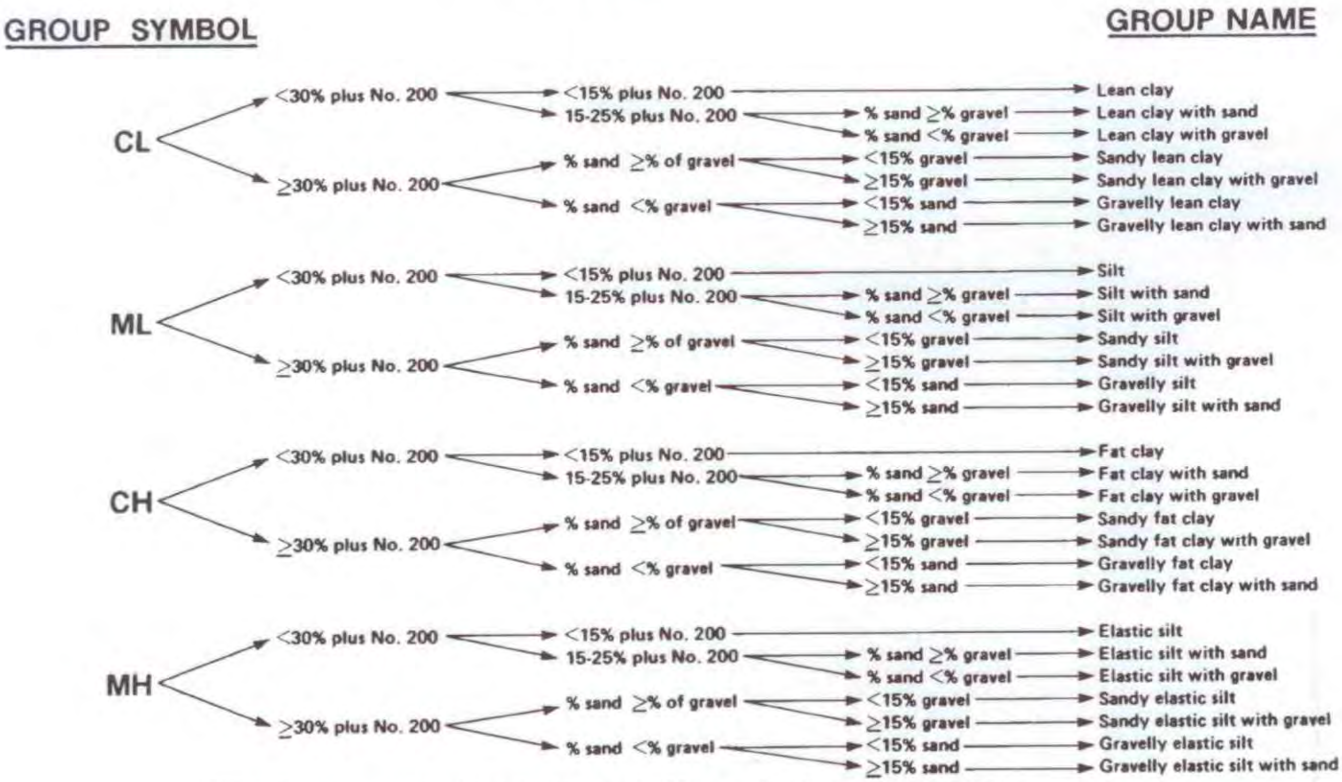
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

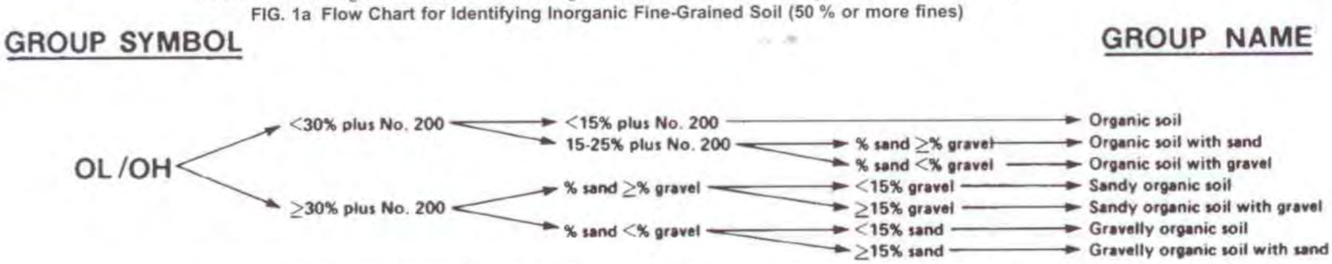
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

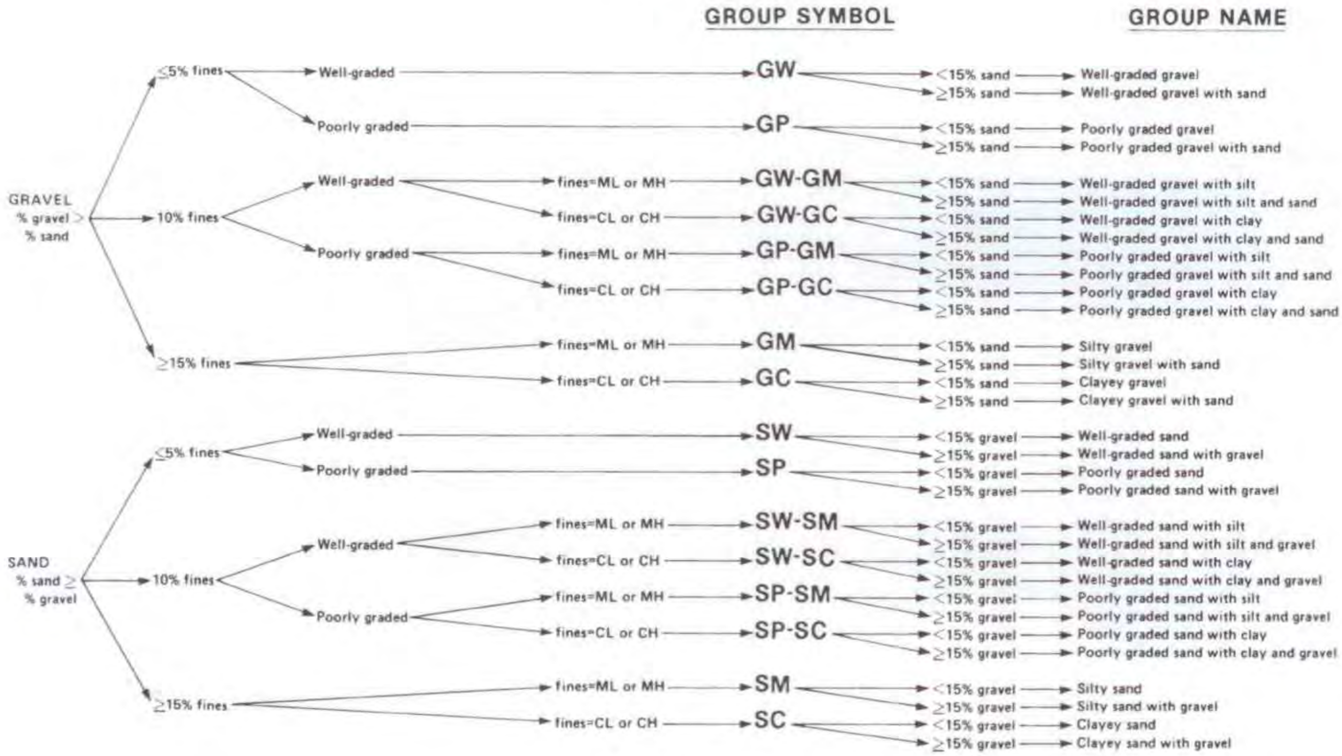
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

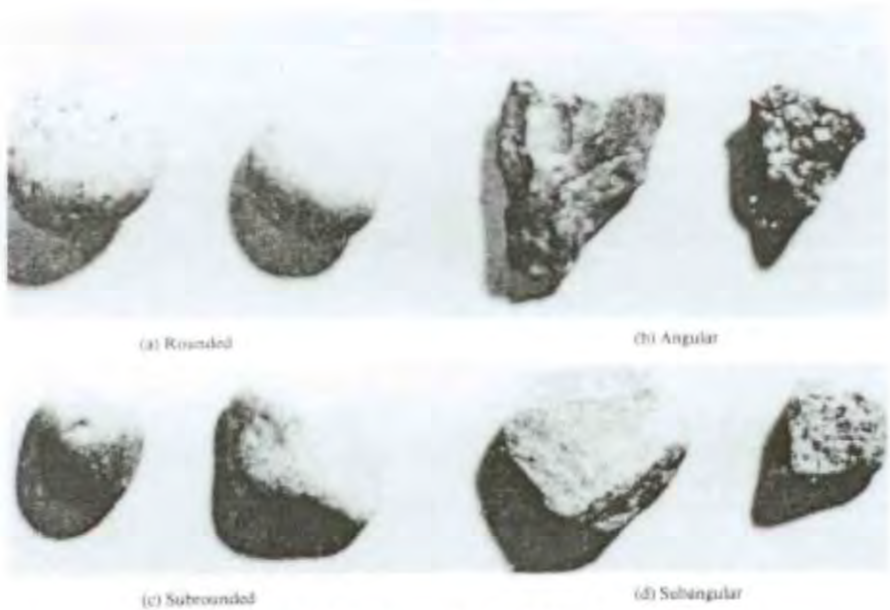


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

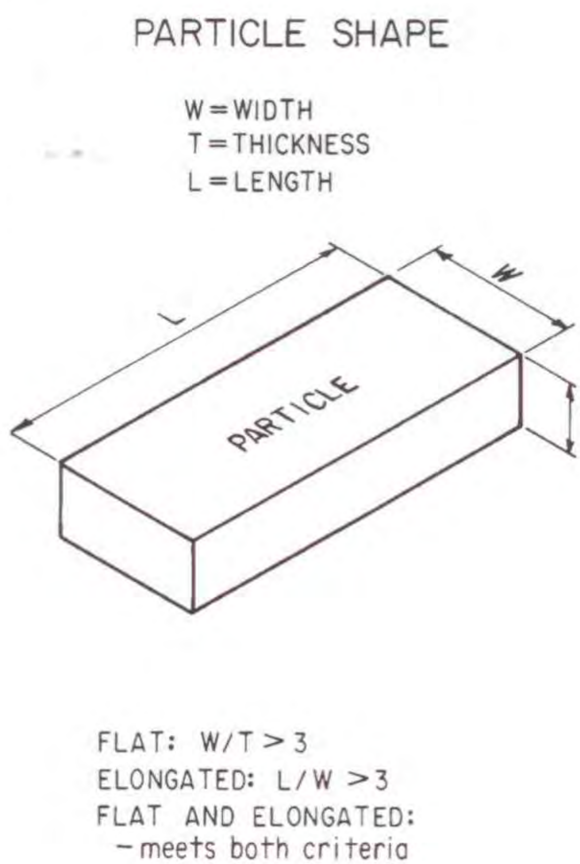


FIG. 4 Criteria for Particle Shape

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Dilatancy

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Toughness

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Dilatancy

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

TABLE 8 Criteria for Describing Toughness

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix: Suffix:

s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition ($1993^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

Designation: D 1586 – 08

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative disturbed soil sample for identification purposes, and measure the resistance of the soil to penetration of the sampler. Another method (Test Method D 3550) to drive a split-barrel sampler to obtain a representative soil sample is available but the hammer energy is not standardized.

1.2 Practice D 6066 gives a guide to determining the normalized penetration resistance of sands for energy adjustments of N-value to a constant energy level for evaluating liquefaction potential.

1.3 Test results and identification information are used to estimate subsurface conditions for foundation design.

1.4 Penetration resistance testing is typically performed at 5-foot depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.

1.5 This test method is limited to use in nonlithified soils and soils whose maximum particle size is approximately less than one-half of the sampler diameter.

1.6 This test method involves use of rotary drilling equipment (Guide D 5783, Practice D 6151). Other drilling and sampling procedures (Guide D 6286, Guide D 6169) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface investigations should be recorded in accordance with Practice D 5434. Samples should be preserved and transported in accordance with Practice D 4220 using Group B. Soil samples should be identified by group name and symbol in accordance with Practice D 2488.

1.7 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026, unless superseded by this test method.

1.8 The values stated in inch-pound units are to be regarded as standard, except as noted below. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.8.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs.

1.9 Penetration resistance measurements often will involve safety planning, administration, and documentation. This test method does not purport to address all aspects of exploration and site safety. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Performance of the test usually involves use of a drill rig; therefore, safety requirements as outlined in applicable safety standards (for example, OSHA regulations,[2] NDA Drilling Safety Guide,[3] drilling safety manuals, and other applicable state and local regulations) must be observed.

2. Referenced Documents

2.1 *ASTM Standards:* [4]

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids
- D 854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- D 1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D 2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D 2488 Practice for Description and Identification of Soils

[1] This method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Feb. 1, 2008. Published March 2008. Originally approved in 1958. Last previous edition approved in 1999 as D 1586 – 99.

[2] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, http://www.osha.gov.

[3] Available from the National Drilling Association, 3511 Center Rd., Suite 8, Brunswick, OH 44212, http://www.nda4u.com.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

(Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

D 4633 Test Method for Energy Measurement for Dynamic Penetrometers

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6026 Practice for Using Significant Digits in Geotechnical Data

D 6066 Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization

D 6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

3. Terminology

3.1 *Definitions:* Definitions of terms included in Terminology D 653 specific to this practice are:

3.1.1 *cathead, n*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.2 *drill rods, n*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.3 *N-value, n*—the blow count representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows (*N*) required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.4 *Standard Penetration Test (SPT), n*—a test process in the bottom of the borehole where a split-barrel sampler having an inside diameter of either 1-1/2-in. (38.1 mm) or 1-3/8-in. (34.9 mm) (see Note 2) is driven a given distance of 1.0 ft (0.30 m) after a seating interval of 0.5 ft (0.15 m) using a hammer weighing approximately 140-lbf (623-N) falling 30 ± 1.0 in. (0.76 m ± 0.030 m) for each hammer blow.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *anvil, n*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2.2 *drive weight assembly, n*—an assembly that consists of the hammer, anvil, hammer fall guide system, drill rod attachment system, and any hammer drop system hoisting attachments.

3.2.3 *hammer, n*—that portion of the drive-weight assembly consisting of the 140 ± 2 lbf (623 ± 9 N) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.2.4 *hammer drop system, n*—that portion of the drive-weight assembly by which the operator or automatic system accomplishes the lifting and dropping of the hammer to produce the blow.

3.2.5 *hammer fall guide, n*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.2.6 *number of rope turns, n*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.2.7 *sampling rods, n*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

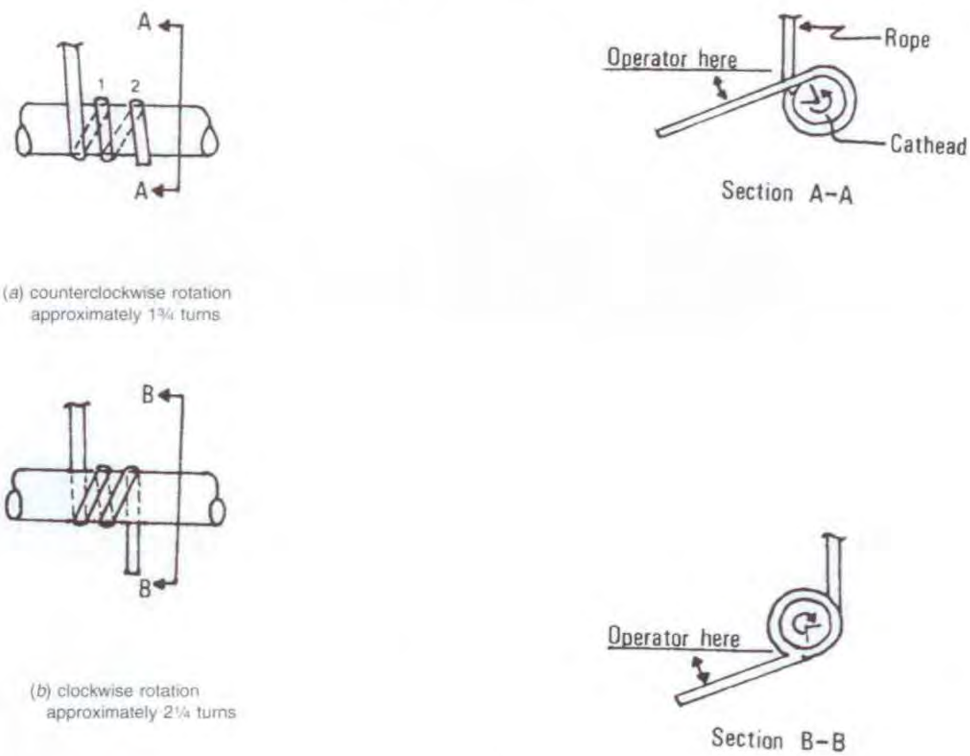
4. Significance and Use

4.1 This test method provides a disturbed soil sample for moisture content determination, for identification and classification (Practices D 2487 and D 2488) purposes, and for laboratory tests appropriate for soil obtained from a sampler that will produce large shear strain disturbance in the sample such as Test Methods D 854, D 2216, and D 6913. Soil deposits containing gravels, cobbles, or boulders typically result in penetration refusal and damage to the equipment.

4.2 This test method provides a disturbed soil sample for moisture content determination and laboratory identification. Sample quality is generally not suitable for advanced laboratory testing for engineering properties. The process of driving the sampler will cause disturbance of the soil and change the engineering properties. Use of the thin wall tube sampler (Practice D 1587) may result in less disturbance in soft soils. Coring techniques may result in less disturbance than SPT sampling for harder soils, but it is not always the case, that is, some cemented soils may become loosened by water action during coring; see Practice D 6151, and Guide D 6169.

4.3 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate blow count, or *N*-value, and the engineering behavior of earthworks and foundations are available. For evaluating the liquefaction potential of sands during an earthquake event, the *N*-value should be normalized to a standard overburden stress level. Practice D 6066 provides methods to obtain a record of normalized resistance of sands to the penetration of a standard sampler driven by a standard energy. The penetration resistance is adjusted to drill rod energy ratio of 60 % by using a hammer system with either an estimated energy delivery or directly measuring drill rod stress wave energy using Test Method D 4633.

NOTE 1—The reliability of data and interpretations generated by this practice is dependent on the competence of the personnel performing it



(*a*) counterclockwise rotation approximately 1¾ turns

(*b*) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 generally are considered capable of competent testing. Users of this practice are cautioned that compliance with Practice D 3740 does not assure reliable testing. Reliable testing depends on several factors and Practice D 3740 provides a means of evaluating some of these factors. Practice D 3740 was developed for agencies engaged in the testing, inspection, or both, of soils and rock. As such, it is not totally applicable to agencies performing this practice. Users of this test method should recognize that the framework of Practice D 3740 is appropriate for evaluating the quality of an agency performing this test method. Currently, there is no known qualifying national authority that inspects agencies that perform this test method.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitable borehole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions:

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6½ in. (165 mm) and greater than 2¼ in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

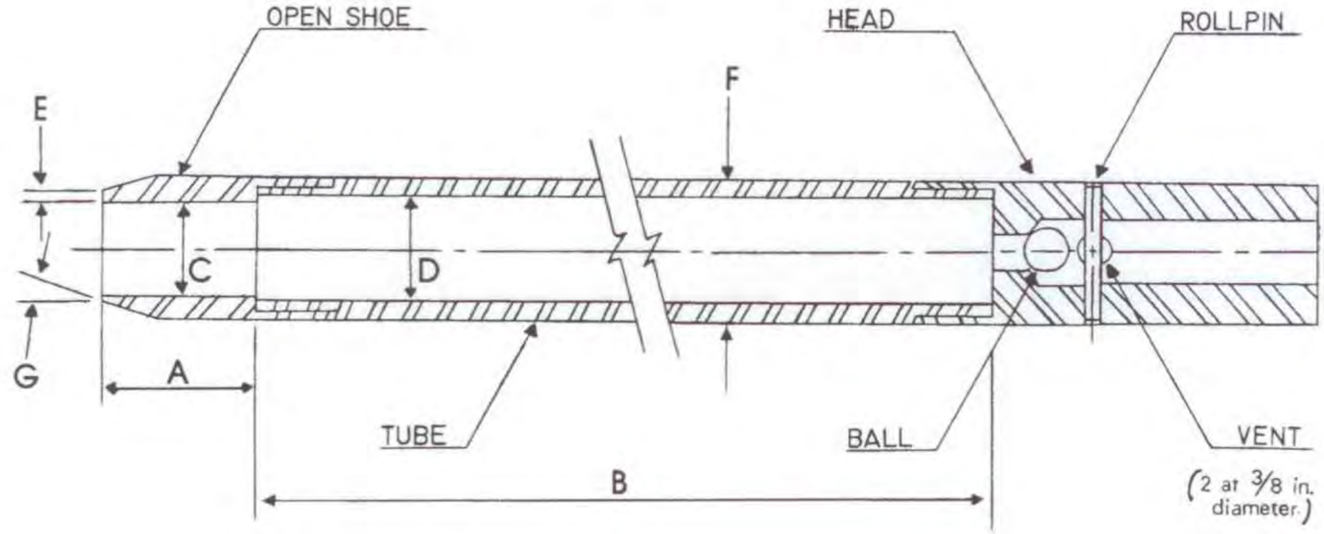
5.1.2 *Roller-Cone Bits*, less than 6½ in. (165 mm) and greater than 2¼ in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the borehole. The inside diameter of the hollow-stem augers shall be less than 6½ in. (165 mm) and not less than 2¼ in. (57 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6½ in. (165 mm) and not less than 2¼ in. (57 mm) in diameter may be used if the soil on the side of the borehole does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod that has an outside diameter of 1-5/8 in. (41.3 mm) and an inside diameter of 1-1/8 in. (28.5 mm).

5.3 *Split-Barrel Sampler*—The standard sampler dimensions are shown in Fig. 2. The sampler has an outside diameter of 2.00 in. (50.8 mm). The inside diameter of the of the split-barrel (dimension D in Fig. 2) can be either 1½-in. (38.1



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 – 0.00 in. (38.1 ± 1.3 – 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 – 0.00 in. (50.8 ± 1.3 – 0.0 mm)
G = 16.0° to 23.0°

FIG. 2 Split-Barrel Sampler

mm) or 1⅜-in. (34.9 mm) (see Note 2). A 16-gauge liner can be used inside the 1½-in. (38.1 mm) split barrel sampler. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The penetrating end of the drive shoe may be slightly rounded. The split-barrel sampler must be equipped with a ball check and vent. Metal or plastic baskets may be used to retain soil samples.

