Quality Assurance Project Plan

Groundwater, Soil Gas, and Landfill Gas Monitoring

Former Fort Ord, California

Prepared for:

U.S. Department of the Army
Fort Ord Base Realignment and Closure
4463 Gigling Road, Room 101
Seaside, CA 93955-7302

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Acronyms and Abbreviations:

%	percent
%v	percent by volume
°C	degrees Celsius
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2-DCE (total)	total 1,2-dichloroethene
1,2-DCPA	1,2-dichloropropane
1,3-DCPE (total)	total 1,3-dichloropropene
ACL	Aquifer Cleanup Level
ADR	Automated Data Review
Ahtna	Ahtna Global, LLC
APP	Accident Prevention Plan
Army	U.S. Department of the Army
ASTM	ASTM International
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
BFB	4-bromofluorobenzene
bgs	below ground surface
BRAC	Base Realignment and Closure
CAMU	Corrective Action Management Unit
CCR	California Code of Regulations
CCRWQCB	California Central Coast Regional Water Quality Control Board
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CO	carbon monoxide
CO_2	carbon dioxide
COC	chemical of concern
COD	coefficient of determination
CQCR	Contractor Quality Control Report
CQM	Construction Quality Management
CPR	cardiopulmonary resuscitation

CT	carbon tetrachloride
CTS	California tiger salamander
DCL	discharge limit
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EDD	electronic data deliverable
EISB	enhanced in situ bioremediation
ELAP	Environmental Laboratory Accreditation Program
EP	Extraction Point
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
Eurofins	Eurofins Environment Testing Northern California, LLC
EW	Extraction Well
FODIS	Fort Ord Data Integration System
FONR	Fort Ord Natural Reserve
FO-SVA	Fort Ord-Salinas Valley Aquitard
FS	Feasibility Study
FSOP	field standard operating procedure
GAC	granular activated carbon
GC/MS	gas chromatography-mass spectrometry
GIS	geographic information system
GWMP	groundwater monitoring program
GWTP	groundwater treatment plant
GWTS	groundwater treatment system
H&S	health and safety
HACCP	Hazard Analysis & Critical Control Points
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HDPE	high-density polyethylene
HHRA	human health risk assessment
HNO_3	nitric acid
ICAL	initial calibration
ICP	inductively coupled plasma

ICS	interference check sample
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste
LCS	laboratory control sample
LCSD	LCS duplicate
LFG	landfill gas
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
MCWD	Marina Coast Water District
MEC	munitions and explosives of concern
mg/L	milligrams per liter
mL	milliliter
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
N_2	nitrogen
NA	not applicable
ND	non-detect or not detected
NELAP	National Environmental Laboratory Accreditation Program
NMOC	non-methane organic compounds
NO_X	nitrogen oxides
NPL	National Priorities List
O&M	operations and maintenance
O_2	oxygen
ORP	oxidation-reduction potential
OU	operable unit
OU2	Operable Unit 2
OUCTP	Operable Unit Carbon Tetrachloride Plume
PARCCS	precision, accuracy, representativeness, comparability, completeness, sensitivity
Pb	lead
PCE	tetrachloroethene
PDB	passive diffusion bag
PDS	post-digestion spike
PE	registered Professional Engineer

QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual for Environmental Laboratories
QT	quick connect
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RI	Remedial Investigation
RF	response factor
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
RSL	Regional Screening Level
Sb	antimony
SCAQMD	South Coast Air Quality Management District
scfm	standard cubic feet per minute
SGCL	soil gas cleanup level
SGMP	soil gas monitoring program
SGS	SGS North America, Inc.
SIM	selected ion monitoring
Sites 2/12	Sites 2 and 12
SL	screening level
SOP	standard operating procedure
SQL	Structured Query Language
SO_2	sulfur dioxide
SVE	soil vapor extraction
SVETS	soil vapor extraction and treatment system
SVTU	soil vapor treatment unit
TAL	target analyte list
TAT	turnaround time
TCE	trichloroethene
THC	total hydrocarbons
trans-1,2-DCE	trans-1,2-dichloroethene
TTU	thermal treatment unit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey

VD	Area D passive vents
VF	Area F passive vents
VFD	variable frequency drive
VOA	volatile organic analysis
VOC	volatile organic compound

1.0 Introduction

Ahtna Global, LLC (Ahtna) prepared this Basewide Quality Assurance Project Plan (QAPP) under U.S. Army Corps of Engineers (USACE) Contract No. W9123824D0003, Delivery Order No. W9123825FA013. This QAPP addresses the following tasks:

- Groundwater extraction and treatment monitoring activities at Operable Unit 2 (OU2) and Sites 2 and 12 (Sites 2/12).
- Groundwater monitoring activities at locations related to the former Fort Ord including, but not limited to:
  - Sites 2/12
  - Operable Unit Carbon Tetrachloride Plume (OUCTP)
  - OU2
- Soil vapor extraction and treatment system (SVETS) monitoring activities at Sites 2/12.
- Soil gas monitoring activities at Sites 2/12.
- Landfill gas (LFG) extraction and treatment system monitoring activities at the OU2 Landfills.
- LFG monitoring activities at the OU2 Landfills.
- Groundwater well installation and decommissioning.
- Soil gas probe installation and decommissioning.

Per- and polyfluoroalkyl substances (PFAS) are not included in this QAPP. This QAPP is meant to be a broad overarching document that will be applicable for up to five (5) years and will be supplemented by an annual addendum. The annual addendum will update the regulatory requirements, chemistry requirements, standard operating procedures, and lists of specific monitoring points based on applicable decision rules.

This work is being conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to address historical releases of chemicals of concern (COCs) at the former Fort Ord. This QAPP details quality assurance (QA) and quality control (QC) procedures for remedy and sampling activities at the former Fort Ord. The QAPP ensures that the data generated follow the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS parameters) and are of sufficient quality to support project decisions. The Uniform Federal Policy (UFP) QAPP Manual, Compendium, and Optimized Worksheets were utilized in the preparation of this QAPP (IDQTF, 2005a, 2005b, 2012).

2.0 Project Management

2.1 Worksheet #1 & 2: Title and Approval Page

Site Name/Project Name: Former Fort Ord/Superfund Response Actions

Site Location: Monterey County, California

Contract No. W9123824D0003

Task Order No. W9123825FA013

Task No. B.1

Lead Organization: United States Department of the Army

Investigative Organization: Ahtna Global, LLC

Personnel Approval Signatures

Project Role	Name Organization	Signature	Date
Investigative Organization's Project Manager/Chemist	Eric Schmidt Ahtna		
Investigative Organization's QC Manager	Steven Bennett Ahtna		
Lead Organization's Technical Lead	Kirsten Hiortdahl USACE		
Lead Organization's Project Chemist	Samantha Fujita USACE		

Federal regulatory agency: U.S. Environmental Protection Agency (EPA)

State regulatory agencies: California Department of Toxic Substance Control (DTSC), and Central Coast Regional Water Quality Control Board (CCRWQCB)