NOTE 2—Both theory and available test data suggest that *N*-values may differ as much as 10 to 30 % between a constant inside diameter sampler and upset wall sampler. If it is necessary to correct for the upset wall sampler refer to Practice D 6066. In North America, it is now common practice to use an upset wall sampler with an inside diameter of 1½ in. At one time, liners were used but practice evolved to use the upset wall sampler without liners. Use of an upset wall sampler allows for use of retainers if needed, reduces inside friction, and improves recovery. Many other countries still use a constant ID split-barrel sampler, which was the original standard and still acceptable within this standard.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lbf (623 ± 9 N) and shall be a rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting an unimpeded fall shall be used. Fig. 3 shows a schematic of such hammers. Hammers used with the cathead and rope method shall have an unimpeded over lift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged as shown in Fig. 3. The total mass of the hammer assembly bearing on the drill rods should not be more than 250 ± 10 lbm (113 ± 5 kg).

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic or automatic hammer drop systems, as shown in Fig. 4 may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The borehole shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 m) or less in homogeneous strata with test and sampling locations at every change of strata. Record the depth of drilling to the nearest 0.1 ft (0.030 m).

6.2 Any drilling procedure that provides a suitably clean and stable borehole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures has proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable boreholes. The process of jetting through an open tube sampler and

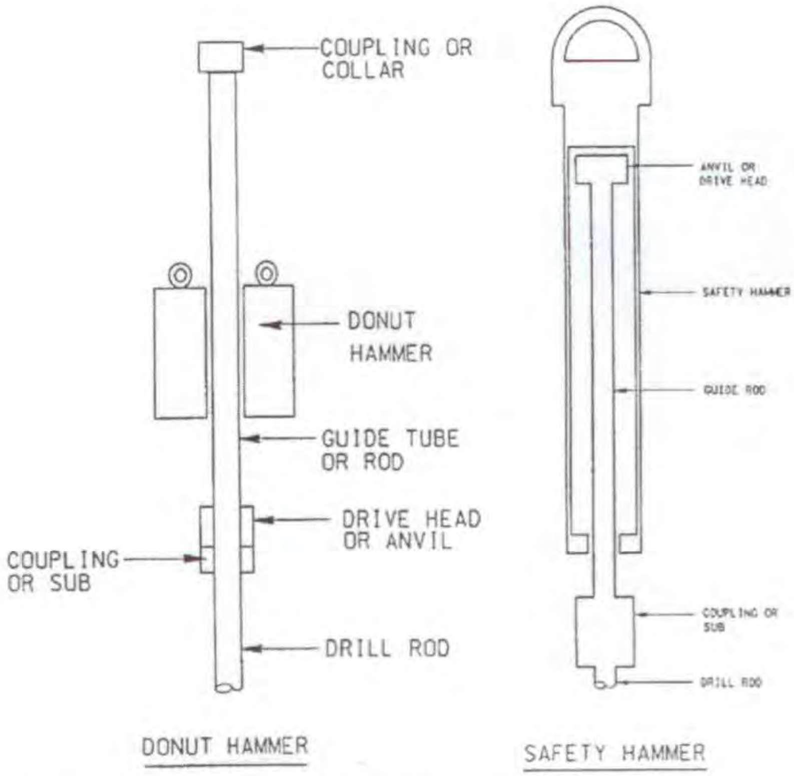


FIG. 3 Schematic Drawing of the Donut Hammer and Safety Hammer

then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the borehole below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a borehole with bottom discharge bits is not permissible. It is not permissible to advance the borehole for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the borehole or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the borehole has been advanced to the desired sampling elevation and excessive cuttings have been removed, record the cleanout depth to the nearest 0.1 ft (0.030 m), and prepare for the test with the following sequence of operations:

7.1.1 Attach either split-barrel sampler Type A or B to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the borehole. Record the sampling start depth to the nearest 0.1 ft (0.030 m). Compare the sampling start depth to the cleanout depth in 7.1. If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and sampling rods from the borehole and remove the cuttings.

7.1.4 Mark the drill rods in three successive 0.5-foot (0.15 m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 0.5-foot (0.15 m) increment.

7.2 Drive the sampler with blows from the 140-lbf (623-N) hammer and count the number of blows applied in each 0.5-foot (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 0.5-foot (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 1.5 ft. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.2.5 If the sampler sinks under the weight of the hammer, weight of rods, or both, record the length of travel to the nearest 0.1 ft (0.030 m), and drive the sampler through the remainder of the test interval. If the sampler sinks the complete interval, stop the penetration, remove the sampler and sampling rods from the borehole, and advance the borehole through the very soft or very loose materials to the next desired sampling elevation. Record the *N*-value as either weight of hammer, weight of rods, or both.

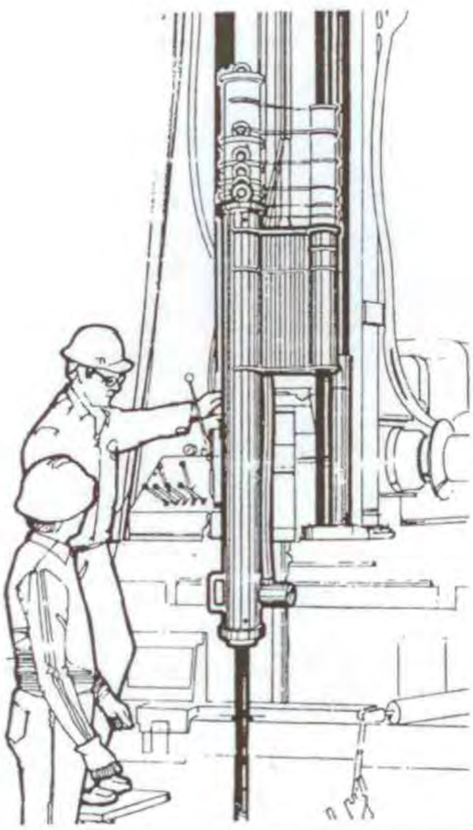


FIG. 4 Automatic Trip Hammer

7.3 Record the number of blows (*N*) required to advance the sampler each 0.5-foot (0.15 m) of penetration or fraction thereof. The first 0.5-foot (0.15 m) is considered to be a seating drive. The sum of the number of blows required for the second and third 0.5-foot (0.15 m) of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 1.5 ft (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 0.5-foot (0.15 m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 0.1 ft (0.030 m) in addition to the number of blows. If the sampler advances below the bottom of the borehole under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lbf (623-N) hammer shall be accomplished using either of the following two methods. Energy delivered to the drill rod by either method can be measured according to procedures in Test Method D 4633.

7.4.1 *Method A*—By using a trip, automatic, or semi-automatic hammer drop system that lifts the 140-lbf (623-N) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 0.030 m) with limited unimpedence. Drop heights adjustments for automatic and trip hammers should be checked daily and at first indication of variations in performance. Operation of automatic hammers shall be in strict accordance with operations manuals.

7.4.2 *Method B*—By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM.

7.4.2.3 The operator should generally use either 1-3/4 or 2-1/4 rope turns on the cathead, depending upon whether or not the rope comes off the top (1-3/4 turns for counterclockwise rotation) or the bottom (2-1/4 turns for clockwise rotation) of the cathead during the performance of the penetration test, as shown in Fig. 1. It is generally known and accepted that 2-3/4 or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be stiff, relatively dry, clean, and should be replaced when it becomes excessively frayed, oily, limp, or burned.

7.4.2.4 For each hammer blow, a 30 ± 1.0 in. (0.76 m ± 0.030 m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

NOTE 4—If the hammer drop height is something other than 30 ± 1.0 in. (0.76 m ± 0.030 m), then record the new drop height. For soils other than sands, there is no known data or research that relates to adjusting the *N*-value obtained from different drop heights. Test method D 4633 provides information on making energy measurement for variable drop heights and Practice D 6066 provides information on adjustment of *N*-value to a constant energy level (60 % of theoretical, N60). Practice D 6066 allows the hammer drop height to be adjusted to provide 60 % energy.

7.5 Bring the sampler to the surface and open. Record the percent recovery to the nearest 1 % or the length of sample recovered to the nearest 0.01 ft (5 mm). Classify the soil samples recovered as to, in accordance with Practice D 2488, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 0.5-foot (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel. Samples should be preserved and transported in accordance with Practice D 4220 using Group B.

8. Data Sheet(s)/Form(s)

8.1 Data obtained in each borehole shall be recorded in accordance with the Subsurface Logging Guide D 5434 as required by the exploration program. An example of a sample data sheet is included in Appendix X1.

8.2 Drilling information shall be recorded in the field and shall include the following:

8.2.1 Name and location of job,

8.2.2 Names of crew,

8.2.3 Type and make of drilling machine,

8.2.4 Weather conditions,

8.2.5 Date and time of start and finish of borehole,

8.2.6 Boring number and location (station and coordinates, if available and applicable),

8.2.7 Surface elevation, if available,

8.2.8 Method of advancing and cleaning the borehole,

8.2.9 Method of keeping borehole open,

8.2.10 Depth of water surface to the nearest 0.1 ft (0.030 m) and drilling depth to the nearest 0.1 ft (0.030 m) at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.2.11 Location of strata changes, to the nearest 0.5 ft (15 cm),

8.2.12 Size of casing, depth of cased portion of borehole to the nearest 0.1 ft (0.030 m),

8.2.13 Equipment and Method A or B of driving sampler,

8.2.14 Sampler length and inside diameter of barrel, and if a sample basket retainer is used,

8.2.15 Size, type, and section length of the sampling rods, and

8.2.16 Remarks.

8.3 Data obtained for each sample shall be recorded in the field and shall include the following:

8.3.1 Top of sample depth to the nearest 0.1 ft (0.030 m) and, if utilized, the sample number,

8.3.2 Description of soil,

8.3.3 Strata changes within sample,

8.3.4 Sampler penetration and recovery lengths to the nearest 0.1 ft (0.030 m), and

8.3.5 Number of blows per 0.5 foot (0.015 m) or partial increment.

9. Precision and Bias

9.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site.

9.1.1 The Subcommittee 18.02 is seeking additional data from the users of this test method that might be used to make a limited statement on precision. Present knowledge indicates the following:

9.1.1.1 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent boreholes in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.1.1.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; soil; split-barrel sampling; standard penetration test

APPENDIX

(Nonmandatory Information)

X1. Example Data Sheet

X1.1 See Fig. 5.

DRILLERS BORING LOG

Project ______________ Project No ______________ Boring No ______

Location ______________ Sheet ______ of ______

Date Started ______ Date Completed ______ Drill Crew:

Boring Location
Station ______ Offset ______

Elevation

Strata Depth		Soil Description and Remarks	Sample Type	No.	Depth		Recovery	N-Values		
From	To				From	To		6"	6"	6"

Drill Rig Type ______________

Method Of Drilling:

Auger ______ Size ______

Wash ______ Water ______ Mud ______

Hammer Type

Auto ______ Manual ______

Split-Spoon Type

Length ______ Liner Used ______

Boring Size ______ Bit Used ______

Casing Size ______ Length ______

Weather ______________

Non-Drilling Time (Hrs.)

Boring Layout ______ Moving ______

Hauling Water ______ Standby ______

Water Level @ ______ Date ______ Time ______

@ ______ Date ______ Time ______

@ ______ Date ______ Time ______

Cave-in Depth

@ ______ Date ______ Time ______

FIG. 5 Example Data Sheet

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1586 – 99) that may impact the use of this standard. (Approved February 1, 2008.)

(*1*) There have been numerous changes to this standard to list them separately. From the most recent main ballot process, additional changes were requested and incorporated into this newest revision. Stated below is a highlight of some of the changes.

(*2*) Scope was completely revised.

(*3*) Referenced Documents updated to include new standards.

(*4*) Terminology: added section on Definitions.

(*5*) Significance and Use: clarified use of the SPT test.

(*6*) Apparatus: general editorial changes.

(*7*) Sampling and Testing Procedure: general editorial changes.

(*8*) Data Sheets/Forms: general editorial changes.

(*9*) Precision and Bias: added Sections 9.1.1.1 and 9.1.1.2.

Table 1
EXAMPLE SOIL DESCRIPTIONS

POORLY GRADED SAND (SP), light brown, moist, loose, fine sand size

FAT CLAY (CH), dark gray, moist, stiff

SILT (ML), light greenish gray, wet, very loose, some mica, lacustrine

WELL-GRADED SAND WITH GRAVEL (SM), reddish brown, moist, dense, subangular gravel to 0.6 inches max

POORLY GRADED SAND WITH SILT (SP-SM), white, wet, medium dense

ORGANIC SOIL WITH SAND (OH), dark brown to black, wet, firm to stiff but spongy undisturbed, becomes soft and sticky when remolded, many fine roots, trace of mica

SILTY GRAVEL WITH SAND (GM), brownish red, moist, very dense, subrounded gravel to 1.2 inches max

INTERLAYERED SILT (60 percent) AND CLAY (40 percent): SILT WITH SAND (ML), medium greenish gray, nonplastic, sudden reaction to shaking, layers mostly 1.5 to 8.3 inches thick; LEAN CLAY (CL), dark gray, firm and brittle undisturbed, becomes very soft and sticky when remolded, layers 0.2 to 1.2 inches thick

SILTY SAND WITH GRAVEL (SM), light yellowish brown, moist, medium dense, weak gravel to 1.0 inches max, very few small particles of coal, fill

SANDY ELASTIC SILT (MH), very light gray to white, wet, stiff, weak calcareous cementation

LEAN CLAY WITH SAND (CL/MH), dark brownish gray, moist, stiff

WELL-GRADED GRAVEL WITH SILT (GW-GM), brown, moist, very dense, rounded gravel to 1.0 inches max

Table 2
CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

Table 3
RELATIVE DENSITY OF COARSE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Relative Density	Field Test
0-4	Very loose	Easily penetrated with ½-in. steel rod pushed by hand
5-10	Loose	Easily penetrated with ½-in. steel rod pushed by hand
11-30	Medium	Easily penetrated with ½-in. steel rod driven with 5-lb hammer
31-50	Dense	Penetrated a foot with ½-in. steel rod driven with 5-lb hammer
>50	Very dense	Penetrated only a few inches with ½-in. steel rod driven with 5-lb hammer

Table 4
CONSISTENCY OF FINE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Consistency	Pocket Penetrometer (TSF)	Torvane (TSF)	Field Test
<2	Very soft	<0.25	<0.12	Easily penetrated several inches by fist
2-4	Soft	0.25-0.50	0.12-0.25	Easily penetrated several inches by thumb
5-8	Firm	0.50-1.0	0.25-0.5	Can be penetrated several inches by thumb with moderate effort
9-15	Stiff	1.0-2.0	0.5-1.0	Readily indented by thumb, but penetrated only with great effort
16-30	Very stiff	2.0-4.0	1.0-2.0	Readily indented by thumbnail
>30	Hard	>4.0	>2.0	Indented with difficulty by thumbnail

STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

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

I. Purpose and Scope

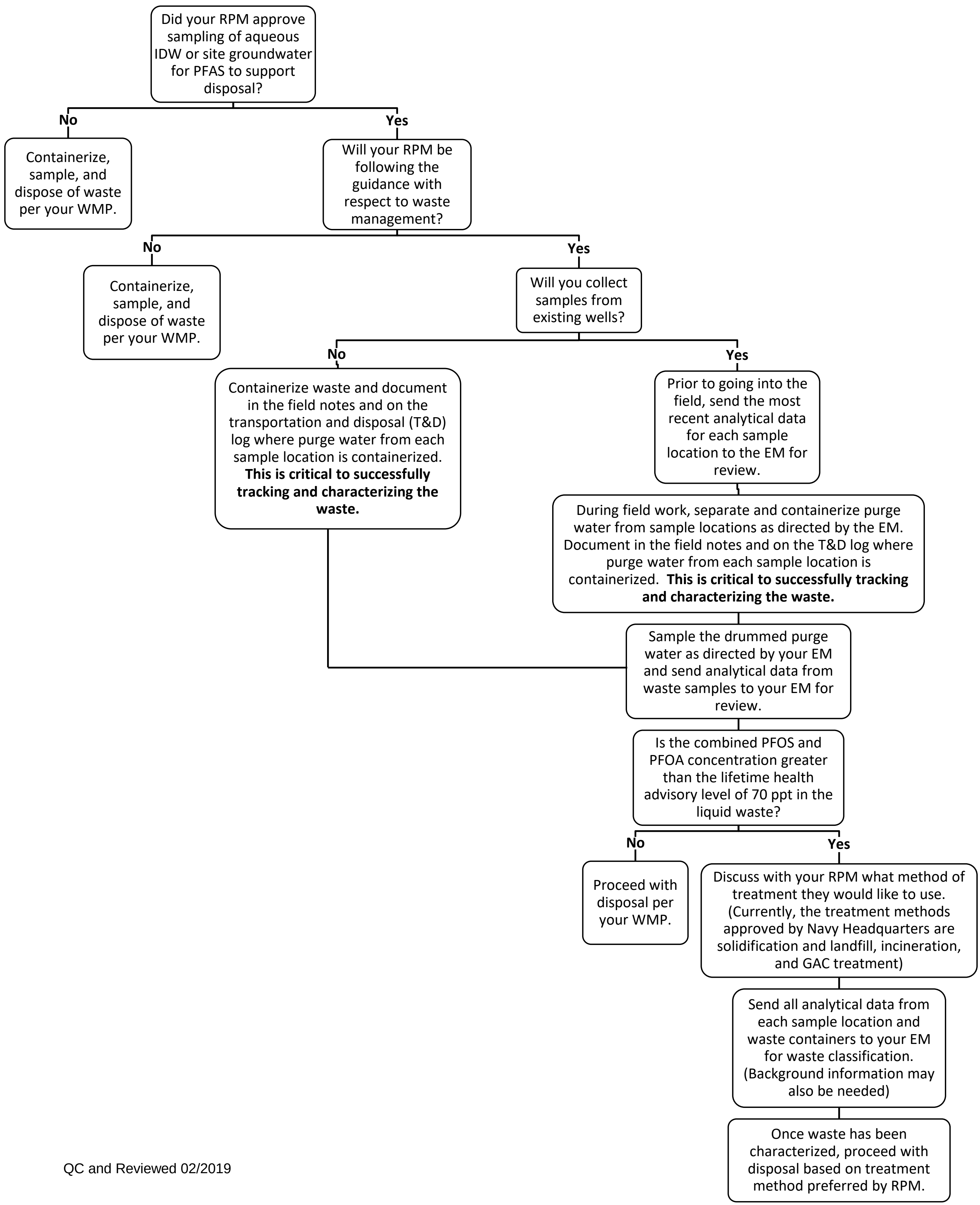
This SOP provides guidelines for managing waste containing per- and polyfluoalklyl substances (PFAS) in accordance with the *Interim Per- and Polyfluoralkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/September 2017 Update* (guidance). This SOP should be used in conjunction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

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

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

II. Procedures and Guidelines

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


Did your RPM approve sampling of aqueous IDW or site groundwater for PFAS to support disposal?
No
Containerize, sample, and dispose of waste per your WMP.
Yes
Will your RPM be following the guidance with respect to waste management?
No
Containerize, sample, and dispose of waste per your WMP.
Yes
Will you collect samples from existing wells?
No
Containerize waste and document in the field notes and on the transportation and disposal (T&D) log where purge water from each sample location is containerized. **This is critical to successfully tracking and characterizing the waste.**
Yes
Prior to going into the field, send the most recent analytical data for each sample location to the EM for review.
During field work, separate and containerize purge water from sample locations as directed by the EM. Document in the field notes and on the T&D log where purge water from each sample location is containerized. **This is critical to successfully tracking and characterizing the waste.**
Sample the drummed purge water as directed by your EM and send analytical data from waste samples to your EM for review.
Is the combined PFOS and PFOA concentration greater than the lifetime health advisory level of 70 ppt in the liquid waste?
No
Proceed with disposal per your WMP.
Yes
Discuss with your RPM what method of treatment they would like to use. (Currently, the treatment methods approved by Navy Headquarters are solidification and landfill, incineration, and GAC treatment)
Send all analytical data from each sample location and waste containers to your EM for waste classification. (Background information may also be needed)
Once waste has been characterized, proceed with disposal based on treatment method preferred by RPM.

STANDARD OPERATING PROCEDURE

Direct-Push Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) groundwater sampling methods.

III. Equipment and Materials

- Direct-push (e.g., Geoprobe®) sampling rods and retractable stainless-steel screen
- New, clean, polyethylene sampling tubing and stainless-steel foot valve
- Peristaltic pump
- Pre-cleaned sample containers
- Air monitoring and water quality instruments
- Personal protective equipment

IV. Procedures and Guidelines

1. Decontaminate slotted lead rod and other downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive lead probe rod to the desired sampling depth and withdraw rods 2 to 3 feet to expose the retractable screen to the aquifer formation.
3. Insert the stainless-steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods or insert peristaltic pump tubing through rods, depending on which method is used.
4. Purge groundwater and monitor water quality parameters until stable prior to sampling.
5. Fill all sample containers, beginning with the containers for VOC analysis. Samples should be collected in accordance with SOPs *Low-Flow Groundwater Sampling from Monitoring Wells –EPA Regions I and III* or *Low-Flow Groundwater*

Sampling from Monitoring Wells –EPA Region IV, which ever region is applicable to the project site.

6. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing.

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

V. Key Checks and Items

- Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.
- Ensure that the screened lead rod has been inserted to the desired sampling depth.
- Verify that the borehole made during sampling activities has been properly backfilled.

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Sampling tubes and acetate liners
- Pre-cleaned sample containers and stainless-steel sampling implements
- Personal Protective Equipment as specified by the Health and Safety Plan

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.
4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).

5. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement. For the VOC samples, place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core®** or **Terra Core®** sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. Label the vials and immediately place samples on ice for shipment to the laboratory.

6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.

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

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

DRAFT FINAL STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Groundwater Sampling for Per- and Polyfluoroalkyl Substances (PFAS)

I. Purpose and Scope

This SOP provides guidelines for groundwater sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified. This SOP should be used in conjunction with approved region-specific groundwater sampling SOPs which provide methods for general and low-flow groundwater sampling. In cases in which information in this SOP conflicts with region-specific groundwater sampling SOPs, this SOP will supersede the information in the general SOPs.

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

II. Equipment and Materials

Equipment and Materials Required

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

[1] Geotech and Waterra offer PFAS free bailer options

- Monsoon or Mega Monsoon submersible pump
- Grundfos Rediflo2 (this pump contains small Teflon components, but has not been shown to leach, it is less preferable than the other options)
- Peristaltic pump (may be suitable for shallow locations)

- Groundwater sample containers (high density polyethylene [HDPE] bottle with HDPE screwcap), sample bottles should not be glass as glass may sorb PFAS. Sample bottle caps should not contain Teflon. Notify your project manager (PM) if bottles provided by the lab are glass or contain Teflon parts.
- Laboratory prepared deionized, certified PFAS-free water for field blank collection
- PFAS-free shipping supplies (labels [if available][2], coolers, and ice)
- Loose leaf paper without waterproof coating or a spiralbound notebook (not waterproof)
- Metal clip board (if using loose-leaf paper)
- Pen (not Sharpie)
- Nitrile or latex gloves

Equipment and Materials to Avoid During Sampling

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

Specifically, the following material should be avoided during sampling:

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

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

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

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

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

III. Procedures and Guidelines

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

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

Sample Collection

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

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

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

Equipment Decontamination

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

Use of Water Quality Equipment and Water Level Indicators

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

V. References

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

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

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

Appendix D
Laboratory DoD ELAP
Accreditation Letter

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

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

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2017 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.3 February 2018 and is accredited is accordance with the:

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

This accreditation demonstrates technical competence for the defined scope:
Environmental Testing
(As detailed in the supplement)

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

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
November 17, 2016	December 20, 2018	February 28, 2021
Revision Date:	*Accreditation No.:*	*Certificate No.:*
February 11, 2020	91667	L18-588-R2

Tracy Szerszen
President/Operations Manager

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

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

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 537.1	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
Drinking Water	EPA 537.1	LC/MS/MS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
Drinking Water	EPA 537.1	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
Drinking Water	EPA 537.1	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluorononanoic acid (PFNA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Drinking Water	EPA 537.1	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Drinking Water	EPA 537.1	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Drinking Water	EPA 537.1	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic Acid (3:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (5:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (7:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-octanesulfonamide (PFOSA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (Adona)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9CI-PF3ONS)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11CI-PF3OUdS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Sodium perfluoro-1-pentanesulfonate (PFPeS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-nonanesulfonate (PFNS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-heptanesulfonate (PFHpS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorohexane sulfonate (4:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorooctane sulfonate (6:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorodecane sulfonate (8:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-butanoic Acid (PFBA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-pentanoic acid (PFPeA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluorononanoic acid (PFNA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

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

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

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

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Battelle

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

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

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

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

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

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

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

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Battelle

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

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

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

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Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061

Contact Name: Jonathan Thorn Phone: 781-681-5565

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

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

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

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

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

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270DE MOD	GC-MS	trans-Decalin
Aqueous	EPA 3510 C	Separatory Funnel	Prep
Aqueous	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Aqueous	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Solid	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	NOAA NOS ORCA 71	Orbital Shaker	Prep
Tissue	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Tissue	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Tissue	NOAA NOS ORCA 71	Tissuemizer	Prep

Appendix E
Laboratory-Specific
Standard Operating Procedures

Annual review confirmed that this SOP still reflects current practice.
Initials: KN for MM Date: 1-22-16
Initials: KN for RL via S. Michaels Date: 7/13/2018
Initials: ______ Date: ______

Battelle
Standard Operating Procedure

for

The Storage and Disposal of Regulated and Non-Regulated Waste

Summary of changes in this version: SOP revised for occupancy of Norwell location. Revision also combines Columbus internal operating procedures (IOPs) for waste operation all into this SOP.

1.0 OBJECTIVE

The purpose of this standard operating procedure (SOP) is to provide a protocol for the handling, transport, storage, and disposal of regulated and non-regulated wastes generated by this facility that is in compliance with the regulations defined by the Massachusetts Department of Environmental Protection (DEP), Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA). These procedures are implemented in order to reduce the risks to personnel associated with the handling of hazardous or toxic substances and to prevent contamination of the environment.

The waste streams defined in this SOP include both regulated wastes and non-regulated solid waste generated in the laboratory.

1.1. SCOPE AND APPLICABILITY

Wastes generated during Laboratory Operations and facility support activities are picked up by Hazardous Waste Coordinator (HWC) and Hazardous Waste Handlers (HWH) as needed from designated satellite accumulation areas (SAAs). SAAs are populated by the generating organization in accordance with Battelle internal policies and procedures and My Process procedure area.

All laboratory staff is required to fully comply with sections 1.0 and 2.0. Only the HWC and designated HWH may carry out procedures described in sections 2.0-5.0. All staff is expected to familiarize themselves with all portions.

Refer to section 10.0 for training requirements for HWC and HWH.

1.1.1. Regulated wastes (also referred to as hazardous wastes) may include but is not limited to

- Waste, flammable liquids (drum solvent). This waste stream includes rinse solvent, HPLC solvent, or other waste solvent generated during laboratory operations. Discarded sample extracts, surplus aqueous samples, processed aqueous samples, and surplus petroleum product samples are also included in this category.
- Waste, corrosive liquids (acid wastes).
- Waste, flammable liquid, corrosive (acidic solvent).

1.1.2. Non-regulated wastes (also referred to as solid waste) include:

- Discarded surplus (un-processed) solid samples (biological tissue, soils, sediment, or other matrix determined by the laboratory manager to be non-hazardous. Note: The disposal of foreign soils is described in SOP 5-269.
- Processed solid samples.
- Other non-regulated wastes, such as paper towels, latex gloves, aluminum foil, empty glass bottles, etc.

2.0 PREPARATION

2.1. COLLECTION IN THE LABORATORY

2.1.1. Working Containers

Working containers are defined as small waste containers (i.e., 2-gallons or less) used for the temporary collection of hazardous waste and managed under the control of laboratory staff. Working containers may include flasks, beakers, or small bottles, depending upon the laboratory operation.

Hazardous waste is collected at the point of generation by laboratory staff working in fume hoods or other designated areas into working containers. Working containers must be:

- Under the control of laboratory staff directly responsible for the process generating the waste being collected.
- Labeled with the words "Hazardous Waste."
- Labeled with words describing the nature of the waste and the chemicals such as organic solvent (dichloromethane).
- Labeled or marked to indicate the hazard of the waste; e.g. flammable, corrosive, toxic, etc.
- Managed to prevent spills and minimize releases.
- Emptied into satellite containers at the end of each active use, when full, or at the end of the work shift, whichever occurs first.

2.1.2. Satellite Containers

Satellite containers, located in Satellite Accumulation Areas (SAA), are used for the collection of hazardous wastes in the laboratory and are under the management and control of the Hazardous Waste Coordinator (HWC). Laboratory staff accesses them to empty the working containers. Satellite containers include container types such as:

- 5-gallon plastic safety cans for drum solvent or acidic solvent wastes,
- 55 or 30-gallon closed-top, steel drums with a screw-plug opening for drum solvent wastes,
- 5-gallon plastic or metal buckets with lids for solid wastes.

Laboratory staff are responsible for labeling satellite containers as they are brought into use. A Hazardous Waste tag (see Attachment 4) must be attached to all in use and full Satellite containers. Information on the hazardous waste tag must include: Chemical name or words describing the nature of the waste such as organic solvent (dichloromethane), and labeled or marked to indicate the hazard of the waste; e.g. flammable, corrosive, toxic, etc.

Each SAA may contain one container (up to 55-gallons) per waste stream. Prior to the container becoming completely full, laboratory staff members shall notify the HWC of the time of anticipated filling. Any time more than 55-gallons of hazardous waste or 1 quart of acutely hazardous waste accumulates at a designated SAA, it must be removed within 3 working days. (To determine if your waste is acutely hazardous waste, contact the HWC.) If there is any question concerning compatibility, the HWC or the Environmental, Safety, and health (ES&H) Officer should be contacted prior to combining or mixing of any substances.

Processed or surplus solid samples discarded in the laboratory are placed into 5-gallon open top plastic or metal buckets by laboratory personnel. There is no regulation limiting the number or location of solid waste buckets in the laboratory. However, laboratory management requires that they be co-located with hazardous waste in SAA areas. These buckets are removed when they are filled or as convenient by the HWC or HWH personnel. Other solid wastes (defined in section

1) are discarded in large waste receptacles located in the laboratory and discarded in the normal facility waste stream.

2.2. ACCUMULATION AREA SUPPLIES

2.2.1. Containers

Laboratory solid and liquid wastes are stored and shipped in containers specifically designed for the type of materials being handled such as:

- Solid wastes are stored in 55 gallon open-topped, steel drums.
- Liquid sample waste and solvent waste are stored separately in closed-top, steel drums with a screw-plug opening.
- Aqueous organic and acid wastes are stored in 30 gallon closed top poly drums to prevent corrosion.

Contact BCO Hazardous Waste Operations for ordering additional containers, when needed.

2.2.2. Personal Protective Equipment

- Lab coats and safety glasses
- Disposable plastic gloves (nitrile or butyl rubber, or Viton™)
- Respirator and cartridges [consult ES&H Officer]

2.2.3. Spill Cleanup Equipment and Supplies

- Spill absorbent (Vermiculite or Speedidry™)
- Broom, foxtail and dustpan
- Plastic shovel
- Paper towels

3.0 PROCEDURES

3.1. RELOCATING HAZARDOUS MATERIALS TO 90-DAY ACCUMULATION STORAGE AREA

HWC or HWH personnel will pick up chemical wastes as needed from the established SAAs. The HWC will notify the operator of the SAA of any nonconforming waste. Waste containers not in conformance with the requirements shall not be picked up.

- Inspect waste containers for integrity and proper closure.
- Inspect waste tag on containers for compliance and ensure all needed information to properly classify waste is included. Write hazardous waste accumulation start date on the waste tag.
- Transfer acceptable tagged waste containers from the SAA to appropriate waste handling equipment.
- Containers less than 4 liters in size should be placed inside another container such as poly bins, to prevent the containers from being dropped or broken while relocated to 90-day area.
- Ensure all incompatible wastes are separated. Refer to the Chemical Compatibility Chart (see Attachment 3) for guidance on chemical compatibility.
- Ensure route is clear of obstructions and is safe for movement.

3.2. CLASSIFICATION AND SEGREGATION OF HAZARDOUS AND NON HAZARDOUS MATERIALS

Battelle has approved acceptable Waste Profiles established through current disposal vendor. These profiles are maintained by Battelle Columbus Operations (BCO) Hazardous Waste Operations. If a waste stream is generated that does not meet already established Waste Profiles contact BCO Hazardous Waste Operations for guidance processing the material.

- Using generator knowledge and information listed on the hazardous waste tag determine the hazard of the material.
- Assign all applicable waste codes, refer to 49 CFR 261.20.
- Separate all materials according to their DOT hazard classes. To determine which DOT hazard class these materials fall into, locate the materials by name in column 2 of the Hazardous Material Table (49 CFR 172.101) and reference column 3 to determine hazard class.
- Choose the appropriate hazard class using 49 CFR 173 Subpart D after the material has been properly classified.
- Use Disposal Facility Waste Profile Sheets and Chemical Compatibility Chart to determine whether the materials are to be consolidated (i.e. "bulked") or lab packed and separate accordingly.
- If the determination is made that the material needs to be lab packed refer to Section 3.5 for lab pack guidance.

3.3. CONTAINER LABELING

Once the hazard class and other compatibility factors have been determined select an appropriate DOT container for processing and shipment of materials. Solid and liquid hazardous and nonhazardous wastes are processed into containers specifically designed for the type of waste being disposed of such as:

- Solid wastes are stored in 55 gallon open-topped, steel drums or 30 gallon open-topped, poly drums
- Liquid sample waste and solvent waste are stored separately in closed-top drums with a screw-plug opening.
- Aqueous organic and acid wastes are stored in 30 gallon closed top poly drums to prevent corrosion.

Label and mark the empty container with the following information.

- A drum ID number,
- Profile number,
- A hazard label, if applicable (e.g. corrosive, flammable label)
- A preprinted DOT hazardous waste or non-regulated label.

Any chemical waste that does not meet the criteria of a DOT hazardous material or EPA hazardous waste must have adequate markings during accumulation. Once packaged for shipment, materials must have a Non-RCRA label attached with the following statement, "Not a D.O.T. Regulated Material," as the shipping name. Materials in the storage area used as products (i.e. cleaning supplies) need to be identified as such with appropriate labels in accordance with the Occupational Safety and Health Association's Hazard Communication Standard (29 CFR 1910.1200).

Prior to shipment of any DOT hazardous materials as defined in 49 CFR 171.8, containers must comply with the marking and labeling requirements found in 49 CFR 172 Subparts D and E.

3.4. CONSOLIDATION OF LIQUID AND SOLID MATERIALS

CAUTION: Ground all containers containing flammable material.

- Place appropriate shipping container, in the hazardous waste accumulation fume hood.
- Verify proper operation of fume hood or ensure adequate ventilation for transferring materials.
- Properly ground the shipping container to avoid a static charge for flammable material.
- Ensure that all waste to be consolidated is chemically compatible.
- Remove both of the bungs and place a funnel into the drum. Carefully pour the liquids into the shipping container. After waste is added, close the bungs
- Solid wastes are transferred into 55-gallon open top drums. The lid is removed from the collection container and the contents dumped into the storage drum.
- Place a Hazardous Waste Label (if applicable) on the drum with its proper shipping name, EPA waste code, and accumulation start date.
    - **Note:** Drums must remain closed at all times unless processing.

3.5. LAB PACKING

Some chemicals that cannot be consolidated must be packaged separately to meet the U.S. Department of Transportation (DOT) and the Treatment, Storage, and Disposal Facilities TSDF packaging criteria.

- Select an appropriate lab pack (i.e., outer) new container [reference 49 CFR 173.12 (b)(2)(i)].
- Check the TSDF packaging requirements for specific instructions for packaging lab packs. The facility may also require evaluation forms for certain chemicals, such as azides, peroxide formers, and gas cylinders. Consult BCO Hazardous Waste Operations about the specific TSDF packaging requirements. Also, packaging absorbent must be present in sufficient quantity to absorb the lab pack's total liquid content.
- Place 2 to 4 inches of absorbent packaging material in the bottom of the outer container.

  Note: These inner containers must not exceed 4 liters for glass containers and 20 liters for metal and plastic containers in volume and must comply with the standards set by 49 CFR 173.12 (b)(2)(ii), with a maximum total packaged weight of 205 kilograms per container. The contents of this container must always be marked.
- Place the inner containers into the outer container. Do not mix different hazard classes in the same outer container.
- Surround inner containers with appropriate absorbent material. When all inner containers have been placed into the outer container, fill the remaining space in the outer container with absorbent material. Each inner container must be labeled with the container's contents.
- Generate a lab pack drum inventory form for each outer container. The inventory form will have a list of each chemical in the container, its weight/volume, and applicable waste codes.
- Weigh the lab pack and place it in the appropriate accumulation area. Record the weight on the container.

- Lab packs that contain liquids must have arrow-up labels affixed on opposite sides of the outer container (per 49 CFR 172.312).
- In addition, all lab pack containers must have packing slips attached (per TSDF requirements).
- The waste tags and the lab pack inventories need to be sent to BCO Hazardous Waste Operations 1 week before the shipment date for submission and approval of vendor.
- Lab Pack inventories with approval codes from the disposal facility will be sent prior to shipment with the shipping package via FedEx by BCO Hazardous Waste Operations.

3.6. UNIVERSAL WASTE HANDLING

Materials considered to be Universal waste, such as batteries and light bulbs, can remain in the 90-day accumulation area up to 1 year after being placed in storage. While in accumulation, unbroken batteries and light bulbs are to be marked with the words "Universal Waste Batteries" and "Universal Waste Bulbs".

Broken light bulbs and broken batteries are considered hazardous waste and need to be labeled as Hazardous Waste. The less than 90-day accumulation time applies to these materials.

3.7. POLYCHLORINATED BIPHENYL (PCB)

The 90-day accumulation area is not permitted to store PCB material greater than 50 parts per million (PPM) for more than 30 days. The HWC should contact BCO Hazardous Waste Operations when PCB material is placed into the 90-day accumulation area to ensure compliance retention. BCO Hazardous Waste Operations will then reschedule the shipment date to accommodate regulatory limit, if needed. In addition to general labeling requirements in Section 3.3, PCB shipping containers also require;

- A unique container tracking number,
- Weight in kilograms,
- Out-of-service date, and
- PCB label.

3.8. SHIPPING OF WASTE

Shipping of hazardous waste is the responsibility of the HWC. The schedule for the transport and disposal of the waste must be arranged through BCO Hazardous Waste Operations.

- Once waste has been placed into the 90-day area, contact BCO Hazardous Waste Operations to schedule a shipment.
- An inventory of waste must be sent to BCO Hazardous Waste Operations at least one week prior to shipment, a uniform Hazardous Waste Manifest and other regulatory required forms will be sent via FedEx prior to shipment.
- Copies of the manifest are sent to the Massachusetts DEP by the HWC once the shipment is made.
- A signed copy of the manifest from the designated facility certifying they have received the waste should be sent to Battelle within 35 days of the shipment.
- If the returned manifest is not received within 35 days the HWC should inform BCO Hazardous Waste Operations.

3.9. SHIPMENT LOADING

- Select a location for vehicle loading/unloading and ensure the parking brake is set.

  Note: Weighted axle and one other axle of the transport vehicle shall be chocked. One wheel chock shall be applied in front of and behind each chocked wheel.

- Chock the wheels to prevent unexpected movement of the transport vehicle.
- Load the waste containers/materials onto the transport vehicle. The driver shall specify or approve of the placement of the containers in the transport vehicle in order to ensure proper weight distribution and segregation of hazardous materials.
- Ensure the completion of all shipping papers before the shipment proceeds. Upon completion, remove the wheel chocks.

3.10. STORAGE OF HAZARDOUS WASTE

As a large quantity generator, Battelle is not permitted to hold hazardous waste for more than 90 days after the waste initially enters the hazardous waste storage area. As required by 40 CFR 264.14, the area is to be clearly identified by a sign that reads DANGER - UNAUTHORIZED PERSONNEL KEEP OUT. The area must have a solid concrete floor and a surrounding lip that will retain any waste resulting from spills or leakage.

- The materials being stored must be segregated according to their hazard classes and other compatibility factors to avoid any potential dangers of mixing incompatible materials.
- Any chemical waste that meets the criteria of a hazardous waste per 40 CFR 261.21 through 261.24, 261.31, or 261.33 must be marked with the words "Hazardous Waste" and the accumulation start date.
- Additionally, Massachusetts has state hazardous wastes, including used oil, which are subject to the same requirements as federal hazardous wastes. Massachusetts state hazardous wastes are listed in 310 CMR 30.130
- Any chemical waste that does not meet the criteria of a DOT hazardous material or EPA hazardous waste must, during accumulation, must have adequate markings to describe the material in accordance with the Occupational Safety and Health Association's Hazard Communication Standard (29 CFR 1910.1200). Once packaged for shipment, such materials must have a non-RCRA waste label attached with the following statement, "Not a D.O.T. Regulated Material," on the shipping name blank. Any container holding used oil that does not contain a federal hazardous waste (i.e. any waste codes in addition to MA01) must be clearly labeled with the words "Used Oil."

3.11. INSPECTIONS

Inspections of the hazardous waste storage area and its contents are carried out by the HWC or HWH. These inspections occur every 7 days, and following any shipment of waste. The results are recorded on the Hazardous Waste Area Inspection Log (see Attachment 2). All records are collected by the HWC and kept in the Hazardous Waste File. These weekly inspection reports are kept on file for 3 three years from the date of inspection and a copy is submitted to the ES&H Officer.

3.12. PERSONNEL RESPONSIBILITIES

The ES&H Representative is responsible for ensuring the Battelle facility operates in accordance with internal, State, and Federal regulations as they relate to the environment, safety, and health. The ES&H Representative is responsible for:

- Developing training programs relative to job safety, health, and the proper handling of chemical and laboratory wastes.
- Monitoring the activities of the HWC and HWH.
- Performing routine inspections of the department facilities, including the hazardous waste areas.
- Making recommendations to upgrade safety, health, and environmental compliance-related deficiencies.
- Informing department personnel of recent developments in the above areas, which may affect operations.

In addition, the ES&H Officer coordinates departmental operations with BCO-ESH.

3.12.1. Hazardous Waste Coordinator

The HWC is responsible for overseeing the overall operation in accordance with Massachusetts Hazardous Waste Regulations (310 CMR 30.000). The responsibilities of the HWC include:

- Packaging and labeling of containers.
- Arranging for waste removal
- Maintaining manifest records and tracking the manifest until it's signed and returned
- Conducting weekly inspections of the waste area
- Ensuring the proper waste-handling materials and personal protective equipment are available and adequate
- Maintaining emergency spill response equipment

In addition, the HWC has primary responsibility for overseeing the collection and transfer of waste by the department waste handlers. Waste generated by other departments in the laboratory is labeled, picked up in their area by designated HWH, transferred to the waste storage area, and transferred into drums.

The HWC reports directly to his/her Section Manager, but is responsible for notifying the ES&H Representative if any problems encountered. In addition, the HWC keeps them informed of ongoing activities.

3.12.2. Hazardous Waste Handlers

The Hazardous Waste Handlers are responsible for monitoring the proper storage of wastes generated by their associated departments and the transfer of these materials to the Hazardous Waste Storage Area. Specific responsibilities include:

- Inspection of waste collection containers
- Labeling and pickup of wastes
- Transfer of wastes into proper storage containers
- Recording and reporting of these activities to the HWC
- Provisions of assistance with regards to spill response and emergency procedures

- Documentation of any accidental spills and remedial action taken.

4.0 SUMMARY OF CALCULATIONS

There are no calculations used in this procedure.

5.0 QUALITY CONTROL

There are no specific quality control requirements for this procedure.

6.0 TRAINING

The trainee must read and fully understand the policies and procedures outlined in this SOP. The trainee will then be given a demonstration of all aspects of this SOP. Next, the trainee will demonstrate the SOP procedures. Completion of training will be documented as outlined in the Quality Assurance Manual (QAM). Technicians may work independently once they have satisfactorily performed the procedures outlined in this SOP under direct supervision.

Staff members who perform waste related job duties including handling, classifying, segregating waste, consolidating material into shipping container, labeling packaging, creating shipping documents, signing shipping documents or otherwise handle waste after it has been placed in 90 day accumulation area for any purpose to ship or transfer material offsite or otherwise participating in functions that involve hazardous materials or emergency response must successfully complete all required training. Each staff member should keep a certificate of instruction or other supporting documentation.

The Training matrix is regulatory driven by State and Federal regulations and Battelle policies.

Training	**Frequency**
Contingency Plan for 90 day accumulation area	Annual
DOT/Battelle Specific Transportation Security Plan	2-years
Internal Operating Procedure review	Annual
Blood borne Pathogens	Annual
Respirator training and Fit Testing	Annual
SCBA training and Fit Testing	Annual
Physical	Annual
CPR/First Aid	3-years
Fire Extinguisher Initial Hands On Training	Annual review
40 hour HAZWHOPER	One time
8 hour HAZWOPER refresher	Annual

7.0 SAFETY

As part of the above training program, the analyst will be made aware of the particular safety concerns of this procedure, including:

- Use of protective eyewear and clothing
- Proper use of fume hoods
- Handling of hazardous chemicals and reagents
- Location and use of laboratory safety devices; eyewashes, emergency showers, fire extinguishers, fire blankets, and first aid kits, as well as MSDS sheets.