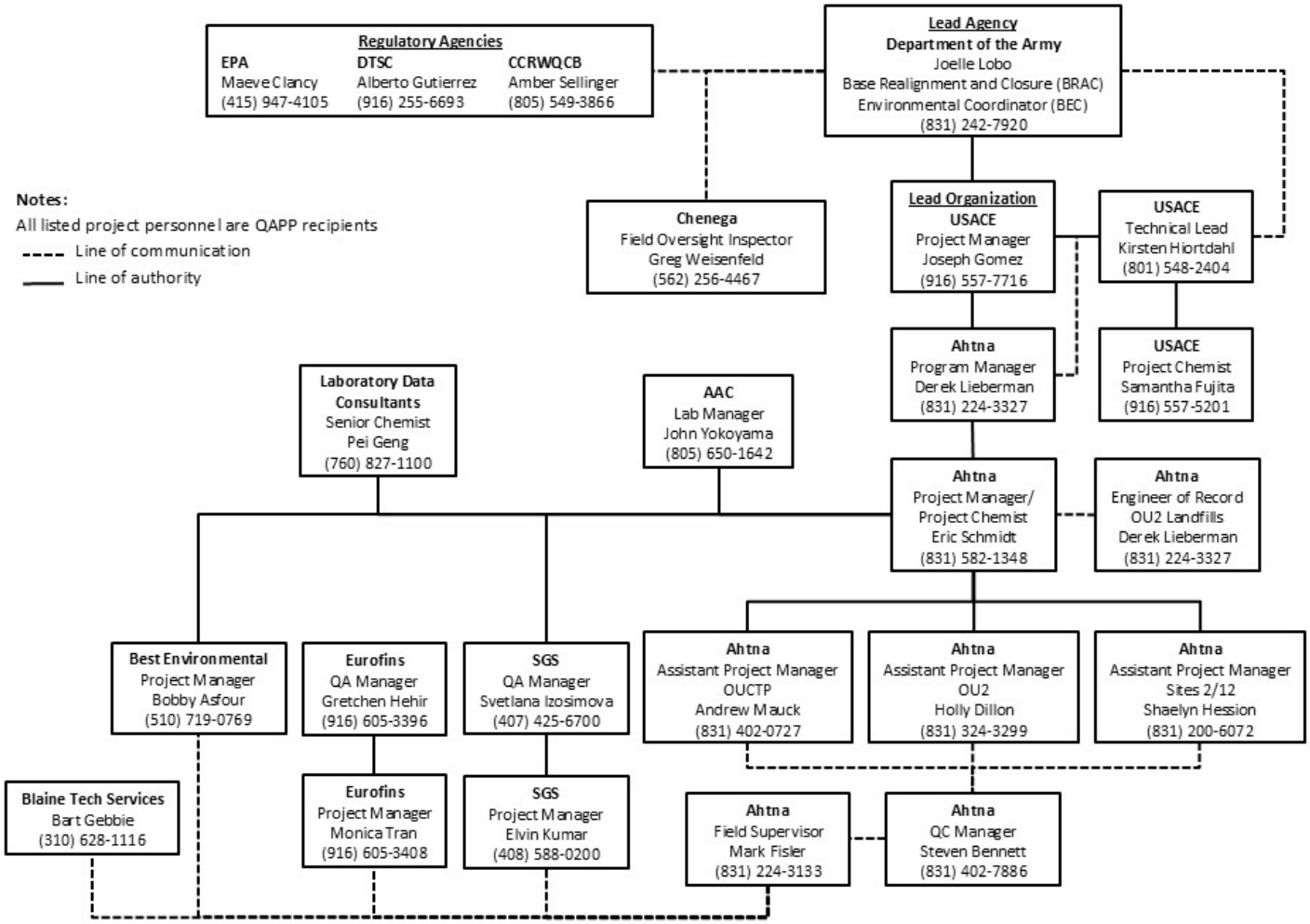
Plans and reports from previous investigations relevant to this project:

Title	Approval Date
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix A Final Revision 13, Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume (BW-2785GG)	March 2026
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Addendum No. 1, Well Installation and Decommissioning (BW-2785W)	December 2023
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Addendum No. 1, Well Installation and Decommissioning, Update No. 1 (BW-2785DD)	July 2025
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Draft Final Addendum No. 2, Sites 2 and 12 Monitoring Well Installation (BW-2785HH)	December 2023
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Addendum No. 2, Operable Unit Carbon Tetrachloride Plume Upper 180-Foot Aquifer Extraction Well Installation (BW-2948B)	May 2024
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix C, Final Revision 10, Soil Gas Monitoring at Sites 2 and 12 (BW-2792BB)	March 2026
Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix C, Final Addendum No. 1, Soil Gas Monitoring at Sites 2 and 12 (BW-2792K)	March 2020
Quality Assurance Project Plan, Volume I, Appendix D, Final Revision 10, Landfill Gas Monitoring at Operable Unit 2 Landfills (OU2-702BB)	February 2026
Operations and Maintenance Manual Revision 5, Operable Unit 2 Groundwater Treatment System	August 2025
Operations and Maintenance Plan Revision 4, Operable Unit 2 Landfills	December 2023
Final Operations and Maintenance Manual Volume II, Sites 2 and 12 (Sites 2/12) Groundwater Remedy (BW-2479G)	August 2009
Replacement pages for Section 2.5.3 of the Final Operations and Maintenance Manual Volume II, Sites 2 and 12 (Sites 2/12) Groundwater Remedy (BW-2479G.2)	March 2015
Final Operations and Maintenance Manual Volume III, Sites 2 and 12 Soil Vapor Extraction and Treatment System (BW-2763A)	December 2015
Final Groundwater and Soil Gas Monitoring and Treatment System Report, Sites 2 and 12, Fourth Quarter 2023 through Third Quarter 2024 (BW-2963B)	March 2026
Final Operable Unit 2 Remedy Monitoring and Operations and Maintenance, Fourth Quarter 2023 through Third Quarter 2024 (OU2-747B)	March 2026
Final Operable Unit Carbon Tetrachloride Plume Fourth Quarter 2023 through Third Quarter 2024 Groundwater Monitoring Report (OUCTP-0117B)	March 2026
Final Operable Unit Carbon Tetrachloride Plume A-Aquifer Monitoring Well Installation Work Plan Update (OUCTP-0106E)	March 2026

Title	Approval Date
Biological Monitoring Completion Report for the Fort Ord Natural Reserve (FONR) at the Operable Unit Carbon Tetrachloride Plume (OUCTP) (OUCTP-0119)	February 2025
Reinitiation of Formal Consultation for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (Original Consultation #8-8-09-F-74, 81440-2009-F-0334) (BW-2747A)	June 2017
Installation-Wide Habitat Management Plan for Former Fort Ord, California (BW-1787)	April 1997

2.2 Worksheet #3 & 5: Project Organization and QAPP Distribution

Reporting relationships between organizations involved in the project, including the lead agency, lead organization, contractors, and subcontractor organizations are identified below.