In addition to the safety precautions previously mentioned involving handling, transferring, and minor spill management, a current copy of the Contingency Plan for Hazardous Waste Accumulation Areas is accessible to staff members and has been distributed to public sectors per 40 CFR 265.54.

8.0 REFERENCES

None

ATTACHMENTS

Attachment 1	Revision History Log
Attachment 2	Waste Storage Area Inspection Log
Attachment 3	Chemical Compatibility Chart
Attachment 4	Waste Tag

APPROVALS

Author	Stephanie Mitchell	1/6/15
Technical Reviewer	Michael Meara 2015.01.06 14:32:43 -05'00'	
Quality Systems Manager		Zachary Willenberg 2015.01.06 16:29:43 -05'00'
Laboratory Manager		Jonathan Thorn 2015.01.07 08:04:32 -05'00'
	Name	Date

Attachment 1: Revision History

Version	Summary of Changes
02	SOP changes were not summarized for this revision.
03	SOP changes were not summarized for this revision.
04	SOP changes were not summarized for this revision.
05	SOP changes were not summarized for this revision.
06	SOP changes were not summarized for this revision.
07	SOP changes were not summarized for this revision.
08	SOP changes were not summarized for this revision.

Attachment 2: Waste storage area inspection log

Waste Storage Area Inspection Log

		DATE					
Use Post Shipment column if inspection is performed for post shipment Put date of inspection at the top of the column and a Pass/Fail grade	**MONTH 20__**						**Post Shipment**
CONTAINERS		**P/F**	**P/F**	**P/F**	**P/F**	**P/F**	
1)All containers closed or sealed properly?							
2)All containers leak-free?							
3)Any containers show signs of damage?							
4)All drums fully numbered and labeled?							
SCBA		**P/F**	**P/F**	**P/F**	**P/F**	**P/F**	
5)SCBA in working condition with no splits or cracks in lines							
AREA		**P/F**	**P/F**	**P/F**	**P/F**	**P/F**	
6)All warning signs posted?							
7)The floor free from severe cracks?							
8)Are there any cracks or damage to sidewalls?							
9)Is the Waste Transfer File in order?							
10)Are there extra labels available?							
SAFETY		**P/F**	**P/F**	**P/F**	**P/F**	**P/F**	
11)Is the pad free from standing water?							
12)Is the fire extinguisher present and full?							
13)Is the spill control equipment present?							
14)Is the transfer equipment present and in working order?							
15)Is there adequate space between drum for inspection?							
16)Is there adequate space between drum for access?							
Inspectors Initials							

Post Shipment	Yes	No	Oldest Accumulation start date in storage	N/A
17) Was all regulated waste removed from area during shipment?				

Accumulation start date	Date	N/A
18) Initial Accumulation start date for waste placed into storage prior to next 90 day shipment		

Attachment 2 (cont.) Waste storage area inspection log discrepancy form

TYPE OF DISCREPANCY:

(A separate form should be filled out for each discrepancy.)

☐ COLLECTION CONTAINERS ☐ STORAGE CONTAINERS
☐ STORAGE AREA ☐ SAFETY
☐ TRANSFER EQUIPMENT ☐ DOCUMENTATION

DESCRIPTION OF DISCREPANCY DATE: ______________________________

____

____

____

____

____

DATE: ____________________ REPORTED BY: ____________________

CORRECTIVE ACTION: ______________________________

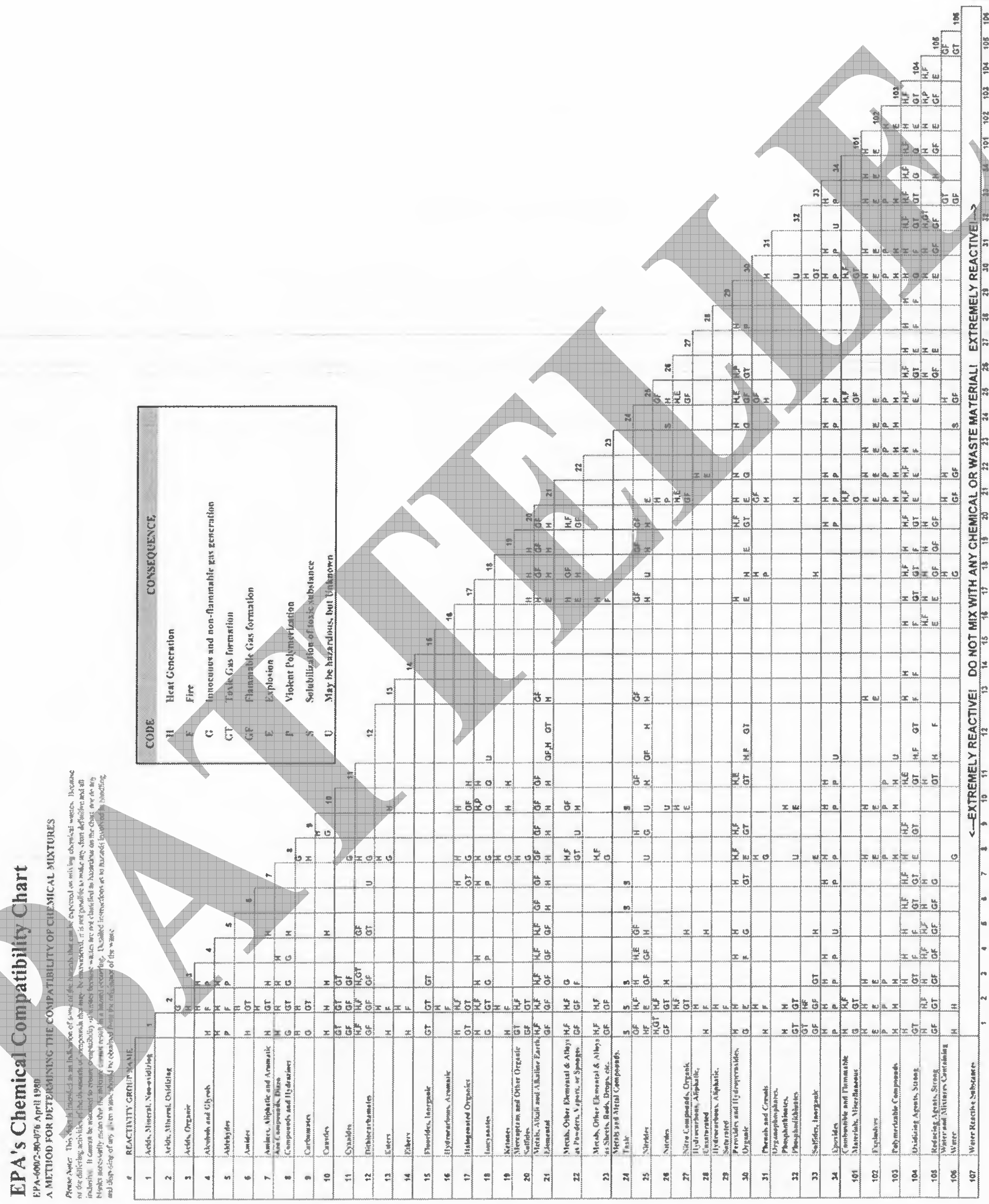
____

____

____

____

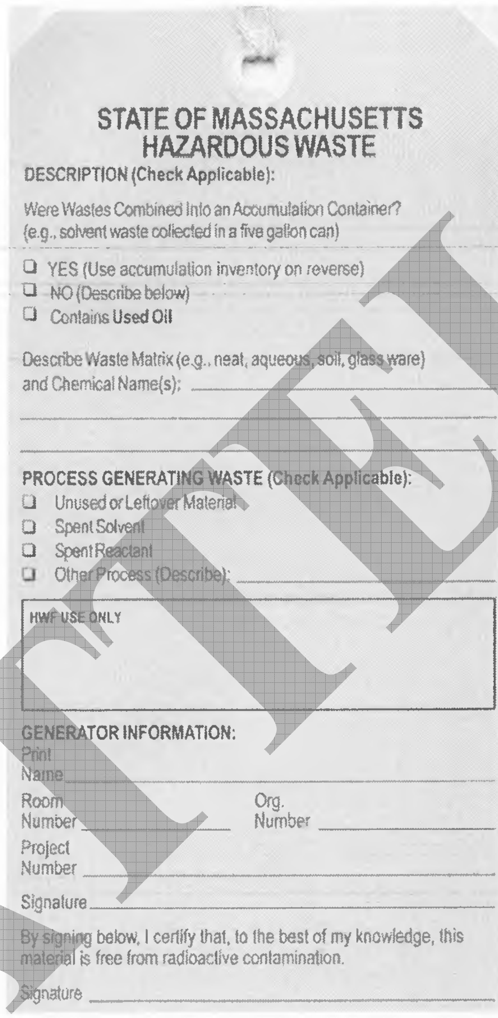
Attachment 3: Chemical Compatibility Chart



Attachment 4: Waste Tag

All portions of waste tag must be filled out completely

Use Additional space on back of tag if needed



STATE OF MASSACHUSETTS
HAZARDOUS WASTE

DESCRIPTION (Check Applicable):

Were Wastes Combined Into an Accumulation Container?
(e.g., solvent waste collected in a five gallon can)

- ❑ YES (Use accumulation inventory on reverse)
- ❑ NO (Describe below)
- ❑ Contains **Used Oil**

Describe Waste Matrix (e.g., neat, aqueous, soil, glass ware)
and Chemical Name(s): ______________________

PROCESS GENERATING WASTE (Check Applicable):

- ❑ Unused or Leftover Material
- ❑ Spent Solvent
- ❑ Spent Reactant
- ❑ Other Process (Describe): ______________

HWF USE ONLY

GENERATOR INFORMATION:

Print Name ______________________

Room Number ____________ Org. Number ____________

Project Number ______________________

Signature ______________________

By signing below, I certify that, to the best of my knowledge, this material is free from radioactive contamination.

Signature ______________________

Battelle
Standard Operating Procedure

for

ANALYSIS OF POLY AND PERFLUOROALKYL SUBSTANCES IN ENVIRONMENTAL SAMPLES BY LIQUID CHROMATOGRAPHY AND TANDEM MASS SPECTROMETRY (LC-MS/MS)

Summary of changes in this version: Updated several sections to comport with QSM 5.3. Updated section 5.2.4 and 5.2.5 to clarify instrument blanks and post spike and matrix duplicate analysis. Added section 5.4.4 to include additional information on ion ratios. Updated CAS numbers. Minor formatting changes. Clarified process for determination of sample volume. Updated recommended calibration ranges. Removed example branched chromatograms from Attachment 4, new Attachment 4 included detection limits. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the identification and quantification of perfluoroalkyl substances (PFASs) in environmental samples by liquid chromatography and tandem mass spectrometry (LC-MS/MS). This method was developed with consideration given to ASTM method 7968 (ASTM, 2014), EPA Method 537.1 (Shoemaker, Tettenhorst, Grimmett, & Boutin, 2018), and Sciex application notes for PFAS extraction and analysis (Simon, et al., 2016). Overarching quality guidance and method quality objectives for this method are taken from Departement of Defense (DoD Quality Systems Manual (QSM) for Environmental Laboratories Version 5.3, 2019) Table B-15.

2.0 METHOD SUMMARY

PFAS compounds are extracted and prepared for analysis utilizing the appropriate technique dependent on matrix (SOP 5-370). The extracts are analyzed by LC-MS/MS monitoring the primary transition for each target analyte, when available, a secondary transition is monitored for confirmation. The analytes are identified by the primary transition and retention time. The identified analytes are quantified using an isotopic dilution approach (where an isotopically labelled compound was not available for a target analyte, the labelled analog with the closet retention time (RT) or chemical similarity to the analyte is used for quantification (internal standard quantitation)). A data system interfaced to the LC-MS/MS is used to control acquisition and to store, retrieve, and manipulate LC-MS/MS data. This method provides specific procedures for the identification and measurement of the PFAS listed in Attachment 1. Individual projects may analyze all or a subset of the target analytes presented in this attachment.

3.0 EQUIPMENT AND SUPPLIES

The following equipment is required to perform the analytical method. Equivalent apparatus and materials may be substituted if approved by the laboratory and project managers.

- HPLC (Shimadzu LC20ADXR, Agilent 1260 SL, or equivalent)
- Tandem Mass Spectrometer (Sciex 6500, Sciex 5500, or equivalent)
- Analytical column (Phenomenex Gemini® C18 3 µm; 50 x 2 mm, part No. 00B-4439-B0, or equivalent)
- Delay Column (Phenomenex Luna® C18(2) 5 µm; 30 x 2 mm, part No. 00A-4252-B0, or equivalent)

4.0 REAGENTS AND STANDARDS

4.1 Reagents and Consumable Materials

The following Battelle SOPs outline reagent login, labeling, and storage that are applicable to this method:

5-015 (Solvent/Reagent Inventory and Contaminant Residue Checks)
5-027 (Analytical Standards in the Organics Laboratory)
5-217 (Labeling of Chemical Materials in the Laboratory)

4.1.1 Solvents and Reagents

- Methanol (HPLC grade, or equivalent)
- Ammonium Acetate (reagent grade, or equivalent)
- Reagent water (Millipore or equivalent)
- 20 mM Ammonium Acetate in Millipore water (mobile phase) – bring 1,540 mg of ammonium acetate to a final volume of 1 L with Millipore water. Due to potential volatility losses, this solution expires one week after preparation.

4.1.2 Consumables

- Polypropylene vials (Environmental Express part No. UC475-GN, or equivalent)
- 1 mL Polypropylene LC extract vials (Fisher Scientific part No. C4011-14, or equivalent)
- 800 µL Polypropylene LC extract vials (Fisher Scientific part No. C4011-11, or equivalent)
- 450 µL Polypropylene LC extract vials (Fisher Scientific part No. C4011-13, or equivalent)
- Snap caps (Fisher Scientific part No. C4011-50B, or equivalent)

4.2 Standards and Solutions

Standard preparation procedures for all calibration solutions are detailed in SOP 5-027. All prepared standards must be stored refrigerated and can be kept in screw-cap polypropylene vials. Standards are stored separately from samples. All stock solutions are prepared in 96% methanol in reagent water.

Selected analytes are commercially available as neat materials or as certified stock solutions as the ammonium, sodium, or potassium salts. While these are acceptable for purchase, the concentrations of the standards must be converted to the concentration of the acid form for use in calculations. Most vendors provide the concentrations of both the salt and the acid on the certificates of analysis, however, if the concentration of the acid is not provided, the concentration must be converted using the formula below.

$$Mass\ (acid\ form) = Mass\ (salt\ form) * \frac{MW\ (acid)}{MW\ (salt)}$$

4.2.1 Calibration Standards

Calibration standards should contain all individual target compounds. Primary stock solutions that contain the target analytes are purchased and used to prepare the Initial Calibration (ICAL), Continuing Calibration Verification (CCV), and Independent Calibration Check (ICC) standards. Most standards used for this method are purchased from standard providers (e.g., Sigma Aldrich and Wellington) in neat or solution form. Equivalent standards may be substituted if approved by the laboratory and project manager. All final calibration standards for this method are made in 80% methanol in reagent water. The ICC must be independent of the ICAL standards and thus should be made using either a standard from a different vendor or a standard from the same vendor with a lot number different from the ICAL standard. When commercially available, the calibration curve will contain both branched and linear isomers. Technical grade standards cannot be used for quantitative analysis.

The recommended calibration levels for the ICAL standards are presented in **Table 1** below. The concentration of the IS does not vary with each level. The lowest point of the calibration curve will be at or below the LOQ for all target analytes. The remaining concentration levels should not exceed the working range of the LC-MS/MS system. If concentrations of samples are above the calibration range, the extract will be diluted and re-analyzed.

Table 1*: Nominal Calibration Concentrations (ng/L)*

	L1	L2	L3	L4	L5	L6	L7
Targets	125	250	500	1,000	2,500	10,000	25,000
Labeled Analogues	1,250						
Internal Standard	1,250						

4.2.2 ICC Spiking Solution

The ICC spiking solution should include all target compounds proposed for analysis from a source independent from the initial calibration (if commercially available). The concentration should be at or near the midpoint of the initial calibration.

5.0 PROCEDURES

5.1 Sample Analysis

The extracts were analyzed under the conditions presented in Table 2.

***Table 2**: Analytical Parameters*

Column:	Phenomenex Gemini® C18 – 3 µm; 50 x 2 mm (analytical) Phenomenex Lina® C18(2) – 5 µm; 30 x 2 mm (delay)		
Column Temperature:	40 ºC (analytical), delay column installed between the pump mixing chamber and the column, outside of the column oven		
Injection Volume:	10 µL		
Flow Rate:	600 µL/min		
Mobile Phase A:	Millipore water with 20 mM ammonium acetate		
Mobile Phase B:	Methanol		
Analytical Run Time (end)	7.00 minutes		
	Time – minutes	% A	% B
	0.00	90	10
	0.10	45	55
	4.50	1	99
	4.95	1	99
	7.00	90	10
Ion Source:	Turbo Ion Spray		
Polarity:	Negative		
Ion Spray Voltage (IS):	-4500 v		
Collision Gas (CAD):	Medium		
Temperature (TEM):	450 °C		
Curtain Gas (CUR):	35 PSI		
Ion Source Gas 1 (GS1):	50 PSI		
Ion Source Gas 2 (GS2):	50 PSI		
Entrance Potential (EP):	10		

Multiple Reaction Monitoring (MRM) transitions are monitored for each analyte, labeled analogue, and internal standard using the scheduled MRM™ algorithm in the data acquisition software. The MRM transitions are collected inside of a 60 second window around the expected retention time to maximize the spectra scans collected.

The following quality control checks are required for analysis.

5.1.1 Mass Calibration

Prior to initial use and after performing major maintenance, calibrate the mass scale of the MS with calibration compounds as described by the instrument manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. This is performed during the scheduled 6-month preventative maintenance (PM) by an outside vendor. Mass calibration must be verified to be +/- 0.5 amu of the true value by acquiring a full scan continuum mass spectrum of a PFAS stock standard.

5.1.2 Tune Check

When the masses fall outside of the +/- 0.5 amu of the true values (as determined by the product ion formulas) the instrument must be retuned and verified. Sample analysis shall not proceed until the masses are within +/- 0.5 amu of the true values. This is performed after instrument re-tuning and during the scheduled 6-month PM by an outside vendor.

5.2 Peak Asymmetry Factor

Peak asymmetry factors must be calculated using the equation in Section 7 for the first two eluting peaks included in EPA method 537.1 (PFBS and PFHxA) in a mid-level calibration curve point. This factor must be calculated each time a new ICAL is performed. The peak asymmetry factor must be between 0.8 and 1.5. If the criteria are not met, change the initial mobile phase conditions to a higher aqueous content until the asymmetry ration for each peak is between 0.8 and 1.5 (modification of standard or extract composition to more aqueous content is not permitted).

5.3 Calibration

Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. The ICAL must be verified by analysis of an ICC immediately following the ICAL. A CCV is required at the beginning of each sample analysis sequence and after ten injections during the sample analysis sequence.

5.3.1 Initial Calibration

Analyze a minimum of five calibration standards that will represent the expected concentration range of the samples. Suggested standard concentrations are outlined in **Table 1** above.

For each level of calibration, calculate the correlation coefficient (r) with a weighted (1/x) regression (linear or quadratic) not forced through the origin (per EPA SW-846 Method 8000, weighted regressions should not be forced through the origin). for each analyte of interest in the calibration standard using the software supplied with the LC-MS/MS data system. The formula is provided in Section 7.0.

ICAL acceptance criteria
The ICAL criteria are:

- $r^2 > 0.99$ for each analyte
- Minimum of 5 points for a linear curve fitting
- Minimum of 6 points for a quadratic curve fitting
- Each target compound must be within 70% – 130% of their true value
- Extracted Internal Standards and Injection Internal standard (if used to quantify Extracted Internal Standard concentrations) area must be within +/- 50% of the Mid-Point of the calibration curve

If these requirements are not met for the ICAL, corrective action is performed and the calibration is repeated.

PFHxS, PFOS, NMeFOSAA, and NEtFOSAA may contain branched and linear isomers. All peaks present must be integrated and included in the total area used to for calculations of curve fittings.

5.3.2 Independent Calibration Check

Verify the ICAL with an ICC immediately after the ICAL is completed. The ICC is analyzed under the same analytical conditions used in the ICAL and for the analysis of samples.

ICC Target Analyte Performance Criteria

The ICC criteria are:

- Individual %DIFF ≤ 30%
- Extracted Internal Standards and Injection Internal standard (if used to quantify Extracted Internal Standard concentrations) area must be within +/- 50% of the Mid-Point the calibration curve

If ICC meets the above criteria, then the ICAL is assumed to be valid. If the criteria are not met, reanalyze the ICC. If the second ICC fails, a new ICAL must be performed or justification for continuing must be documented.

5.3.3 Continuing Calibration Verification

The ICAL is verified at least at the beginning and end of each 12-h period during which analyses are to be performed. The CCV is analyzed under the same analytical conditions used for the ICAL and ICC. The appropriate CCV solution is analyzed, quantified, and assessed as described below.

CCV Target Analyte Performance Criteria

The CCV criteria are:

- Frequency: beginning of each sample analysis sequence (if not preceded by and ICC) and after 10 injections during sample analysis sequence
- Individual % DIFF ≤ 30%
- Extracted Internal Standards and Injection Internal standard (if used to quantify Extracted Internal Standard concentrations) area must be within +/- 50% of the Mid-Point the calibration curve

If CCV meets the above criteria, then the ICAL is assumed to be verified. Proceed with the analysis of samples. When a CCV fails to meet any of the above criteria, two additional CCV's are analyzed consecutively. If both additional CCV's pass criteria, the samples can be reported. If either of the two additional CCV's fail criteria or cannot be analyzed all samples that were analyzed after the prior acceptable CCV must be re-analyzed. If a CCV fails because a target analyte exceeded the acceptance limit defined above (over response only) and that analyte was not detected in any samples, then the samples do not need to be reanalyzed. In all other cases, the sample must be reanalyzed after an acceptable CCV has been established or justification for continuing is approved by the project manager and documented.

For successive continuing calibrations, vary the CCV standard concentration (between LOQ and mid-level calibration concentration).

5.3.4 Instrument Blank (IB)

An instrument blank must be analyzed immediately following the highest calibration standard analyzed and daily prior to sample analysis. Any concentration that can be determined for each analyte must be ≤ ½ of the LOQ. The instrument blank includes extracted internal standards and injection internal standards. The extracted internal standards and injection internal standards must meet the criteria defined in section 5.3.8 and 5.3.9. If acceptance criteria are not met, verify that instrument autosampler is functioning properly and correct, if needed. If the instrument autosampler is functioning properly, a calibration using a lower concentration for the highest standard will be used until acceptance criteria is met.Additional IB samples will be analyzed until acceptance is met.

5.3.5 Post Spike and Matrix Duplicate Samples

Post spike and Matrix Duplicate (MD) sample analysis is not required for samples processed via solid phase extraction (SPE). If direct injection analysis is required for high level samples (i.e. AFFF formulations, the post spike and MD samples will be addressed in the Project Plan to meet the requirements of QSM 5.3 (or later versions) Table B-15.

5.3.6 Technical Grade Standards

A solution of technical grade PFOA will be run after each calibration to verify that potential branched transitions are collected during analysis. Branched isomers will be quantified vs. the linear isomer unless the calibration contains branched isomers.

5.3.7 Instrument Sensitivity Check (ISC)

An instrument sensitivity check at a concentration no greater than the LOQ value is analyzed to verify instrument sensitivity. The analyte concentrations must be within 30% of their true values. An ISC must be analyzed prior to sample analysis and at least every twelve hours during sample analysis. No samples can be analyzed until the ISC has met criteria. The ISC can be used as a CCV during analysis.

5.3.8 Labeled Analogues (Extracted Internal Standards)

The labeled analogues used for quantification must be added prior to extraction (extractions detailed in SOP 5-370). The extracted internal standard area for all injections must be within +/- 50% of the internal standard area of the mid-oint of the ICAL. When the calibration is not performed on the same day as the analysis, the area must be within +/- 50% of the area of the daily initial CCV. If the area are acceptable in QC samples but not field samples, the field samples must be repreped and reanalyzed as a greater dilution may be needed. If recoveries of the QC samples are not acceptable, the problem must be corrected and all associated samples must be reanalyzed. The data will be qualified and discussed in the case narrative only if the reanalysis confirms the failures.

If required, recoveries must be between 50% – 150% of their true value. Recoveries are only calculated if required by the client. If the recoveries are acceptable in QC samples but not field samples, the field samples must be repreped and reanalyzed as a greater dilution may be needed. If recoveries of the QC samples are not acceptable, the problem must be corrected and all associated samples must be reanalyzed. The data will be qualified and discussed in the case narrative only if the reanalysis confirms the failures.

5.3.9 Internal Standard Area (Injection Internal Standards)

The internal standard area for all injections must be within +/- 50% of the internal standard area of the L5 of the ICAL. When the calibration is not performed on the same day as the analysis, the area must be within +/- 50% of the area of the daily initial CCV. Internal standard areas are only required if the recoveries of the extracted internal standards are required. If the area of a sample extract fails criteria, corrective action must be taken. Corrective action includes analyzing a second aliquot of sample, if available, or reanalysis of the original extract. If the second analysis passes criteria, the second analysis will be reported. If the IS are fails after additional analysis, either value can be reported with the appropriate data qualifier and discussed in the case narrative.

5.3.10 Retention Time Windows

Retention time (RT) windows are set at the beginning of each new ICAL and at the beginning of a new analytical sequence. The RT is set using the midpoint standard of the ICAL, if an ICAL is not run, the initial CCV of the sequence is used. RT for each analyte and extracted internal standard in the samples must fall within 0.4 minutes (24 seconds) of the predicted RT.

Analytes must elute within 0.1 minutes (6 seconds) of the associated extracted internal standard. This criterion applies only to native compounds with a direct labeled analog.

5.4 Sequence of Analysis

An analysis sequence is initiated with an acceptable ICAL and ICC (if necessary) or an acceptable CCV followed by the appropriate number of samples to be analyzed and ending with a CCV. The sequence may be continued with another group or groups of samples and CCVs provided the CCV results remain within the acceptance criteria (reference Section 5.2.3). All QC and authentic samples must be bracketed by acceptable CCVs or ICAL.

The order of calibration and analysis is as follows (if a new ICAL is needed):

a. Methanol
b. ICAL
c. IB
d. ICC
e. Branched Standard
f. Methanol
g. Sample analysis sequence
h. CCV or ISC (ISC required every 12 hours, otherwise CCV is varied from L2 –L7 of calibration curve; ISC is any standard between L2 and L5 of the calibration curve)
i. Methanol

Repeat g, h, and i for continued analysis of QC and authentic samples if g and h continue to pass criteria.

When a new ICAL is not needed, analysis must start with a high standard followed by a IB and an ISC sample.

5.5 Sample Analysis

Samples are run under the same conditions as the ICAL. Start the analysis of samples with quality control samples.

5.5.1 Qualitative Identification of Individual Target Compounds

Sample peaks are identified visually using the MultiQuant™ display program. Sample peaks should fall within the established retention time window. A narrative must accompany any target analyte selected that falls outside its retention time window. For peak identification, the experience of the analysts should weigh heavily in the interpretation of data.

Identify the target compounds (Attachment 2) based on retention time established during the calibration and the transitions presented in Attachment 3. Comparison of both retention times and transitions to reference standard is also useful in compound identification.

5.5.2 Mass Spectral Acquisition Rate

A minimum of 10 spectra scans are acquired for each peak.

5.5.3 Ion Transitions

With the exception of PFBA and PFPeA, two transitions and the ion transition ratio will be monitored for each target analyte and reported. Transitions are defined in **Attachment 3**. Two transitions are not required for labeled analogues and internal standards.

5.5.4 Ion Ratios

The MultiQuant software calculates the ion ratio for each analyte using a weighted average (1/x) of the areas for the secondary transition divided by the primary transition. The ion ratio is recalculated for each initial calibration. Ion ratios are monitored and any ratio excceding 50% difference to the expected ion ratio is documented in the case narrative.

5.5.5 Signal to Noise Ratio

A minimum signal to noise ratio of 10:1 is required for all ion transitions used for quantification. Analytes must have a signal to noise ratio of at least 3:1 for the confirmatory transition.

5.5.6 Quantification of Analytes

Identify target analyte peaks that match retention times and other criteria above. Confirm the auto-baseline on the quantification ions or redraw the baselines, as necessary. Quantify each peak following procedures presented in the instrument manufacturer user's manual and Battelle SOP 4-038.

Quantification of analytes identified in samples will be performed by the isotopic dilution method, using the appropriate curve fitting from the ICAL. See Section 7.0 for additional information regarding calculations used for the determination of target analyte concentrations in samples. Upon selection of the appropriate calibration option and the identification of a peak, the MultiQuant™ software calculates the compound amounts from the peak areas, as described in Section 7.0. Review the results against calibration standards and other project samples for reasonableness.

PFHxS, PFOS, NMeFOSAA, and NEtFOSAA may contain branched and linear isomers. All peaks present must be integrated and included in the total area used to for calculations of sample concentrations.

5.5.7 Manual Integrations

Using the MultiQuant™ software, identify target analyte peaks that match retention time and other criteria above. Confirm acceptance of the MultiQuant™ auto-baseline for the peak or redraw the baseline, as necessary. Manual integrations will be used to separate near co-eluted peaks, remove negative peaks, and compensate for other peak shape or baseline anomalies that often occur in environmental samples. Guidance for manual integrations is provided in SOP 4-038.

> *DoD projects*:
> The rationale for manual integrations must be documented in the data package; samples and analytes which required manual integrations must be identified in the case narrative.

5.5.8 Reporting Units

Reporting units are ng/L for water and ng/g for soil, sediments, and tissues unless the QAPP specifies otherwise. Soils and sediments are typically reported on a dry weight basis while tissues are reported on a wet weight basis.

6.0 QUALITY CONTROL

LC Facility operations are documented according to SOP 6-025. Electronic files of all calibrations and sample data are kept in project specific network folders (SOP 6-032). Analysis of quality control samples including Procedural Blank (PB), Laboratory Control Sample (LCS), laboratory Control Sample Duplicate (LCSD), Matrix Spike (MS), Matrix Spike Duplicate (MSD), Duplicate (DUP), and Triplicate (TRP) are specified in the QAPP. The quality control acceptance criteria will follow the criteria outlined in SOP 7-029 unless modified in the QAPP. Key elements of the quality control program include:

1. There must be an initial calibration of the instrument as specified in 5.

2. Each day that analysis is performed, the calibration verification standard should be evaluated to determine if the chromatographic system is operating properly.

3. It is recommended each day that analysis is performed, an instrument blank should be evaluated to determine if the chromatographic system is free of contamination.

4. Peak shape should be evaluated for proper peak shape and symmetry.

5. The instrumental response should be comparable to previous calibrations.

6. The system must be recalibrated at method setup and after major maintenance.

> *DoD projects*:
> The analysis, frequency, and acceptance criteria of quality control samples will be determined in the latest revision of the Quality Systems Manual.

7.0 DATA ANALYSIS AND CALCULATIONS

7.1 Initial Calibration

Correlation Co-efficient

$$r = \left(\sum w \sum wyy_c - \sum wy \sum wy_c\right) / \sqrt{\left(D_y D_{yc}\right)}$$

where:

$$D_y = \sum w \sum wy^2 - \left(\sum wy\right)^2$$

y_c = calculated y-value using the equation below:

$$D_{yc} = \sum w \sum wy_c^2 - \left(\sum wy_c\right)^2$$

Linear Regression Method

- Y = mX + b

  which is equivalent to: A_A/A_{IS} = [[m H (C_A/C_{IS})] + b]

- C_A = [(A_A/A_{IS}) b] H (C_{IS}/m)

The slope and intercept are calculated as:

$$m = \left(\sum w \sum wxy - \sum wx \sum wy\right) / D_x$$

$$b = \left(\sum wx^2 \sum wy - \sum wx \sum wxy\right) / D_x$$

Where:

$$D_x = \sum w \sum wx^2 - \left(\sum wx\right)^2$$

Weighting Type Weight (w)
1 / x	If $|x| < 10^{-5}$, then $w = 10^5$. Otherwise, $w = 1 / |x|$.

7.2 Calibration Verification

Calculate the percent difference (%DIFF) between the calculated amount ("found" amount) and the true amount using the equation below:

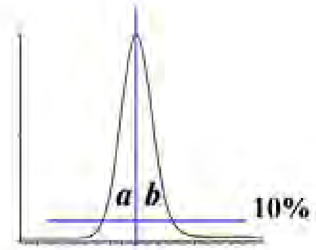
$$\%DIFF = \frac{(A_C - A_I)}{A_I} * 100\%$$

Where:
A_I = "true" analyte amount
A_C = "found" analyte amount

7.3 Peak Asymmetry

Peak asymmetry is calculated using:

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



where:

A_s = peak asymmetry factor

B = width of the back half of the peak measured (at 10% peak height) from the trailing edge of the peak to a line dropped perpendicularly from the peak apex

a = the width of the front half of the peak measured (at 10% peak height) from the leading edge of the peak to a line dropped perpendicularly from the apex.

7.4 Quantification of Samples

Samples are quantified as detailed in Section 5. The concentration of target analytes is determined using the following equation:

$$x = (y - b) / m$$

8.0 TRAINING

The trainee must read and fully understand the policies and procedures outlined in this SOP and have documented training in Battelle SOPs 4-038 and 6-025. Training for these SOPs should be documented according to procedures outlined in the Quality Assurance Manual. The trainee will then be given a demonstration of all aspects of this SOP.

Analysts may work independently once they have satisfactorily performed the following training:

- Demonstrate ability to set up the instrument and perform routine maintenance
- Analyze an acceptable initial calibration
- Analyze at least four LCS samples concurrently or over a period of days that meet the criteria outlined in SOP 7-029.

When training is completed, the trainee will be issued a Demonstration of Capability (DOC) Certificate (SOP 2-011). The original completed training certificate and all supporting documentation will be stored in the Chemistry files.

Analysts must also demonstrate annual proficiency in the method. SOP 2-011 (Staff Training) outlines the acceptable performance procedures. When annual training is completed, the analyst will be issued a DOC Certificate.

9.0 SAFETY

All LC-MS/MS operators must be experienced with the operation and maintenance of the LC-MS/MS system.

- Protective clothing should be worn when appropriate.
- Proper care must be exercised when using syringes.
- Certain areas of the LC-MS/MS system are heated zones and bodily contact with these zones should be avoided.
- High voltages exist in certain marked areas of the LC-MS/MS system and bodily contact with these areas is to be avoided.
- Care should be taken when using solvents in and around the LC system.

10.0 POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Staff should make every effort to use the minimum amount of sample and reagent for this analytical procedure. All samples and reagents are contained and disposed of in an appropriate manner (Section 12).

11.0 CORRECTIVE ACTION

Battelle maintains a corrective action program that is detailed in SOP 4-035. The Laboratory Manager must approve all corrective actions initiated within the laboratory. The effectiveness of corrective actions is verified by the Quality Assurance Unit.

12.0 WASTE MANAGEMENT

All waste streams generated within the laboratory are collected and stored in an appropriate container and disposed according to SOP 5-114 or when appropriate, by other approved waste management procedures.

13.0 INTERFERENCES

Method inferences may be caused by contaminants in solvents, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baselines in chromatograms. All solvent/reagents must be analyzed initially to demonstrate they are free from interferences (SOP 5-015). Glassware must be scrupulously cleaned following the procedures outlined in SOP 5-216. The use of high purity reagents and solvents helps to minimize these interference problems. Significant effort must be taken to ensure no PTFE or other surface containing PFAS comes in contact with the materials or equipment in the sample pathway from preparation to analysis.

Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending on the nature and diversity of the sample. Specific to PFOS analysis in tissues, the transition 499 → 80 from taurodeoxycholic acid (TDCA) may interfere with quantification. The transition 499 → 107 will be monitored for the presence of TDCA, if present, the quantification of PFOS will be performed using the confirmation transition of 499 → 99.

Cross-contamination can occur whenever high-level and low-level samples are analyzed sequentially. Whenever an unusually concentrated sample is analyzed, the samples following it may need re-analysis if cross-contamination is suspected. The LC system may require maintenance if it has been exposed to high level samples.

14.0 DEFINITIONS

Battelle's methodology terms are consistent with the The NELAC Institute (TNI) Glossary of Terms outlined in the TNI Constitutions, Bylaws and Standards Manual. The TNI Glossary of Terms currently being utilized by Battelle is outlined in Attachment B of Battelle's Quality Assurance Manual. Battelle's method detection terminology is defined in SOP 5-291 and quality control terminology in SOP 7-029.

15.0 METHOD DETECTION LIMITS

Battelle maintains a program for determining and verifying method detection limits (MDL), LOD, LOQ, and reporting limit (RL) values. The policies and procedures are defined in SOP 5-291 and Battelle's Quality Assurance Manual. All MDL, LOD, and LOQ study results are accessible within the laboratory network files. All reporting limits are based on the low standard of the calibration curve, sample dilutions and sample size.

16.0 METHOD PERFORMANCE

Battelle maintains a program for determining method performance. The policies and procedures are outlined in SOP 5-295 and Battelle's Quality Assurance Manual. The Laboratory Manager must approve all new methodologies before use.

17.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA

Battelle maintains a program for assessing data and determining acceptance criteria for quality control measures. These policies and procedures are outlined in SOP 7-029 and in Battelle's Quality Assurance Manual. Battelle also maintains a program for handling out-of-control or unacceptable data. These policies and contingencies are outlined in SOP 4-035, SOP 7-029, and Battelle's Quality Assurance Manual.

18.0 REFERENCES

ASTM. (2014). *D7968: Standard Test Method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Sectrometry (LC/MS/MS).* West Conshohocken: ASTM.

DoD Quality Systems Manual (QSM) for Environmental Laboratories Version 5.3. (2019). Department of Defense (DoD).

Shoemaker, J. A., Tettenhorst, D. R., Grimmett, P. E., & Boutin, B. K. (2018). *Method 537.1 Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).* Cincinnati: EPA.

Simon, R., KC, H., Craig, B., Scott, K., Eric, R., & Christopher, B. (2016). *Quantitation of PFASs in Water Samples Using LC/MS/MS: Large-Volume Direct Injection and Solid Phase Extraction.* Framingham: Sciex.

ATTACHMENTS

Attachment 1 Revision History
Attachment 2 PFAS Target Analyte List
Attachment 3 Acquisition Parameters and Transitions
Attachment 4 DL/LOD/LOQ Values

APPROVALS:

	Name	Date
Author Jonathan Thorn		Digitally signed by Jonathan Thorn Date: 2019.10.15 14:44:32 -04'00'
Technical Reviewer Denise Schumitz		Digitally signed by Denise Schumitz Date: 2019.10.15 14:54:17 -04'00'
Quality Systems Manager Zachary Willenberg		Digitally signed by Zachary Willenberg Date: 2019.10.15 14:57:37 -04'00'
Laboratory Director Jonathan Thorn		Digitally signed by Jonathan Thorn Date: 2019.10.15 14:44:44 -04'00'

ATTACHMENT 1

Revision History

Version	Summary of Changes
02	Removed sample preparation methods from SOP (moved to SOP 5-370). Updated analytical method. This method is not equivalent to the previous analytical method, new Demonstrations of Capability (DOC) will be needed for this version of the SOP. Revision history added as **Attachment 1**.
03	Updated the analyte list and corrected an error in the labeling of the branched isomer examples This method is equivalent to the previous version, a new Demonstration of capability (DOC) will not be needed for this version.
04	Added three target analytes to the analyte list, expanded the list of labeled analogs and internal standards used. Clarified section on post spike samples and Matrix Duplicate samples. This revision requires a new Demonstration of capability (DOC) for the additional analytes.
05	Primary transition for PFHpS updated. The storage of prepared standards updated.
06	Secondary transition for PFHpS updated. Updated internal standard area criteria to use level 5 of the calibration curve. Updated section 5.3 to define calibration points for the CCV and ISC samples.
07	Added seven new analytes to the method. Updated the example chromatograms for branched isomers. With the exception of the new analytes, this SOP is considered technically equivalent to the previous SOP version based on the summary of changes to this version and therefore IDCs and ODCs performed under the previous SOP version also demonstrate proficiency in this version.

ATTACHMENT 2

PFAS Target Analyte List

Analyte	Code	CAS No.	Quant Standard
Perfluoro-n-butanoic acid	PFBA	375-22-4	$^{13}C_4$-PFBA
Perfluoro-n-pentanoic acid	PFPeA	2706-90-3	$^{13}C_5$-PFPeA
Perfluororhexanoic acid	PFHxA	307-24-4	$^{13}C_5$-PFHxA
Perfluoroheptanoic acid	PFHpA	374-85-9	$^{13}C_4$-PFHpA
Perfluorooctanoic acid	PFOA	335-67-1	$^{13}C_8$-PFOA
Perfluorononanoic acid	PFNA	375-95-1	$^{13}C_9$-PFNA
Perfluorodecanoic acid	PFDA	335-76-2	$^{13}C_6$-PFDA
Perfluoroundecanoic acid	PFUnA	2058-94-8	$^{13}C_7$-PFUnA
Perfluorododecanoic acid	PFDoA	307-55-1	$^{13}C_2$-PFDoA
Perfluorotridecanoic acid	PFTrA	72629-94-8	$^{13}C_2$-PFTeDA
Perfluorotetradecanoic acid	PFTeDA (PFTA)	376-06-7	$^{13}C_2$-PFTeDA
N-methylperfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	d3-MeFOSAA
N-ethylperfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	d5-EtFOSAA
Perfluoro-1-octanesulfonamide	PFOSA	754-91-6	$^{13}C_8$-FOSA
Perfluororbutanesulfonic acid	PFBS	375-73-5	$^{13}C_3$-PFBS
Perfluororpentanesulfonic acid	PFPeS	2706-91-4	$^{13}C_3$-PFHxS
Perfluororhexanesulfonic acid	PFHxS	3781-99-6	$^{13}C_3$-PFHxS
Perfluororheptanesulfonic acid	PFHpS	375-99-6	$^{13}C_3$-PFHxS
Perfluorooctanesulfonic acid	PFOS	1763-23-1	$^{13}C_8$-PFOS
Perfluorornonanesulfonic acid	PFNS	98789-57-2	$^{13}C_8$-PFOS
Perfluorordecaanesulfonic acid	PFDS	2806-15-7	$^{13}C_8$-PFOS
1H,1H,2H,2H-Perfluorohexane sulfonate	4:2 FTS	757124-24-4	$^{13}C_2$-4:2FTS
1H,1H,2H,2H-Perfluorooctane sulfonate	6:2 FTS	27619-97-2	$^{13}C_2$-6:2FTS
1H,1H,2H,2H-Perfluorodecane sulfonate	8:2 FTS	39108-34-4	$^{13}C_2$-8:2FTS
3-perfluoropropyl propanoic acid	3:3 FTCA	356-02-5	$^{13}C_5$-PFHxA
3-perfluoropentyl propanoic acid	5:3 FTCA	914637-49-3	$^{13}C_8$-PFOA
3-perfluoroheptyl propanoic acid	7:3 FTCA	812-70-4	$^{13}C_6$-PFDA
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	$^{13}C_3$-HFPO-DA
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	$^{13}C_3$-HFPO-DA
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	$^{13}C_3$-HFPO-DA
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	$^{13}C_3$-HFPO-DA
Labeled Analogues			
Perfluoro-n-[1,2,3,4-$^{13}C^4$]butanoic acid	$^{13}C_4$-PFBA	BDO-2105	$^{13}C_3$-PFBA
Perfluoro-n-[$^{13}C^5$]pentanoic acid	$^{13}C_5$-PFPeA	BDO-2216	$^{13}C_3$-PFBA
Perfluoro-n-[1,2,3,4,6-$^{13}C_5$]hexanoic acid	$^{13}C_5$-PFHxA	BDO-2217	$^{13}C_2$-PFOA
Perfluoro-n-[1,2,3,4-$^{13}C_4$]hepetanoic acid	$^{13}C_4$-PFHpA	BDO-2218	$^{13}C_2$-PFOA
Perfluoro-n-[$^{13}C_8$]octanoic acid	$^{13}C_8$-PFOA	BDO-2219	$^{13}C_2$-PFOA