2.3 Worksheet #4, 7 & 8: Personnel Qualifications and Sign-Off Sheet

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Ahtna Personnel					
Derek Lieberman	Program Manager/ Project Geologist/ Engineer	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Eric Schmidt	Project Manager/ Chemist	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Holly Dillon	Assistant Project Manager	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Shaelyn Hession	Assistant Project Manager	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Andrew Mauck	Field Supervisor GIS Manager	Resume on file	First aid, CPR, MEC, HAZWOPER, CQM		
Steven Bennett	QC Manager	Resume on file	MEC, HAZWOPER, CQM		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Blaine Tech Services Personnel					
Bart Gebbie	Project Manager/ Field Coordinator	Resume on file	HAZWOPER, MEC		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
SGS North America, Inc. (SGS) Lab Personnel					
Elvin Kumar	Project Manager, Florida	Resume on file	Not applicable		
Svetlana Izosimova	QA Officer, Florida	Resume on file	Not applicable		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Eurofins Environment Testing Northern California, LLC (Eurofins) Lab Personnel					
Monica Tran	Project Manager	Resume on file	Not applicable		
Gretchen Hehir	QA Manager	Resume on file	Not applicable		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Atmospheric Analysis and Consulting, Inc. Lab Personnel					
John Yokogawa	Lab Manager	Resume on file	Not applicable		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Best Environmental Lab Personnel					
Bobby Asfour	Project Manager	Resume on File	Not applicable		

Name	Project Title/ Role	Education/ Experience	Specialized Training/ Certifications[1]	Signature[2]	Date
Laboratory Data Consultants, Inc. Personnel					
Pei Geng	Senior Chemist	Resume on File	Not applicable		

2.4 Worksheet #6: Communication Pathways

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
Regulatory agency Interface	Army	Joelle Lobo, BEC	(831) 242-7920 joelle.l.lobo.civ@army.mil	Materials and information regarding the project will be forwarded by email to the EPA, DTSC and CCRWQCB (collectively the "regulatory agencies") through the Army Base Realignment and Closure Environmental Coordinator (BEC) for review at scheduled Base Realignment and Closure (BRAC) Cleanup Team meetings.
Army BRAC Office interface	USACE	Kirsten Hiortdahl, Technical Lead	(801) 548-2404 Kirsten.M.Hiortdahl@usace.army.mil	Materials and information regarding the project will be forwarded by email to the Army BRAC Office through USACE Technical Lead for review at scheduled Army Internal Progress Meetings.
Lead Organization Project Manager interface	Ahtna	Eric Schmidt, Project Manager	(831) 582-1348 eschmidt@ahtna.net	Materials and information regarding the project will be forwarded by email to USACE by the Ahtna Project Manager for review at weekly status meetings.
Field progress reports	Ahtna	Mark Fisler, Field Supervisor	(831) 224-3133 mfisler@ahtna.net	Ahtna Field Supervisor will report fieldwork progress by email to Ahtna Project Manager daily.
Stop work due to safety issues	Ahtna	Scott Davis, Site Safety and Health Officer	(970) 634-3270 rdavis@ahtna.net	All onsite Personnel have the authority and responsibility to stop work on the site if an imminent hazard is observed. The Site Safety and Health Officer will be consulted by phone immediately for further recommendations.
QAPP changes prior to fieldwork	Ahtna	Eric Schmidt, Project Manager	(831) 582-1348 eschmidt@ahtna.net	Significant changes to the QAPP must be approved by the Ahtna Project Manager, USACE Technical Lead, and USACE Project Chemist, and submitted to the regulatory agencies for review and comment via email (where the subject of the email is "QAPP Change") prior to implementation.