Analyte	Code	CAS No.	Quant Standard
Perfluoro[$^{13}C_9$]nonanoic acid	$^{13}C_9$-PFNA	BDO-2221	$^{13}C_2$-PFOA
Perfluoro[1,2,3,4,5,6-$^{13}C_6$]decanoic acid	$^{13}C_6$-PFDA	BDO-2222	$^{13}C_2$-PFDA
Perfluoro[1,2,3,4,5,6,7-$^{13}C_7$]undecanoic acid	$^{13}C_7$-PFUnA	BDO-2223	$^{13}C_2$-PFDA
Perfluoro[1,2-$^{13}C_2$]dodecanoic acid	$^{13}C_2$-PFDoA	BDO-2112	$^{13}C_2$-PFDA
Perfluoro[1,2-$^{13}C_2$]tetradecanoic acid	$^{13}C_2$-PFTeDA	BDO-2224	$^{13}C_2$-PFDA
N-methyl-d3-perfluorooctanesulfonamidoacetic acid	d3-MeFOSAA	BDO-2125	$^{13}C_4$-PFOS
N-ethyl-d5-perfluorooctanesulfonamidoacetic acid	d5-EtFOSAA	BDO-2126	$^{13}C_4$-PFOS
Perfluoro[$^{13}C_8$]octanesulfonamide	$^{13}C_8$-FOSA	BDO-2225	$^{13}C_4$-PFOS
perfluoro[2,3,4-$^{13}C_3$] butanesulfonic acid	$^{13}C_3$-PFBS	BDO-2226	$^{13}C_4$-PFOS
perfluoro[1,2,3-$^{13}C_3$]hexanesulfonic acid	$^{13}C_3$-PFHxS	BDO-2227	$^{13}C_4$-PFOS
perfluoro[13C_8]octanesulfonic acid	$^{13}C_8$-PFOS	BDO-2228	$^{13}C_4$-PFOS
1H,1H,2H,2H-perfluoro[1,2-$^{13}C_2$]hexanesulfonate	$^{13}C_2$-4:2FTS	BDO-2229	$^{13}C_4$-PFOS
1H,1H,2H,2H-perfluoro[1,2-$^{13}C_2$]octanesulfonate	$^{13}C_2$-6:2FTS	BDO-2230	$^{13}C_4$-PFOS
1H,1H,2H,2H-perfluoro[1,2-$^{13}C_2$]decanesulfonate	$^{13}C_2$-8:2FTS	BDO-2220	$^{13}C_4$-PFOS
[$^{13}C_3$]Hexafluoropropylene oxide dimer acid	$^{13}C_3$-HFPO-DA	BDO-2276	$^{13}C_2$-PFOA
Internal Standards			
Perfluoro[2,3,4-$^{13}C_3$]butanoic Acid	$^{13}C_3$-PFBA	BDO-2231	NA
Perfluoro[1,2-$^{13}C_2$]octanoic acid	$^{13}C_2$-PFOA	BDO-2107	NA
Perfluoro[1,2-$^{13}C_2$]decanoic acid	$^{13}C_2$-PFDA	BDO-2110	NA
Perfluoro[1,2,3,4-$^{13}C_4$]octanesulfonic acid	$^{13}C_4$-PFOS	BDO-2121	NA
Potential Interferences			
Taurodeoxycholic acid	TDCA	1180-95-6	NA

ATTACHMENT 3

Acquisition Parameters and Transitions

	Primary Transition		Confirmation Transition			
Analyte Code	Q1	Q3	Q1	Q3	**DP**	**CE**
PFBA	213	169	NA	NA	25	12
PFPeA	263	219	NA	NA	20	12
PFHxA	313	269	313	119	25	12
PFHpA	363	319	363	169	25	12
PFOA	413	369	413	169	25	14
PFNA	463	419	463	219	25	14
PFDA	513	469	513	219	25	16
PFUnA	563	519	563	269	25	18
PFDoA	613	569	613	319	25	18
PFTrA	663	619	663	169	25	20
PFTeDA	713	669	713	169	25	22
NMeFOSAA	570	419	570	512	40	36
NEtFOSAA	584	419	584	483	50	36
PFOSA	498	78	498	83	60	85
PFBS	299	80	299	99	35	48
PFPeS	349	99	349	80	35	48
PFHxS	399	80	399	99	60	74
PFHpS	449	80	449	99	65	88
PFOS	499	80	499	99	65	108
PFNS	549	99	549	80	50	120
PFDS	599	80	599	99	85	118
4:2 FTS	327	307	327	80	50	32
6:2 FTS	427	407	427	81	50	32
8:2 FTS	527	507	527	487	50	40
3:3 FTCA	241	177	NA	NA	12	12
5:3 FTCA	341	237	NA	NA	30	20
7:3 FTCA	441	337	NA	NA	50	18
HFPO-DA	285	169	285	118	12	8
ADONA	377	251	377	85	14	12
11Cl-PF3OUdS	631	451	631	83	40	24
9Cl-PF3ONS	531	351	531	83	40	24
$^{13}C_4$-PFBA	217	172	NA	NA	15	10
$^{13}C_5$-PFPeA	268	223	NA	NA	20	15
$^{13}C_5$-PFHxA	318	273	NA	NA	20	15
$^{13}C_4$-PFHpA	367	322	NA	NA	20	15
$^{13}C_8$-PFOA	421	376	NA	NA	20	15
$^{13}C_9$-PFNA	472	427	NA	NA	20	15
$^{13}C_6$-PFDA	519	474	NA	NA	20	15
$^{13}C_7$-PFUnA	570	525	NA	NA	20	15
$^{13}C_2$-PFDoA	615	570	NA	NA	25	18
$^{13}C_2$-PFTeDA	715	670	NA	NA	20	15
d3-MeFOSAA	573	419	NA	NA	40	36

Analyte Code	Primary Transition		Confirmation Transition		DP	CE
	Q1	Q3	Q1	Q3		
d5-EtFOSAA	589	419	NA	NA	40	36
$^{13}C_8$-FOSA	506	78	NA	NA	65	108
$^{13}C_3$-PFBS	302	99	NA	NA	45	65
$^{13}C_3$-PFHxS	402	99	NA	NA	50	75
$^{13}C_8$-PFOS	507	99	NA	NA	65	108
$^{13}C_2$-4:2FTS	329	81	NA	NA	50	75
$^{13}C_2$-6:2FTS	429	81	NA	NA	50	75
$^{13}C_2$-8:2FTS	529	81	NA	NA	50	75
$^{13}C_3$-HFPO-DA	287	169	NA	NA	10	6
$^{13}C_3$-PFBA	216	172	NA	NA	40	20
$^{13}C_2$-PFOA	415	370	NA	NA	25	14
$^{13}C_2$-PFDA	515	470	NA	NA	25	16
$^{13}C_4$-PFOS	503	99	NA	NA	75	100
TCDA	NA	NA	499	107	NA	NA

Attachment 4
MDL/LOD/LOQ Values[1]

Non-potable water:

Analyte	CAS No.	MDL (ng/L)	LOD (ng/L)	LOQ (ng/L)
PFBA	375-22-4	0.14	0.5	5.0
PFPeA	2706-90-3	0.31	1.0	5.0
PFHxA	307-24-4	0.19	0.5	5.0
PFHpA	375-85-9	0.16	0.5	5.0
PFOA	335-67-1	0.18	0.5	5.0
PFNA	375-95-1	0.26	1.0	5.0
PFDA	335-76-2	0.16	0.5	5.0
PFUnA	2058-94-8	0.29	1.0	5.0
PFDoA	307-55-1	0.18	0.5	5.0
PFTrDA	72629-94-8	0.15	0.5	5.0
PFTeDA	376-06-7	0.25	1.0	5.0
NMeFOSAA	2355-31-9	0.56	2.0	5.0
NEtFOSAA	2991-50-6	0.49	1.0	5.0
PFOSA	754-91-6	0.27	1.0	5.0
PFBS	375-73-5	0.13	0.5	5.0
PFPeS	2706-91-4	0.67	2.5	5.0
PFHxS	355-46-4	0.11	0.4	5.0
PFHpS	375-92-8	0.20	0.5	5.0
PFOS	1763-23-1	0.19	0.5	5.0
PFNS	68259-12-1	0.46	1.0	5.0
PFDS	335-77-3	0.17	0.5	5.0
4:2FTS	757124-72-4	0.14	0.5	5.0
6:2FTS	27619-97-2	1.36	2.5	5.0
8:2FTS	39108-34-4	0.22	0.5	5.0
HFPO-DA	13252-13-6	0.20	0.4	5.0
Adona	919005-14-4	0.18	0.4	5.0
11Cl-PF3OUdS	763051-92-9	0.18	0.4	5.0
9Cl-PF3ONS	756426-58-1	0.10	0.4	5.0

1 Values valid as of the date this version of the SOP was finalized, values subject to change as new studies are completed.

Solids:

Analyte	CAS No.	MDL (ng/g)	LOD (ng/g)	LOQ (ng/g)
PFBA	375-22-4	0.36	1.0	5.0
PFPeA	2706-90-3	0.39	1.0	5.0
PFHxA	307-24-4	0.33	1.0	5.0
PFHpA	375-85-9	0.44	1.0	5.0
PFOA	335-67-1	0.5	1.0	5.0
PFNA	375-95-1	0.43	1.0	5.0
PFDA	335-76-2	0.27	1.0	5.0
PFUnA	2058-94-8	0.41	1.0	5.0
PFDoA	307-55-1	0.24	0.5	5.0
PFTrDA	72629-94-8	0.28	1.0	5.0
PFTeDA	376-06-7	0.63	2.0	5.0
NMeFOSAA	2355-31-9	1.12	2.5	5.0
NEtFOSAA	2991-50-6	0.57	2.0	5.0
PFOSA	754-91-6	0.39	1.0	5.0
PFBS	375-73-5	0.36	1.0	5.0
PFPeS	2706-91-4	0.57	2.0	5.0
PFHxS	355-46-4	0.22	0.5	5.0
PFHpS	375-92-8	0.34	1.0	5.0
PFOS	1763-23-1	0.27	1.0	5.0
PFNS	68259-12-1	0.74	2.0	5.0
PFDS	335-77-3	0.19	0.5	5.0
4:2FTS	757124-72-4	0.29	1.0	5.0
6:2FTS	27619-97-2	0.58	2.0	5.0
8:2FTS	39108-34-4	0.59	2.0	5.0
3:3 FTCA	356-02-5	0.41	1.0	5.0
5:3 FTCA	914637-49-3	0.53	2.0	5.0
7:3 FTCA	812-70-4	0.66	2.0	5.0
HFPO-DA	13252-13-6	0.57	2.0	5.0
Adona	919005-14-4	0.32	1.0	5.0
11Cl-PF3OUdS	763051-92-9	0.40	1.0	5.0
9Cl-PF3ONS	756426-58-1	0.45	1.0	5.0

Tissues:

Analyte	CAS No.	MDL (ng/g)	LOD (ng/g)	LOQ (ng/g)
PFBA	375-22-4	0.35	1.0	5.0
PFPeA	2706-90-3	0.15	0.5	5.0
PFHxA	307-24-4	0.32	1.0	5.0
PFHpA	375-85-9	0.15	0.5	5.0
PFOA	335-67-1	0.17	0.5	5.0
PFNA	375-95-1	0.36	1.0	5.0
PFDA	335-76-2	0.27	1.0	5.0
PFUnA	2058-94-8	0.47	1.0	5.0
PFDoA	307-55-1	0.34	1.0	5.0
PFTrDA	72629-94-8	0.31	1.0	5.0
PFTeDA	376-06-7	0.21	0.5	5.0
NMeFOSAA	2355-31-9	0.96	2.5	5.0
NEtFOSAA	2991-50-6	0.44	1.0	5.0
PFOSA	754-91-6	0.29	1.0	5.0
PFBS	375-73-5	0.41	1.0	5.0
PFPeS	2706-91-4	0.43	1.0	5.0
PFHxS	355-46-4	0.28	1.0	5.0
PFHpS	375-92-8	0.15	0.5	5.0
PFOS	1763-23-1	0.17	0.5	5.0
PFNS	68259-12-1	0.27	1.0	5.0
PFDS	335-77-3	0.25	1.0	5.0
4:2FTS	757124-72-4	1.05	2.5	5.0
6:2FTS	27619-97-2	0.38	1.0	5.0
8:2FTS	39108-34-4	1.11	2.5	5.0
3:3 FTCA	356-02-5	0.59	2.0	5.0
5:3 FTCA	914637-49-3	0.77	2.0	5.0
7:3 FTCA	812-70-4	0.41	1.0	5.0
HFPO-DA	13252-13-6	0.35	1.0	5.0
Adona	919005-14-4	0.44	1.0	5.0
11Cl-PF3OUdS	763051-92-9	0.32	1.0	5.0
9Cl-PF3ONS	756426-58-1	0.40	1.0	5.0

Battelle
Standard Operating Procedures

for

EXTRACTION OF POLY AND PERFLUOROALKYL SUBSTANCES FROM ENVIRONMENTAL MATRICES

Summary of changes in this version: Modified language regarding centrifugation of water samples containing solids. Modified extraction procedure for solids and tissues. Updated extract cleanup procedure for all matrices. Modified concentration step for final extract preparation. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.

1.0 OBJECTIVE

The objective of this document is to define standard procedures for extracting poly and perfluoroalkyl substances (PFAS) from environmental matrices, including, but not limited to, surface water, ground water, soil, sediment, and tissue. Extraction methods are based on a Sciex application notes for PFAS extraction and analysis (Simon, et al., 2016), EPA Method 537.1 (Shoemaker, Tettenhorst, Grimmett, & Boutin, 2018), and ASTM Method D7968 (ASTM, 2014). All extracts are analyzed via Liquid Chromatography/Tandem Mass Spectrometry (LC-MS/MS) following Battelle SOP 5-369. Overarching quality guidance and method quality objectives for this method are taken from Department of Defense (DoD Quality Systems Manual (QSM) for Environmental Laboratories Version 5.3, 2019) Table B-15.

Note 1: The mixing and sub-sampling procedures presented in this SOP are appropriate for relatively homogeneous soil and sub-aqueous sediment samples. The mixing and sub-sampling presented in section 4 do not apply to solid samples originating at hazardous waste sites or other sites where potential inherent heterogeneity affects representativeness or comparability. For heterogeneous samples, specific mixing and sub-sampling procedures will be presented in the project- specific Project Plan. Project managers should refer to ASTM D 6323, laboratory Sub-sampling of Media Related to Waste Management Activities for guidance.

2.0 METHOD SUMMARY

PFAS compounds are extracted and purified for water samples, using solid phase extraction (SPE) methods. Soil, sediment, and tissue samples are extracted using a Geno/Grinder® followed by extract cleanup. All samples are fortified with labeled surrogate internal standards (SIS) prior to extraction. All extracts are fortified with an internal standard (IS) after cleanup, just prior to analysis.

3.0 PREPARATION

3.1 APPARATUS AND MATERIALS

Apparatus

- Top-loading balance capable of weighing to 0.01 g (SOP No. 3-160)
- Aluminum weighing pans
- Stainless steel spatula (or equivalent)
- Drying oven maintained at 115 ± 15ºC
- Centrifuge
- Spex Geno/Grinder® 2010 (or equivalent)
- Teflon free SPE extraction block (Waters part No. WAT200609, or equivalent)
- SPE manifold vacuum trap (Sigma part No. 57120-U, or equivalent)
- Vacuum pump (Vaccubrand diaphragm pump ME 1, or equivalent)
- Large volume SPE reservoir (Sigma part No. 54258-U, or equivalent)
- High density polyethylene (HDPE) sample bottles, 250 mL (Thermo Fisher part No. 2104-0008, or equivalent), for waters
- HDPE jars (Quality Environmental Containers (QEC) part No. 2214-0008, or equivalent), for solids and tissues
- Falcon 15 mL centrifuge tubes (Fisher Scientific part No. 12-565-268, or equivalent)
- Falcon 50 mL centrifuge tubes (Fisher Scientific part No. 14-432-22, or equivalent)
- 1 mL Polypropylene LC extract vials (Fisher Scientific part No. C4011-14, or equivalent)
- 800 µL Polypropylene LC extract vials (Fisher Scientific part No. C4011-11, or equivalent)
- 450 µL Polypropylene LC extract vials (Fisher Scientific part No. C4011-13, or equivalent)
- Snap caps (Thermo Fisher part No. 03-345-24G, or equivalent)
- Nitrogen evaporation apparatus, N-Evap or equivalent, with water bath
- Class A volumetrics, various sizes
- Class A graduated cylinders, various sizes
- Silanized glass wool (Supelco part No. 20411)
- 10 mg microscoop (TWD Scientific part No. ASPS-03)
- Calibrated pipettes (SOP 3-181)

3.2 SOLVENTS AND REAGENTS

- Methanol (HPLC grade, or equivalent)
- 7 N NH_3 solution in methanol (Sigma part No. 499145, or equivalent)
- 0.5% NH_3 solution in methanol (W/V) = using the 7 N solution, dilute 4.25 mL to 100 mL in methanol. This solution must be prepared fresh on the day of use.
- Strata-X Weak Anion Exchange (WAX) 200 mg / 6 mL SPE cartridge (Phenomenex part No. 8B-S038-FCH, or equivalent)
- Q-Sep QuEChERS extraction salt (Restek part No. 25847, or equivalent)
- ENVI-Carb bulk SPE (Supelco part No. 57210-U)
- 12 M (12 N) Hydrochloric acid, HCl, 36.5 to 38% (Fisher part No. A144S-212)
- 10 M (10 N) Sodium Hydroxide, NaOH (Ricca part No. 747-32)
- Millipore water (PFAS free water)

- Ottawa Sand (Applied Separations part No. 10548, or equivalent)
- Tilapia (locally sourced and verified prior to use)
- Surrogate Internal Standards (SIS) solutions (also referred to as Extracted Internal Standards)
- Internal Standards (IS) solutions
- Target analyte (LCS/MS) spiking solutions

3.3 LABWARE PREPARATION

All glassware and labware must be cleaned according to laboratory protocols defined in SOP 5-216, glassware is then rinsed with methanol and air dried prior to contact with samples. Glassware pre-cleaned by manufacturer may be used as purchased. Teflon material should be avoided for this method.

3.4 RECORD KEEPING

Samples are assigned unique identification numbers and logged into the Laboratory Information Management System (LIMS) according to laboratory protocols (SOP 6-007). All sample data are managed using the LIMS from sample receipt to data reporting.

Data will be recorded in the sample preparation module in the LIMS (refer to the *LIMS Sample Preparation Training Manual* for examples of reports and instructions on entering data). Information to be recorded includes wet and dry weight information, dates of extraction/processing procedures, initials of laboratory personnel performing the procedures, types and volume of internal standards added to samples, and, if necessary, comments regarding individual samples.

Record information regarding sample integrity that might have bearing on the results; for example, amount of overlying water, sulfurous or oil odors, unusual color, or other unusual attributes. If debris or rocks or stones are removed, document the type and amount.

4.0 PROCEDURES

4.1 GENERAL

Samples are processed and extracted in batches of 20 or fewer authentic field samples. Quality control (QC) samples accompanying each batch may include a procedural blank (PB), laboratory control sample (LCS), matrix spike (MS), matrix spike duplicate (MSD) and/or field sample replicates (DUP and/or TRP). For the PB and LCS samples use Millipore water for aqueous samples, Ottawa Sand for soil and sediment samples, and clean fish tissue (e.g. tilapia) for tissue samples. Record the actual weight in LIMS (based on the target weight listed in the project plans). The moisture for sand is automatically entered as 100% dry weight. (See Section 5.0 for more detail).

Sample processing is performed in a vented area free of contamination. For soil and sediment samples, prior to sub-sampling for percent moisture and extraction, decant over-lying water and remove foreign objects, such as leaves, sticks and rocks. For soil, sediment, and tissue samples, stir the entire sample in its original container with a stainless-steel spatula for 2 to 3 minutes, or until the sample appears uniform. Remove subsamples for analysis and percent moisture only after a uniform consistency and color is observed. In each subsample, use material from the top, middle, and bottom of the homogenized sample in case settling or separation of phases has occurred.

For tissue samples that arrive without any prior processing, the samples will be homogenized using Teflon free homogenization equipment prior to aliquoting for extraction.

4.2 SAMPLE PRE-SCREENING

To avoid potential contamination of the laboratory and instruments, all non-potable water samples will be pre-screened to determine if individual analytes are present in the samples above 10x sample equivalent concentrations of the high level of the calibration for each matrix. A small volume of water will be removed from each sample container and pre-screened to determine if concentration levels above 1,000 ng/L are present. All non-potable waters, with the exception of field blanks and equipment blanks will be processed using the following procedure:

- Shake sample bottle well, centrifuge if sample bottle has high levels of particulate matter
- Remove 200 µL of sample
- Add SIS to achieve concentrations of 1,250 ng/L at a PIV of 0.8 mL (100 µL of SIS if concentration is 0.005 ng/µL and final volume is 1 mL)
- Add 500 µL of methanol
- Cap, vortex, and transfer to analysis

Any samples that have concentrations for individual PFAS compounds above 100,000 ng/L may need to be processed in a manner to avoid the potential of cross contamination of the laboratory or the instrument. The client will be consulted if direct injection analysis is required for non-potable water samples.

4.3 AQUEOUS SAMPLE EXTRACTION AND CLEANUP

Water samples should be collected in 250 mL HDPE sample bottles, with the entire sample being extracted. All water samples are extracted using SPE techniques. In some cases, field samples contain suspended solids that may clog the top filter of the SPE cartridge. Samples should be visually inspected prior to the start of the extraction process. For samples that appear to contain levels of suspended solids (> 1% solid) that may clog the filter the following steps should be taken in order to minimize the potential for particulate matter interfering with the extraction process and to ensure minimal loss of PFAS compounds to the walls of the sample containers. If a single sample in the batch requires centrifugation, include the batch QC samples (PB and LCS):

- Fortify samples with extracted internal standards and targets as required in the project plan
- Agitate the sample to ensure that all solids are suspended in the sample
- Decant the entire samples into a clean HDPE bottle
- Centrifuge the sample bottles at approximately 2,500 rpm for 5 minutes
- Decant the overlying water back into the original sample container. This allows for the extraction to include the original sample container from the field, which has had the most contact with the sample since collection
- Keep the solids remaining in the centrifuged bottle with the project samples and return to the sample custodian

Once these steps have been completed, the extraction process can begin.

- Prior to sample fortification and extraction, verify pH is be between 6-8. If needed, adjust pH with small volume of 12 M HCl or 10 M NaOH.

- Initial sample volume is determined by marking the level of the sample on the bottle prior to fortification and extraction. Alternatively, weigh the sample bottle to the nearest 1 g prior to fortification and extraction. Post extraction fill the bottle to the level marked prior to extraction and measure the volume of water necessary to reach this level. Record the volume of water to the nearest 2 mL using a graduated cylinder. If using weight to determine volume, weigh the empty bottle to the nearest 1 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight. Assume a sample density of 1.0 g/mL. (sample size may be changed in the Project Plan)
- If not already fortified during the centrifugation step (for example, samples that did not require centrifugation) fortify samples with the appropriate SIS solutions, per the Project Plan, cap and mix
  - LCS, MS, and MSD samples should be fortified with the appropriate targets
- Condition the WAX cartridges as follows (***if cartridges go dry during the conditioning step, the process must be restarted***):
  - Rinse cartridges with 2 x 5 mL of methanol (collect to waste)
  - Rinse cartridges with 1 x 5 mL of Millipore water (collect to waste)
  - Add 1- 2 mL of Millipore water to each cartridge and close the stopcock to stop the flow through the SPE cartridge
- Attach a reservoir to each SPE cartridge
- Load samples onto the cartridges
- Elute at approximately 5 mL/minute (collect to waste)
  - Record the start and stop times in LIMS to verify proper flow rate
- To ensure that no PFAS compounds have been retained in the original sample container, the following rinses should be added to the original sample bottle prior to eluting the columns
- Rinse The sample bottle onto the cartridge with 2 x 7.5 mL washes of Millipore water, ensuring a good rinse of the sample bottle and the reservoir used for extraction (collect to waste)
- Allow the sample container to dry
- Once the entire sample has passed through the SPE cartridge:
  - Rinse SPE with 2 x 5 mL of Millipore water
- Dry columns under vacuum for a minimum of 10 minutes
- Discard waste and replace with clean 15 mL centrifuge tubes
  - Add 8 mL of 0.5% NH_3 in methanol to the original sample container
  - Pipette into the SPE cartridge, rinsing the sides of the reservoir and SPE cartridge through the bed material
- Under vacuum, elute the SPE cartridge
- Remove the centrifuge tubes from the extraction manifold and proceed to the extraction cleanup procedure (Section 4.6).