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
QAPP changes during project execution*	Ahtna	Eric Schmidt, Project Manager	(831) 582-1348 eschmidt@ahtna.net	Field changes to the QAPP must be approved by the Ahtna Project Manager, USACE Technical Lead, and USACE Project Chemist by phone or email (where the subject of the email is "Field Change Request") prior to implementation.
Field corrective actions*	Ahtna	Mark Fisler, Field Supervisor	(831) 224-3133 mfisler@ahtna.net	Ahtna Field Supervisor will determine the need for corrective action and will report field issues to the Ahtna Project Manager daily. Ahtna Project Manager will notify the Ahtna QC Manager of issues within one business day and will respond to the request for corrective action within 24 hours.
Sample receipt variances (groundwater and soil)	SGS	Svetlana Izosimova, QA Officer	(407) 425-6700 Svetlana.Izosimova@sgs.com	Discrepancies or non-compliance are documented immediately on the Sample Receipt Confirmation Form, which is automatically emailed to the SGS Project Manager, who will immediately contact the Ahtna Project Chemist for resolution.
Sample receipt variances (gases)	Eurofins	Gretchen Hehir, QA Officer	(916)-605-3396 Gretchen.Hehir@et.eurofinsus.com	Discrepancies or non-compliance are documented immediately on the Sample Receipt Confirmation Form, which is automatically emailed to the Eurofins Project Manager, who will immediately contact the Ahtna Project Chemist for resolution.
Laboratory QC variances	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report laboratory QC issues to USACE Technical Lead and USACE Project Manager by email within two business days of the occurrence.
Analytical corrective actions*	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will determine the need for corrective action and will report nonconformance and QC issues to the Ahtna Project Manager and USACE Project Chemist by email within two business days of the occurrence.
Data verification issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report incomplete records issues to USACE Technical Lead and USACE Project Manager by email within five business days of completing data verification (Worksheet #35).

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
Data validation issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report non-compliance with procedures to USACE Technical Lead and USACE Project Manager by email within five business days of receiving data validation reports.
Data usability issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report data quality issues that could impact data usability to USACE Technical Lead/USACE Project Chemist within five business days of completing the usability assessment (Worksheet #37).
Data review corrective actions	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will determine the need for corrective action and will provide recommendations to the Ahtna Project Manager and USACE Technical Lead by email within five business days of completing the data review.
Release of analytical data	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Analytical data will not be released until review or validation is completed, as appropriate. The Ahtna Project Chemist will approve the release of data to the Ahtna Project Manager.
Data import and export	Ahtna	Teri Farrell-Bage, Database Manager	(925) 915-6255 tbage@ahtna.net	The Ahtna Database Manager coordinates with the Ahtna Field Supervisor and SGS Project Manager to obtain data for electronic upload/manual entry into the data management system, review the entered data for QC, and prepare the required tables and plots of the data. The Ahtna Project Chemist coordinates for QC purposes and forwards deliverables to the Project Manager.

Notes:

*****In the event significant QAPP changes occur during project execution or significant corrective action is required for field or laboratory activities, the Army will provide information concerning the QAPP change or corrective action to the regulatory agencies within 14 days of the event or the next scheduled meeting of the BRAC Cleanup Team (BCT), whichever is sooner.

2.5 Worksheet #9: Project Planning Session Summary

Date of Planning Session: August 13, 2025

Purpose: Define scope of work to be included in the QAPP

Project Planning Session Participants

Name	Title	Affiliation	Telephone #	Email Address
Derek Lieberman	Program Manager/ Project Geologist/ Engineer	Ahtna	(831) 287-5258	dlieberman@ahtna.net
Eric Schmidt	Project Manager/ Chemist	Ahtna	(831) 287-5254	eschmidt@ahtna.net
Holly Dillon	Assistant Project Manager	Ahtna	(831) 287-5240	hdillon@ahtna.net

Notes/Comments:

Reviewed contract requirements and schedule and requirements for the QAPP. Reviewed previous revisions of Groundwater QAPP, Soil Gas QAPP, and Landfill Gas QAPP for potential updates needed. This QAPP will address:

- Groundwater extraction and treatment monitoring activities at OU2 Sites 2/12.
- Groundwater monitoring activities at locations related to the former Fort Ord
- SVETS monitoring activities at Sites 2/12.
- Soil gas monitoring activities at Sites 2/12.
- LFG extraction and treatment system monitoring activities at the OU2 Landfills.
- LFG monitoring activities at the OU2 Landfills.
- Groundwater well installation and decommissioning.
- Soil gas probe installation and decommissioning.