4.4 PERCENT MOISTURE DETERMINATION (SOIL / SEDIMENT AND TISSUE SAMPLES)

- Record the weight of an aluminum drying pan
- Place approximately 5 grams of homogenized sample on the drying pan and record the weight
- Place pan in drying oven overnight
- Record the weight of the pan and dried sample

4.5 SOIL / SEDIMENT AND TISSUE EXTRACTION

The default extraction solvent is methanol; however, other solvents may be substituted if specified in the Project Plan.

- Accurately weigh 2.0 g (± 0.2 g) of homogenized sample into a 50 mL centrifuge tube (sample size may be changed in the Project Plan)
- Fortify samples will the appropriate SIS solutions, per the Project Plan
    - LCS, MS, and MSD samples should be fortified with the appropriate targets
- Add 15 mL of Methanol and one Q-Sep QuEChERS extraction salt packet
- Shake on Geno/Grinder for 10 minutes at 1,200 RPM
- Centrifuge at 3,500 RPM for 5 minutes
- Decant the supernatant to a clean Falcon tube
- Aliquot 1.5 mL of sample extract into a 125 mL HDPE bottle containing 50 mL of Millipore water
- Condition the WAX cartridges as follows (***if cartridges go dry during the conditioning step, the process must be restarted***):
    - Rinse cartridges with 2 x 5 mL of methanol (collect to waste)
    - Rinse cartridges with 1 x 5 mL of Millipore water (collect to waste)
    - Add 1- 2 mL of Millipore water to each cartridge and close the stopcock to stop the flow through the SPE cartridge
- Attach a reservoir to each SPE cartridge
- Load samples onto the cartridges
- Elute at approximately 5 mL/minute (collect to waste)
    - Record the start and stop times in LIMS to verify proper flow rate
- Rinse The sample bottle onto the cartridge with 2 x 7.5 mL washes of Millipore water, ensuring a good rinse of the sample bottle and the reservoir used for extraction (collect to waste)
- Allow the sample container to dry
- Once the entire sample has passed through the SPE cartridge:
    - Rinse SPE with 2 x 5 mL of Millipore water
- Dry columns under vacuum for a minimum of 10 minutes
- Discard waste and replace with clean 15 mL centrifuge tubes
    - Add 8 mL of 0.5% NH_3 in methanol to the original sample container
    - Pipette into the SPE cartridge, rinsing the sides of the reservoir and SPE cartridge through the bed material
- Under vacuum, elute the SPE cartridge
- Remove the centrifuge tubes from the extraction manifold and proceed to the extraction cleanup procedure (Section 4.6).

4.6 Extract Cleanup

- Add 10 mg of Envi-Carb using a micro-scoop (1 scoops)
- Shake on Geno/grinder for 5 minutes at the lowest RPM setting
- Centrifuge for 5 minutes at 2,500 RPM
- Decant into new falcon tube

4.7 Final Extract Processing

- Concentrate the entire extract to 500 µL under nitrogen in a water bath (temperature set to approximately 50-60 °C)
- Add 375 µL 48/52 methanol/water (V/V), fortify with IS, and vortex
  - The volume of methanol used should be equal to the pre-injection volume (PIV) in the Project Plan minus the volume of IS fortified (typical PIV is 1,000 µL)
- Aliquot approximately 300 µL into a polypropylene snap cap vial (no Teflon septa) using a pipettor, the remaining extract can be stored in the 15 mL centrifuge tube, at room temperature.
- Transfer the extract for analysis via LC-MS/MS (SOP 5-369)

5.0 CALCULATIONS

Calculate percent dry weight with the following equation:

$$\%\ dry\ weight\ = \frac{aliquot\ dry\ wt^{a}}{aliquot\ wet\ wt^{a}} \times 100$$

[a] corrected for pan weight

Calculate percent moisture with the following equation:

$$\%\ moisture\ = 100\ \text{-}\ \%\ dry\ weight$$

Calculate sample dry weight with the following equation:

$$Sample\ dry\ weight\ (g)\ =\ \%\ dry\ wt.\ *\ sample\ wet\ wt.\ (g)$$

6.0 QUALITY CONTROL

Samples must be extracted in batches of 20 or fewer authentic field samples. QC samples accompanying each batch may include a procedural blank, laboratory control sample, matrix spike, standard reference material and/or field sample replicates.

The QC program for each project is defined in the project plan, which will define the type and amount of internal standards/spiking solutions to be added to the samples, the specific QC samples to be processed, any modifications to the standard QC acceptance criteria, and the corrective action required if QC results do not meet those acceptance criteria.

7.0 TRAINING

The trainee must read and fully understand the policies and procedures outlined in this SOP. The trainee will then be given a demonstration of all aspects of this SOP.

SOP 2-011 defines the training procedures and required documentation for sample preparation and analytical SOPs. These apply to both technicians processing samples and the analysts. The acceptance criteria for the Demonstration of Capability (DOC) are the same as for routine QC samples as defined in SOP 7-029.

When training is completed, the trainee will be issued an IDC Certificate (SOP 2-011). The laboratory Quality Assurance Manual and SOP 2-011 define the locations of training records.

8.0 SAFETY

As part of the above training program, the analyst will be made aware of the particular safety concerns of this procedure, including:

- Use of protective eyewear and clothing
- Proper use of fume hoods
- Location and use of laboratory safety devices; eyewashes, emergency showers, fire extinguishers, fire blankets, and first aid kits, as well as SDS sheets.

9.0 REFERENCES

ASTM. (2014). *D7968: Standard Test Method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Sectrometry (LC/MS/MS).* West Conshohocken: ASTM.

DoD Quality Systems Manual (QSM) for Environmental Laboratories Version 5.3. (2019). Department of Defense (DoD).

Shoemaker, J. A., Tettenhorst, D. R., Grimmett, P. E., & Boutin, B. K. (2018). *Method 537.1 Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).* Cincinnati: EPA.

Simon, R., KC, H., Craig, B., Scott, K., Eric, R., & Christopher, B. (2016). *Quantitation of PFASs in Water Samples Using LC/MS/MS: Large-Volume Direct Injection and Solid Phase Extraction.* Framingham: Sciex.

ATTACHMENTS

Attachment 1 Revision History

APPROVALS

Author Jonathan Thorn		Digitally signed by Jonathan Thorn Date: 2020.03.11 13:23:31 -04'00'
Technical Reviewer Stephanie Schultz		Digitally signed by Stephanie Schultz Date: 2020.03.11 13:28:31 -04'00'
Quality Systems Manager Zachary Willenberg	Zachary Willenberg	Digitally signed by Zachary Willenberg Date: 2020.03.11 13:30:37 -04'00'
Laboratory Director Jonathan Thorn		Digitally signed by Jonathan Thorn Date: 2020.03.11 13:47:48 -04'00'
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ATTACHMENT 1

Revision History

Version	Summary of Changes
02	Modified extraction procedures for tissues and updated the SPE cartridge for aqueous samples. This method is equivalent to the previous sample preparation method for water and soil/sediment, new Demonstrations of Capability (DOC) will only be needed for tissue under this version of the SOP. Revision history added as **Attachment 1**.
03	Updated section 4.2 to require recording the start and stop times for loading the samples onto the solid phase extraction cartridges. Updated section 4.4.2 for tissue extraction procedures. Updated section 4.4.3 for elution of cleanup cartridge. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
04	Updated initial extraction volume for non-potable water samples. Updated extraction section for solids and tissues (serial extraction). This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
05	Updated initial extraction volume for non-potable water samples. Updated extraction section for solids and tissues (serial extraction). This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
06	Updated extraction solvent to be prepared day of use. Reduced blow-down temperatures for final extract concentration. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
07	Updated final extract preparation procedures to change final split and pre-injection volume. Added procedure for prescreening samples. Added procedure for direct injection analysis of highly contaminated non-potable water samples. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
08	Updated to include procedure for handling non-potable water samples that are highly turbid or contain suspended solids. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.
09	Section 4.3 and added clarification in Section 1.0. Minor formatting changes. Removed requirement to pre-screen solid samples. Clarified process for determination of sample volume for non-potable water. Updated solvents and reagent section. Updated extraction procedure, updated elution volume for non-potable water extraction. Removed attachment 2. This method is equivalent to the previous version, new Demonstrations of Capability (DOC) will not be required under this version of the SOP.

Battelle
Standard Operating Procedures

for

SAMPLE RECEIPT, CUSTODY, AND HANDLING

Summary of changes in this Included language in Section 5.0 for QA review of samples prior to sample disposal for GLP studies.

1.0 OBJECTIVE

Sample control is a vital aspect of any environmental monitoring program that generates data that may be used for regulatory purposes or as evidence in a court of law. Additionally, the complexity of many environmental sampling programs, which may involve the collection and analysis of samples of various media from different sites to be analyzed for several parameters, makes a sample control system essential. This standard operating procedure (SOP) defines the procedures, organizational responsibilities, and documentation requirements associated with the Laboratory sample control system.

2.0 DEFINITIONS

Custody Records — the administrative records associated with the possession history of each sample from the time of collection, through analysis, to final disposal.

Chain-of-Custody (COC) Form — the record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. The Battelle COC form is the current version of NAL-056.

Sample Control — the formal system designed to provide sufficient information to reconstruct the history of each sample, including collection, shipment, receipt and distribution within the laboratory, analysis, storage or disposal, and data reporting.

Sample Custody — Samples are considered to be in a person's custody if

- The samples are in a person's actual possession
- The samples are in a person's view after being in that person's possession
- The samples were in a person's possession and then were locked or sealed up to prevent tampering
- The samples are in a secure area.

3.0 RESPONSIBILITIES

Laboratory Sample Custodian — the responsibilities of the Laboratory Sample Custodian include:

- Receiving samples (see LIMS Sample Custody Training Manual for details on recording custody information into LIMS).

- Maintaining records of sample receipt, movement in and out of storage, release, archival, and disposal.

- Distributing completed custody forms according to Section 4.5.

- Communicating sample custody problems to the Project Manager and implementing corrective action as directed (Section 4.1.4).

- Shipping sample splits or whole samples for outside analysis (SOP 5-210).

Alternate Sample Custodian — the Alternate Sample Custodian is responsible for assisting the Laboratory Sample Custodian and for performing the above tasks in the absence of the Laboratory Sample Custodian.

Project Manager — the Project Manager is responsible for communicating

- Expected receipt dates and project-specific receipt requirements to the Sample Custodian via e-mail, memo, or workplan.

- The potential presence of total residual chlorine to the Sample Custodian

- Sample custody-related problems to the client (corrective action)

- Completion of corrective action, notify Sample Custodian of completion

Laboratory Manager — the Laboratory Manager is responsible for designating the Laboratory Sample Custodian and the Alternate Sample Custodian and for ensuring that these individuals are trained to perform the tasks specified in this SOP.

4.0 PROCEDURES

An overview of the sample log-in process is illustrated in Attachment 1.

4.1 SAMPLE RECEIPT

4.1.1 Hours

Samples that are admitted to the laboratory during normal business hours are either delivered to the front desk or to the receiving area (second floor through the gold entrance). The Sample Custodian is notified immediately. If the Sample Custodian is unavailable then the Alternate Sample Custodian will be notified.

It is Battelle policy that samples are not received outside of regular business hours unless the Project Manager has made specific arrangements with the Laboratory Manager and the Sample Custodian in advance. Samples received in the laboratory outside of normal business hours are placed in a secure area under the appropriate storage conditions until they can be formally released to the Laboratory Sample Custodian. For samples received outside normal business hours:

- If samples are shipped by commercial carrier, the person receiving the samples should document the date and time of receipt and the cooler temperature on the container and then place the samples in a secure location.

- If samples are transported from the field to the laboratory by Battelle sampling personnel, the samples should be placed in a pre-arranged, secure location until they can be formally relinquished to the Laboratory Sample Custodian.

In either case, the Laboratory Sample Custodian logs in the samples on the next business day. (Note that the LIMS Receipt Form allows for separate entries of receipt and log-in date).

Upon receipt of the samples, the Laboratory Sample Custodian will move the shipping containers to the sample custody room.

4.1.2 Sample Handling

The shipping container should only be opened under the vented hood. The Sample Custodian must determine whether the sample condition upon receipt is acceptable. That is, that the sample condition and containers, are appropriate for the intended analysis; and that the samples have been received within the required holding times. Attachment 3 defines acceptable sample handling and holding times. If sample containers, preservation, or delivery do not meet the criteria in Attachment 3 and Section 4.1.4, then the Sample Custodian must notify the Project Manager who in turn must notify the client (Section 4.8).

4.1.3 Sample Log-in

During sample log-in, the Sample Custodian performs the following steps in order to verify sample integrity and ensure that custody has been maintained. These receipt conditions are documented on the LIMS, refer to the *LIMS Sample Custody Training Manual* for instructions on the use of LIMS for sample login.

- Method of delivery (i.e. commercial carrier, hand delivered) and presence/absence of chains-of-custodies.

- Inspect the shipping container(s) for the presence/absence and condition of custody seals.

- Measure and record the temperature of each shipping container to document whether or not the samples were maintained at the appropriate temperature (frozen, chilled, or ambient) during shipment. The temperature of a temperature blank (if available), melt water, or the external temperature of the sample containers should be measured and documented. (Thermometers or probes are never inserted into a sample container).

- Inspect each sample for the presence/absence and condition of samples and custody seals.

- Inspect each sample for breaks or leaks (see Section 6.0 for safety instructions).

- Review the accompanying records for completeness and accuracy of sample labels and sample transmittal forms. If sample COC forms are absent then the sample custody should create a new form using information provide on sample containers and/or paperwork received in the shipment. This should be recorded on the LIMS Corrective Action Form.

- The pH of incoming water samples is not routinely taken during sample log in unless it is requested by the Laboratory Manager, Project Manager, or in the QAPP (see Attachment 5). If the COC or sample containers indicate the water samples have been acidified the pH is verified in the lab prior to extraction and prior to the non-preserved expiration date.

- If the Project Manager indicates that total residual chlorine (TRC) may be present, measure samples for TRC and treat samples with sodium thiosulfate (see Attachment 5).

- Inspect VOC vials for head space greater than 1% of the vial volume. If present, notify the Project Manager immediately.

- Upon completion of the sample inspection, the Laboratory Sample Custodian formally acknowledges receipt of the samples by signing, dating, and noting the current time (defined as the time the shipment was delivered to Battelle) on the COC forms.

- Log-in and assign unique laboratory identification numbers to each sample (see LIMS Manual).

- Storage of samples in the appropriate storage location until the samples are ready for further processing. This includes releasing samples to the laboratory and to outside contractors. Note: VOC samples are stored in a separate storage location than samples for other organic analyses.

- Communicate sample custody problems to the Project Manager and implement corrective action as directed.

- Distribute completed custody forms according to Section 4.5.

- Clean and return the shipping coolers to the client or shipper, if necessary.

4.1.4 Sample Acceptance/Rejection Criteria

Under some circumstances Battelle will place itself at risk by accepting samples for analysis that do not meet chain of custody or handling requirements because data that are generated from these samples may be rejected by the client. All discrepancies in the transfer of samples will be noted by the Sample Custodian and a LIMS Corrective Action will be generated and forwarded to the Project Manager. Problems incurring corrective action and that may cause samples to be rejected for analyses include:

- The integrity of the samples being compromised (leaks, cracks, grossly contaminated container exteriors or shipping cooler interiors, obvious odors, etc.)

- The identity of the container being unable to be verified

- The proper preservation of the container cannot be established

- VOC vials contain bubbles of sizes greater than 1% of the vial volume

- Incomplete sample custody forms: the sample collector is not documented or the custody forms are not signed and dated by the person who relinquished the samples

- Samples are designated for VOA analysis but no VOA trip blank is provided.

Section 4.8 describes the notification process that will be followed if any of these conditions exist.

4.2 SAMPLE LOG-IN

The receipt of all samples received by the Chemistry Laboratory will be recorded in the Laboratory Information Management System (See LIMS Sample Custody Training Manual). Each incoming sample is assigned a unique ID number, which is clearly and indelibly marked on each sample container and the custody form. Samples that contain more than one jar for the same analysis will be labeled with the same Lab ID and the container number (e.g. 1 of 2 and 2 of 2). Alternatively, a separate ID number can be assigned to each container if requested by the Project Manager.

4.3 SAMPLE STORAGE

Upon completion of sample log-in procedures, samples are transferred to a secure location for storage. This location may be a laboratory, refrigerator, or freezer, depending on the storage requirements/storage conditions of the samples, but must be an area that can be locked. The initial storage location is documented on the LIMS Sample Receipt form. Only the Sample Custodian, alternate Sample Custodian, Laboratory Manager, and the facilities manager have keys to these controlled-access areas.
Samples that are to be analyzed for volatile organic compounds must be stored in a separate storage location from the samples being analyzed for semi-volatile organic compounds. Additionally, high level samples are stored in a separate location from low level samples (when previous knowledge regarding contamination levels is known prior to receipt of samples).

4.4 DOCUMENTATION

Documentation of sample receipt includes the original sample custody forms, any additional records of transmittal, the shipper's air bill (if applicable), and the Sample Receipt form (generated in LIMS). Sample custody records are filed by the shipment ID in the Custody Logbook that is kept in the access-controlled sample custody room.

The condition of the samples, integrity of the custody seals, discrepancies between sample labels and transmittal forms, and unusual events or deviations from the project work plan or SOPs are documented in detail on a Corrective Action Form (See LIMS Sample Custody Manual).

Occasionally, samples are received with only a letter of transmittal or no COC forms at all. In these cases the Sample Custodian should complete the sample log-in procedures (Section 4.2) and create a sample COC form (form NAL-056) using the information provided on the sample jars and/or on any paper work provide with the shipment. The lack of custody forms should be recorded as part of the shipment's Corrective Action.

4.5 DISTRIBUTION

The Sample Custodian will provide the Project Manager with an electronic copy (PDF) of all documentation that accompanied the samples. The electronic copy will be filed on the network (Data\Custody\ folder on the current LIMS server) under the Project Managers last name and the year, all PDF files will be named as the shipment name in LIMS. The custodian should consult the Project Manager to determine if a copy of the custody records should be returned to the client and/or shipper.

4.6 SAMPLE TRACKING

Sample custody is transferred from the Sample Custodian to the sample preparation Task Leader when sample preparation is initiated. The transfer of custody to laboratory personnel is documented electronically within LIMS on the Daily Sample Tracking page. Each technician is responsible for the care and appropriate storage of the samples in his/her custody. Controlled access of labs/areas which house samples in-progress is maintained through the building security system.

4.7 SAMPLE SPLITTING

The aliquotting of samples for multiple analyses is documented on Sample Split and Transfer Logs (the current version of NAL-033). The approximate weight/mass/volume of the sample split should be recorded on this form along side the sample ID number, or in the header information if applicable. Split samples retain their original Laboratory Sample identification number. Sample Split Logs are maintained with the original sample custody records.

4.8 CLIENT NOTIFICATION

The client must be notified immediately if problems are noted during sample receipt and log-in so that corrective action may be initiated. The Sample Custodian may communicate directly with the client custodian or representative if discrepancies between sample labels and custody forms are noted or if samples are missing. The Project Manager should communicate other problems (e.g., holding time exceedences, preservation issues, incomplete or improper custody records – see Section 4.1.4). This notification and the client's directions for corrective action are documented on the Corrective Action form (See LIMS Sample Custody Manual). It must be specifically documented if the client approves analysis of the samples. All corrective action is communicated to the Sample Custodian or Laboratory Manager (or designee) in writing.

Specific samples may include other client notification requirements (e.g., if permit threshold limits are exceeded the client must be notified within 24 hours of verified sample data). The Project Manager is responsible for this notification and should define the requirements in the QAPP.

4.9 OUTGOING SHIPMENTS

See SOP 5-210 for instructions pertaining to the outgoing shipment of samples.

5.0 SAMPLE ARCHIVAL AND DISPOSAL

The remaining, un-extracted, samples are returned to the custody of the Sample Custodian and stored appropriately (with the exception of water samples, all samples should be frozen at this time, unless otherwise directed by the Project Manager). Once sample analysis is considered final the oil, sediment and tissue samples can be archived. Water samples are not archived.

Un-extracted client samples are archived (frozen) at Battelle for six months after the delivery of final data to the client, unless otherwise stated in the QAPP. Project managers will be notified prior to the disposal of client samples. Sample extracts will be stored for forty days from the extraction date; after this time they are considered no longer viable and will be disposed of in the appropriate waste stream.

Sample IDs for disposal are verified by a second staff member prior to final disposal of the samples. Samples for disposal on GLP studies must be verified by a member of QA prior to final disposal. Sample disposal is documented in the LIMS. The appropriate handling and disposal procedures for samples and sample extracts are discussed in SOP 5-114.

6.0 SAFETY

Sample handlers must always assume that samples are potentially contaminated. Therefore, sample-shipping containers are always opened under a vented fume hood, and personnel protective equipment is worn when unpacking samples (safety glasses, lab coat, and gloves).

Occasionally, samples are received broken. Because the potential hazard may be unknown, all spills must be treated as if the material is hazardous. Clean-up materials should be maintained in proximity to the sample custody room. The Hazardous Waste Coordinator should be contacted if supplies are not present. These supplies consist of:

- absorbent (e.g., speedi-dry)
- dust pan and brush
- glass disposal container
- heavy-duty gloves
- paper towels
- plastic bags
- solid waste stream container

The Hazardous Waste Coordinator should be contacted to determine the proper disposal procedures for spilled samples. In general, water samples are absorbed into chemical absorbent; sediment, soil, oil, or tissues are placed in heavy-duty plastic bags. These are both disposed of in the laboratory's solid waste stream. Broken glass containers are placed in the glass disposal container.

7.0 TRAINING

A person who is being trained as a Sample Custodian must first read this SOP. The person may then perform specific tasks under the supervision of a qualified instructor (Laboratory Sample Custodian or Alternate). Tasks performed by the trainee are reviewed and co-signed by the Laboratory Sample Custodian or Alternate until it has been established that the trainee is able to perform these tasks without supervision. Once these training activities are completed, training is documented according to the laboratory Quality Assurance Manual.