Consensus decisions made:

Previous four quarters of monitoring data (Fourth Quarter 2024 through Third Quarter 2025) will be reviewed and compared to the QAPP decision rules to produce a list of recommended changes to the monitoring programs for incorporation in this QAPP. The recommendations will be presented at upcoming Hazardous and Toxic Waste BCT meetings.

Action Items:

Action	Responsible Party
Initiate QAPP for basewide project tasks	Ahtna
Incorporate existing latest revisions of the Groundwater, Soil Gas, and Landfills QAPPs into a single QAPP	Ahtna
Add elements for monitoring well and soil gas probe construction and decommissioning	Ahtna

Action	Responsible Party
After review of Fourth Quarter 2024 through Third Quarter 2025 data and comparison to the analytic approach in the Groundwater QAPP, update the monitoring frequencies for groundwater monitoring and extraction wells.	Ahtna
After review of Fourth Quarter 2024 through Third Quarter 2025 data and comparison to the analytic approach in the Soil Gas QAPP, update the sampling frequencies for Sites 2/12 soil gas probes.	Ahtna
After review of Fourth Quarter 2024 through Third Quarter 2025 data and comparison to the analytic approach in the Landfill Gas QAPP, update the sampling frequencies for LFG probes.	Ahtna

3.0 Project Quality Objectives

3.1 Worksheet #10: Conceptual Site Model

3.1.1 Background and History

The former Fort Ord is located along the Pacific Ocean in northwest Monterey County, California (Figure 1). The former military installation covers about 28,000 acres, is bounded by Monterey Bay to the west and the Santa Lucia Range to the south, and is surrounded by the cities of Del Rey Oaks, Marina, Sand City, and Seaside. State Route 1 and the former Union Pacific Railroad right-of-way traverse through the western portion of the former Fort Ord, separating the Monterey Bay beachfront from the rest of the installation. The former Fort Ord served as a training and staging facility for infantry troops from 1917 until its closure in 1994. In 1990, the former Fort Ord was placed on the EPA's National Priorities List (NPL)[1] primarily due to volatile organic compounds (VOCs) found in groundwater beneath the Fort Ord Landfills. The former Fort Ord was closed in 1994 under the BRAC Act.[2] Environmental remediation at the former Fort Ord is being completed pursuant to the CERCLA §121 and the National Oil and Hazardous Substances Contingency Plan.

3.1.1.1 Sites 2/12

The Sites 2/12 area is located on the northwest portion of the former Fort Ord in the former Main Garrison area (Figure 1). Site 2 is located west of State Route 1 between the 8th and Imjin Parkway over crossings. Site 12 is located east of State Route 1 between the former 10th Street and Imjin Parkway (Figure 3).

When the former Fort Ord was an active military facility, Site 2 consisted of the primary sewage treatment facility for Fort Ord. From its construction in the mid-1930s through its closure in 1990, the facility served a majority of the residential areas and main industrial areas during its years of operation. The facility had a design capacity of 4.25 million gallons per day but typically treated only 2.8 million gallons per day (EA, 1991). Effluent from the facility was discharged into a storm drain that emptied onto Indian Head Beach during low tide and directly into Monterey Bay during high tide (HLA, 1995). The sewage sludge was digested anaerobically and dried in asphalt-lined sludge drying beds. The configuration of the site and analytical results from soil sampling conducted in 1996 indicate effluent from the sludge drying beds discharged to the evaporation pond immediately to the south (Ponding Area 1) with overflow going to Ponding Area 2 and Ponding Area 3 (HLA, 1997).

No remedial action was proposed for soil at Site 2 (Army, 1997a); however, in 1997, as part of the maintenance and cleanup activities associated with the closure of Site 2, sludge was removed from the drying beds. Approximately 15,000 cubic yards of sludge, soil, and asphalt and wood debris were disposed of in the OU2 Landfills under the engineered cover system. In addition, conveyance piping under the drying beds and evaporation ponds was removed and disposed of in the OU2 Landfills. The area was then revegetated with native plants (IT, 2000). In 2006, the site was transferred to California

[1] The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation.
[2] BRAC is the process the Department of Defense (DoD) has used to reorganize its installation infrastructure to more efficiently and effectively support its forces and increase operational readiness.

Department of Parks and Recreation and is currently operated as part of the Fort Ord Dunes State Park, although public access to the former sewage treatment facility is restricted by a chain-link fence.

Site 12 included numerous industrial activities, including vehicle maintenance and repair, furniture repair, storage of motor oils, hazardous material storage, and vehicle cleaning and degreasing. Site 12 was comprised of four areas:

- **Lower Meadow**. This area was used for disposal of waste material such as scrap metal, oil, and batteries generated by the Directorate of Logistics (DOL). The depth of fill material was up to 30 feet. The area was also used for the disposal of road construction debris. The Lower Meadow received runoff from the DOL Automotive Yard and several pipes discharged into the Lower Meadow.
- **DOL Automotive Yard**. This area included several buildings used for automotive repair, two wash racks, an oil/water separator, an aboveground storage tank, and a paint shop. Activities at the DOL Automotive Yard included transmission repair, degreasing, engine testing, steam cleaning and washing vehicles, and petroleum/oil/lubricant storage.
- **Cannibalization Yard**. This area was used from 1964 until 1994 to disassemble old equipment, primarily decommissioned military vehicles. Used motor oil was collected in pans and transferred to 55-gallon drums for storage. Other activities included draining/removing gasoline (leaded and unleaded), diesel fuel, brake fluid, asbestos-containing brake shoes and linings, antifreeze/coolants, lead and acid from batteries, lubricating greases, and transmission fluids. One oil/water separator at the northeast comer of the yard collected surface runoff from the area.
- **Southern Pacific Railroad Spur**. The spur included in Site 12 extended from the main track east of State Route 1, across First Avenue, and between the DOL Automotive Yard and the Cannibalization Yard and surrounding industrial area. The relatively flat right-of-way was mostly unpaved except in those areas adjacent to loading docks and where the spur crossed First Avenue. Hydrocarbons may have been sprayed in this area for dust control.

The Remedial Investigation (RI) conducted at Sites 2/12 between 1992 and 1994 identified the primary COCs in groundwater as trichloroethene (TCE) and tetrachloroethene (PCE) and the primary COC in soil as total petroleum hydrocarbons (TPH) (HLA, 1995). The RI Sites Record of Decision (ROD; Army, 1997a) defined the selected groundwater remedy as extracting and treating contaminated groundwater with granular activated carbon (GAC) and disposing of the treated water by injection and infiltration back into the aquifer. The RI Sites ROD also defined the selected soil remedy as excavation of soil and debris at Site 12 in the Lower Meadow Disposal Area, the Outfall Area and the Cannibalization Yard containing TPH at concentrations above 500 milligrams per kilogram.

The Sites 2/12 soil remedy was initiated in March 1997 and consisted of excavation of approximately 58,400 cubic yards of TPH-impacted soil and debris. Site restoration, including backfilling the excavations with clean soil, hydroseeding and paving were completed in September 1998 (IT, 1999a). The Sites 2/12 groundwater remedy, consisting of a groundwater treatment plant (GWTP), seven extraction wells, two injection wells, and three infiltration galleries, began operations in 1999 (IT, 1999b). There was no remedial action required by the RI Sites ROD at the DOL Automotive Yard or the railroad spur. In March 2004, the Army transferred the property at Site 12 and the land was redeveloped into a commercial retail area, which included construction of several big-box stores and a large parking area.

Although groundwater remediation activities have been conducted since 1999 and have successfully reduced TCE concentrations in groundwater at Sites 2/12, PCE concentrations began increasing in 2011 (ITSI, 2012), creating the potential for vapor intrusion to the overlying retail area, and additional investigations of soil, soil gas, groundwater, indoor air, and sub-slab soil gas were conducted in 2013 and 2015 as part of the RI Addendum at Sites 2/12 (AES, 2015 and AEI, 2016a).

PCE and TCE were detected in indoor air and sub-slab soil gas and a human health risk assessment (HHRA) was conducted using these data as part of the RI Addendum at Sites 2/12. The HHRA concluded the vapor intrusion pathway does not present an unacceptable risk to human health (AEI, 2016a). Groundwater in the upper portion of the Upper 180-Foot Aquifer, where soil vapors may form, was investigated in 2013 and found to contain a plume of PCE above its Aquifer Cleanup Level (ACL). Vadose (unsaturated) zone soils were also investigated, but only PCE and TCE were detected in the soil samples at concentrations below their respective soil screening levels. Soil gas was also investigated and distinct PCE and TCE plumes were identified in the vadose zone (AES, 2015).

Per the Explanation of Significant Differences (RI Sites ESD No. 1; Army 2016) to the RI Sites ROD (Army, 1997a), the groundwater remedy was expanded in 2015 to address a groundwater remedial unit and a soil gas remedial unit, both within Site 12. EW-12-08-180U is the newest extraction well, installed in 2015 to optimize the capture and extraction of PCE. The Sites 2/12 groundwater remedy was then modified to include a SVETS, in operation since September 2015, to remediate the Sites 2/12 vadose zone and prevent partitioning of PCE and TCE from the vadose zone into groundwater.