ATTACHMENTS

Attachment 1 Sample Log-in Flowchart
Attachment 2 Example LIMS Custody Reports
Attachment 3 Sample Storage Requirements
Attachment 4 Sample Preservation Methods
Attachment 5 Revision History

APPROVALS

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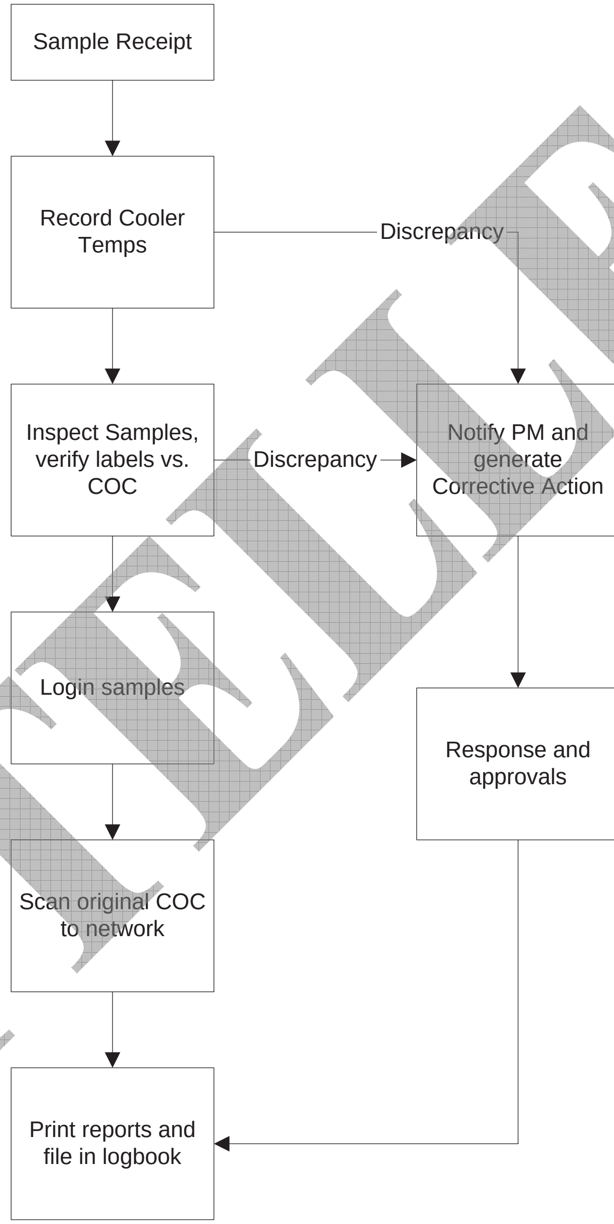
ATTACHMENT 1
Sample Log-in Flowchart



ATTACHMENT 2
Example LIMS Custody Reports

Sample Receipt Form

Approved: ☐ **Authorized** ☐

Project Number: 26-400 and 26-401 **Client:** USACE/NYD
Received by: Thorn, Jonathan **Date/Time Received:** Tuesday, January 09, 2007 12:00 AM
No. of Shipping Containers: 4

SHIPMENT

Method of Delivery: Commercial Carrier **Tracking Number:** Not Recorded
COC Forms: ☐ Shipped with samples ☐ No Forms

Cooler(s)/Box(es)

Cntr	Type	Tracking No.	Seal	Seal Condition	Container Condition	Temp C	Smps
1 of 4	Cooler		Tape	Intact	Intact	2.0	3
2 of 4	Cooler		Tape	Intact	Intact	2.3	2
3 of 4	Cooler		Tape	Intact	Intact	1.8	1
4 of 4	Cooler		Tape	Intact	Intact	3.8	1

Samples

Sample Labels: ☑ Sample labels agree with COC forms
☐ Discrepancies (see Sample Custody Corrective Action Form)

Container Seals: ☐ Tape ☐ Custody Seals ☐ Other Seals (See sample Log)
☑ Seals intact for each shipping container
☐ Seals broken (See sample log for impacted samples)

Condition of Samples: ☑ Sample containers intact
☐ Sample containers broken/leaking (See Custody Corrective Action Form)

Temperature upon receipt (°C): 3.8 Temperature Blank used ☐ Yes ☑ No
(Note: If temperature upon receipt differs from required conditions, see sample log comment field)

Samples Acidified: ☐ Yes ☐ No ☑ Unknown

Initial pH 5-9?: ☐ Yes ☐ No ☑ NA
If no, individual sample adjustments on the Auxiliary Sample Receipt Form

Total Residual Chlorine Present?: ☐ Yes ☐ No ☑ NA
If yes, individual sample adjustments on the Auxiliary Sample Receipt Form

Head Space <1% in samples for water VOC analysis: ☐ Yes ☐ No ☑ NA
Individual sample deviations noted on sample log

Samples Containers:
Samples returned in PC-grade jars: ☐ Yes ☐ No ☑ Unknown /Lot No.: Unknown

Storage Location: Chem North: Freezer - F0002 (Walk-in) **BDO IDs Assigned:** R5506 - R5512
Samples logged in by: Thorn, Jonathan **Date/Time:** 01/09/2007 12:00 AM
Approved By: **Approved On:**
Authorized By: **Authorized On:**

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Battelle
The Business of Innovation

ShpNo SHP-070109-01

Battelle Project No: G603330

Sample Receipt Form Details

Approved: ☐ ☐

Project Number: 26-400 and 26-401 **Client:** USACE/NYD

Received by: Thorn, Jonathan **Date/Time Received:** Tuesday, January 09, 2007 12:00 AM

No. of Shipping Containers: 4

BDO Id:	Client Sample ID:	Collection Date:	Login Date:	Ctrs:	Matrix:	Temp:	pH:	TRC:	VOC:	Stored In:	Loc:	No:	Comments:
R5506	20070021	12/29/06 0:00	01/09/07 11:15	4	SEDIMENT	2.3	NA	NA	NA	F0002 (Walk-in)	BIN	75	RR Reach A Comp (co
R5507	20070034	01/05/07 0:00	01/09/07 11:16	1	WATER	3.8	NA	NA	NA	R0003 (Upper C	BIN	75	RR Site water
R5508	20070028	01/03/07 0:00	01/09/07 15:39	2	SEDIMENT	2.3	NA	NA	NA	F0002 (Walk-in)	BIN	75	SP Reach B composite (
R5509	20070035	01/05/07 0:00	01/09/07 15:39	2	WATER	2	NA	NA	NA	R0003 (Upper C	BIN	75	WP Site Water
R5510	20070036	01/05/07 0:00	01/09/07 15:41	2	WATER	1.8	NA	NA	NA	R0003 (Upper C	BIN	75	SP Site Water
R5511	Raritan-Elut	01/09/07 0:00	01/09/07 15:50	1	ELUTRIATE	2	NA	NA	NA	R0003 (Upper C			Elutriate of R5506 (sed
R5512	Sequine-Elut	01/09/07 0:00	01/09/07 15:50	1	ELUTRIATE	2	NA	NA	NA	R0003 (Upper C			Elutriate of R5508 (sed

Total Samples: 7

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ShpNo: SHP-070109-01

Battelle Project No: G603330

Report Corrective Actions

Corrective Action No: 1 of 1

Approved:

COC Client: USACE/NYD
COC Project: Wards Point / Sequine Point / Raritan River
COC Date: 1/9/2007 10:59:00 AM

	Description of Problem:	Explanation:
Client Id	Missing samples listed on the C-O-C	Client IDs 20070001, 20070002, 20070003, 20070026, and 20070027 not received, 2 jars of 20070028 also missing (missing cooler from shipment).

Documentation of project manager notification

Sample Custodian	Thorn, Jonathan	**Date:**	1/9/2007 3:44:00 PM
Laboratory Manager:	Thorn, Jonathan	**Date:**	1/9/2007 3:45:00 PM
Project Manager	Peven-McCarthy, Carole	**Date:**	3/23/2007 1:33:00 PM

Documentation of client notification (should be completed by project manager within 24 hrs):

On 09-Jan-07 **I contacted** ______ **at**

Results of communication with client (Describe any corrective action directed by the client):

Jon Doi and Tom Dolce contacted at ASI - replacement samples being shipped in case cooler doesn't arrive.

Date this form was received back to the custodian:
Reference Number:

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ATTACHMENT 3
Sample Storage Requirements

WATER

Compound Class	Containers	Preservation		Holding Time
		Temp	Other	
PESTICIDES[1]	Glass with Teflon lined caps Cool 4ºC	Cool <6ºC[2]	Adjust pH to 5-9 if held longer than 72 hours Store in dark	7 days until extraction, 40 days after extraction
PCBs[1]	Glass with Teflon lined caps Cool 4ºC	Cool <6ºC[2]	Store in dark	7 days until extraction, 40 days after extraction
PAH[1]	Glass with Teflon lined caps Cool 4ºC	Cool <6ºC[2]	Store in dark If pH ≤ 2, then 14 d hold time (EPA)	7 days until extraction, 40 days after extraction
Other SVOA	Glass with Teflon lined caps Cool 4ºC	Cool <6ºC[2]	Store in dark If pH ≤ 2, then 14 d hold time (EPA)	7 days until extraction, 40 days after extraction
TPH or FINGERPRINT	Glass with Teflon lined caps Cool 4ºC	Cool <6ºC[2]	Store in dark If pH ≤ 2, then 14 d hold time (EPA)	7 days until extraction, 40 days after extraction
VOA[1]	VOA vial with Teflon insert cap	Cool <6ºC[2]	pH<2 Headspace ≤1% of sample	14 days (if acidified) otherwise 7 days
TBT	Polycarbonate	Freeze ≤ −10ºC	NA	90 days
PFAS Drinking Water	Polypropylene 250mL bottles preserved with Trizma Cool 4 ºC	Cool <6ºC[2]	Store in dark	14 days 28 days after extraction
PFAS NonPotable Water	High density polyethylene 250mL bottles Cool 4 ºC	Cool <6ºC[2]	Store in dark	14 days 28 days after extraction

SEDIMENT/SOIL

Compound Class	Containers	Preservation		Holding Time
		Temperature	Other	
PESTICIDES PCBS	Glass with Teflon lined caps	Cool <6ºC[2]	Freeze ≤ −10ºC	14 days until extraction; extract holding time 40 days after extraction; holding time 1 year for frozen samples
PAH SVOA		Cool <6ºC[2]	Freeze ≤ −10ºC	14 days until extraction; extract holding time 40 days after extraction; holding time 1 year for frozen samples
VOA		Cool <6ºC[2]		14 days
TPH or FINGERPRINT		Cool <6ºC[2]		14 days until extraction; extract holding time 40 days after extraction
TBT		Freeze ≤ −10ºC		1 Year
Oil/NAPL	Glass with Teflon lined caps	ambient	Cool <6ºC[2] For long term	1 Year
PFAS	High density polyethylene 250mL bottles Cool 4 ºC	Cool <6ºC[2]	Store in dark	14 days 28 days after extraction

[1]If Residual Chlorine is present in the sample it must be treated with sodium thiosulfate (Attachment 5).
[2] Samples stored cool should be above freezing (0°C).

TISSUE
Stored frozen ≤ −10ºC for all analyses

ATTACHMENT 4
pH MEASUREMENT AND ADJUSTMENTS

If water samples will not be extracted within 72 hours then the pH is typically adjusted according to the preservation requirements in Attachment 2. To measure pH, withdraw a small volume of water (0.1 mL) from the sample container using a baked Pasteur pipette. Place 1 drop on a narrow range pH paper strip and follow the instructions included with the pH paper to read the results. Record the pH on the Sample Receipt form. If water sample pH is NOT between pH 5 and 9 consult the project and/or Laboratory Manager and make pH adjustments as directed by these managers. The decision to adjust sample pH is based on the target analyte list and is therefore made on a case-by-case basis.

To adjust the sample pH, sulfuric or hydrochloric acid (1+1) or 10 N NaOH is added until the sample pH is between 5 and 9. (Note that NaOH solutions must be pre-extracted prior to use to prevent sample contamination). The final pH and the volume of solution added in making the pH adjustment is recorded on the Sample Receipt form.
The following matrix should be used in the determination of bottle preservation and the pre-cleaned bottles:

Preservation	**Pre-cleaned bottles**
Yes=C-O-C and bottle match, or documented on C-O-C and not on bottle	*Yes*=Sent out and received
No=C-O-C and bottle unmarked	*No*=Not sent and not received
Unknown=documented on the bottle and not on C-O-C	*Unknown*=Sent out and not received

For pre-cleaned bottles the PM should include in a cover letter to the client that the C-O-C should include documentation if Battelle has supplied bottles.

Any problems are documented on the original custody forms. If C-O-C signed without comments then the samples are considered acceptable upon receipt. The C-O-C should never be altered, comments can be added, but information should never be crossed off or written over.

Samples intended for VOA analysis should NOT be opened unless more than one sample has been sent for analysis pH adjustments made in the field must be verified at the time of login. One vial may be sacrificed to verify pH (the vial used for pH will be verified prior to analysis), headspace created by removing water for pH measurement should be removed by adding baked glass beads to the sample vial. In cases where sample pH cannot be verified (one vial received) holding times should be based on an unpreserved sample until pH can be verified during analysis.

TOTAL RESIDUAL CHLORINE MEASUREMENT AND TREATMENT FOR WASTEWATER SAMPLES

If the Project Manager indicates that samples may contain total residual chlorine (TRC) then the sample must be treated with sodium thiosulfate. The Sample Custodian must work directly with the Project Manager in these cases. Ideally, the sample is treated for chlorine in the field. However, the Sample Custodian should verify the absence of TRC using a commercial test kit. If TRC is detected then sodium thiosulfate is added at the ratio of 80 mg/L sample. This treatment is documented on the sample receipt form. Test kits and sodium thiosulfate will be purchased as needed and not kept on hand as wastewater is not a typical matrix received at Battelle.

Samples intended for VOA analysis should NOT be opened. Treatment for TRC must be performed in the field.

ATTACHMENT 5
Revision History

Version	Summary of Changes
02	SOP changes were not summarized for this revision.
03	SOP changes were not summarized for this revision.
04	SOP changes were not summarized for this revision.
05	SOP changes were not summarized for this revision.
06	Minor modifications are made throughout the document to reflect the changes being made to the sample tracking system as the facility moves towards a Laboratory Information Management System (LIMS). Changes were made in the sample log-in documentation procedures and sample archival storage times. Sample custody vs. evidentiary chain of custody are distinguished.
07	The routine monitoring of pH in water samples is discussed. A section describing safety considerations and the handling of hazardous materials and spill has been added. Sample storage requirements are defined and the receipt of samples outside of routine business hours clarified.
08	Sample and archival storage times have been modified to reflect current laboratory policy (Section 4.10).
09	Sample and archival storage times have been modified to reflect current laboratory policy (Section 4.10).
10	The format of the SOP has changed to be more fluid. Specifics about VOC containers have been added, along with other minor changes. The preparation of Field Kits has been moved to SOP 5-210.
11	A new Sample Custody Corrective Action Form has been added. The Sample Receipt Form has been modified. Details on the evaluation of preserved samples and pre-cleaned bottles have been added. A sample log-in flowchart has been added.
12	Repetitive information listed in various sections was removed. The pH and TRC sections were modified and moved to Attachment 4. The Sample Collector section was removed. LIMS documentation is identified.
13	Sample flow chart revised. Example LIMS sample receipt forms added as Attachment 2. Revision summary added as Attachment 7. Definition section updated. Sample archiving section updated
14	Attachment 3 updated to reflect the proper storage temperatures for frozen samples (-10°C), and chilled samples (<6°C but not frozen). Minor formatting changes also made during update.
15	Documentation of training is defined in the Quality Assurance Manual. The pH of acidified samples must be verified upon receipt. Distribution of sample custody forms is now electronic. Quality control chemists no longer validate sample custody information in LIMS.
16	Section 4.9 Outgoing Shipments has been revised.
17	Section 3.0 removed taking the pH for water samples marked as “acidified during login. The pH is being verified by the analysts at the time of sample preparation, prior to the non-acidified holding time expiration. Also clarified the pH statement in Section 4.1.3. Sample receipt time has been defined in Section 4.1.3. Replaced the example COC in Amendment 7.
18	Clarified the Section 5.0 for sample disposal. Removed all forms from the SOP.

Appendix F
December 2018 Partnering Scoping Session Presentation

Scoping Session for PFAS SI Investigations at NAS Patuxent River and Webster Field Annex

December 2018

OVERVIEW

- Project Objectives for PFAS SI Investigations
- NAS Patuxent River PFAS SI Sites (16)
  - Nine High Priority Sites
  - Three Medium Priority Sites
  - Four Low Priority Sites
- Webster Field Annex PFAS SI Site (1)
- Site-specific information includes:
  - Site Description
  - Operational History
  - Conceptual Site Model
  - Proposed Sample Locations
- Proposed Timeline for Path Forward

PROJECT OBJECTIVES FOR PFAS SI INVESTIGATIONS

- Refine understanding of surface water & groundwater flow within vicinity of each PFAS site at both facilities
- Determine PFAS presence/absence in site media. Total budgeted number of samples include:
  - groundwater grab samples at 8 locations per site
  - co-located surface/subsurface soil samples at 5 locations (10 per site)
  - co-located surface water/sediment samples as needed and in place of soil or groundwater samples
  - total samples budgeted = 288 for NAS Patuxent River (16 sites, 18 per site)
  - total samples budgeted = 18 for Webster Field Annex (1 site)
  - flexibility to add/subtract samples but would like to retain same total number
- Analyze samples (all media) for 14 PFAS analytes referenced in Navy 2017 guidance
- If PFAS present, characterize nature and extent to determine if further action is warranted based on risk

WEBSTER FIELD ANNEX
PFAS SI SITE (1)

AFFF CRASH TRUCK MAINTENANCE CHECK AREA SITE DESCRIPTION

- Affiliated with Fire Station 3, Building 8076 and located approximately 100 ft to 150 ft from "T" on taxiway adjacent to northwest runway at Webster Field
- Elevation approximately 12 ft above mean sea level and site is largely flat
- Entirely paved with minimal natural ground exposure around edges
- Not previously characterized; geology and hydrogeology unknown
- General groundwater flow direction anticipated to be consistent with regional hydrogeology

AFFF CRASH TRUCK MAINTENANCE CHECK AREA OPERATIONAL HISTORY

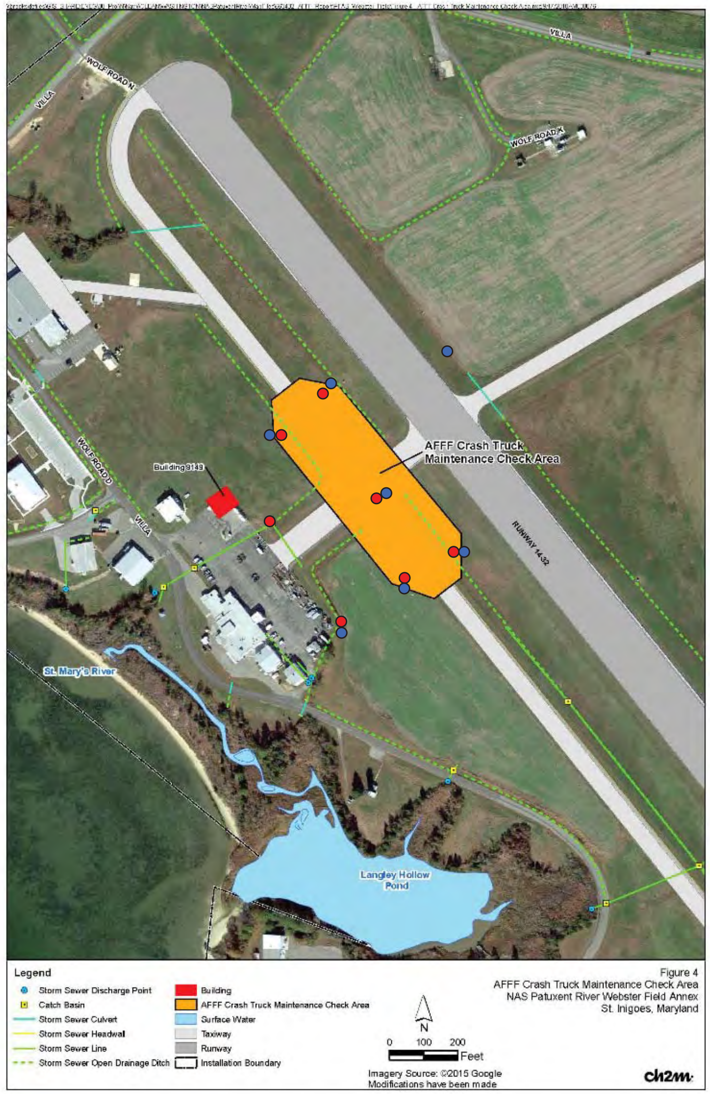
- Location where Webster Field Fire Department conducted monthly AFFF spray checks with crash truck equipment from Fire Station 3, Building 8076
- Spray of AFFF would occur approximately 100 ft to 150 ft to right and left from “T” on taxiway adjacent to northwest runway at Webster Field
- Monthly checks verified proper equipment functioning and correct AFFF spray pattern setup
- Time period over which equipment functioning testing with AFFF was conducted is unknown, but guidance for using NoFoam Kits in lieu of AFFF spray checks available since mid-2000s

AFFF CRASH TRUCK MAINTENANCE CHECK AREA CONCEPTUAL SITE MODEL

- Soil and groundwater pathways exposed through cracks in pavement and overland flow to unpaved surfaces
- Potential shallow groundwater PFAS contamination because AFFF use occurred monthly over extended time period
- Stormwater conveyances lead south; Langley Hollow Pond located approximately 750 ft to south
- Site is an active facility for spray checks with water only
- Onsite workers but no residents; no residential areas within 1 mile
- No schools/daycare centers/medical facilities within 500 ft

AFFF CRASH TRUCK MAINTENANCE CHECK AREA PROPOSED SAMPLE LOCATIONS

- Proposed groundwater sample location
- Proposed surface/subsurface soil sample location
- Proposed surface water/sediment sample location



Note:
Groundwater flow direction consistent with regional hydrogeology (anticipated)

PROPOSED TIMELINE FOR PATH FORWARD

- Complete UFP-SAPs for PFAS SI Investigations
  - NAS Patuxent River (Jan-2019)
  - Webster Field Annex (Mar-2019) – Can Webster SAP be combined with the SAP for Pax?
- Conduct sampling activities for PFAS SI Investigations
  - June 2019 to August 2019 (times will vary depending on site access)
- Prepare PFAS SI Reports
  - NAS Patuxent River (Fall/Winter 2019)
  - Webster Field Annex (Fall/Winter 2019) – Combined w/ Pax report?
- Provide updates to NAS Patuxent River Tier I Partnering Team throughout SI Investigations