3.1.1.2 OU2

As a result of detections of VOCs in Fort Ord and Marina Coast Water District (MCWD) water supply wells, the CCRWQCB issued Cleanup and Abatement Order (CAO) 86-87 that required the initiation of soil and groundwater studies to assess the potential impact of the Fort Ord Landfills on underground water resources. The CCRWQCB also issued CAO 86-317 and CAO 88-139 requiring the investigation and cleanup of groundwater contamination caused by the Landfill and Waste Discharge Requirements No. 87-153 requiring landfill closure by 1989. The Army initiated studies to evaluate whether chemicals from the Fort Ord Landfills had affected the underlying soil or the quality of groundwater beneath the Fort Ord Landfills (HLA, 1990). The *Final Remedial Investigation Report, Remedial Investigation/Feasibility Study, Fort Ord Landfills, Fort Ord, California* (OU2 RI/FS; Dames & Moore, 1993) indicated the presence of VOCs in groundwater samples collected from both the A-Aquifer and the 180-Foot Aquifer.

The OU2 Landfills at the former Fort Ord consist of six landfill areas (Areas A through F), with Area A located north of Imjin Parkway and Areas B through F to the south, covering approximately 150 acres in total (Figure 1). These landfills were used for residential and base-related waste disposal, with Area A, about 33 acres, used from 1956 to 1966, and Areas B through F operating from 1960 until 1987, when waste disposal activities ceased. Waste was placed in parallel trenches 10 to 30 feet deep and then covered over with the native dune sand excavated during trenching operations. Detailed disposal records are not available; however, information gathered during field activities and from other sources indicates household and on-base commercial refuse, dried sewage sludge, construction debris, and small amounts of chemical waste (paint, oil, pesticides, electrical equipment, ink, and epoxy adhesive) were placed in the Fort Ord Landfills. These activities led to the release of contaminants to underlying groundwater.

Remedial actions at Area A were conducted between 1996 and 1998, and involved excavation of approximately 585,000 cubic yards of refuse, which was relocated to Areas B, C, D, and F (IT, 2001). The remedial actions for the debris and soil at the OU2 Landfills include an engineered cover system for Areas B, C, D, E and F, collection and removal of LFG (if necessary), and institutional controls to restrict rainfall infiltration and prevent leaching to underlying groundwater of VOCs remaining in waste materials and soil, prevent potential exposure of VOCs to the environment or people who use the site in the future, and prevent exposure of sanitary waste in the OU2 Landfills to the surrounding environment. The Army completed construction of an engineered cover over Areas B through F from 1997 to 2002 (Shaw, 2005a). In 2001, the Army installed a pilot extraction and treatment system to mitigate LFG migration along the eastern perimeter of Area F where a residential area is located closest to the landfill (Shaw, 2005b). The system began operation on June 4, 2001 and included a series of LFG extraction wells (EWs), LFG treatment with granular activated carbon (GAC) to remove VOCs, and potassium permanganate to remove vinyl chloride. Two 8-inch diameter perforated collector pipes, approximately 800 feet in total length, were installed in the foundation layer at Area E during construction of the engineered cover system in 2002 for possible future methane extraction. The collector pipes are collectively referred to as extraction point (EP) EP-36.

Based on the results of the pilot study, the extraction and treatment system was expanded by adding vertical extraction wells (EW) along the perimeter and within the interior of Area F and replacing the existing treatment system with a thermal treatment unit (TTU), which started operation in April 2006. The TTU, unlike the GAC/potassium permanganate treatment system, removes and treats both VOCs and methane by combustion in an enclosed flare operating in excess of 1,400 degrees Fahrenheit (°F).

In 2008, an EW was installed in Area D to augment the methane output from the Area F extraction system. A conduit from EP-36 to the TTU also was installed as part of the LFG treatment system expansion (Shaw, 2008). In April 2009, EP-36 was brought online to augment the methane output from the Area F extraction system. As part of Field Work Variance TII-138 to the O&M Plan (Shaw, 2009), testing was performed on Area F passive vent (VF) VF-4 to determine if it was a viable source of methane that could be used for operation of the TTU. Results of this test determined that a significant increase in methane removal could be achieved through the addition of VF-4 into the extraction network. In June 2009, VF-4 was brought online to augment the methane output from the Area F extraction system.

In February 2011, two additional Area D passive vents (VD) and two additional VFs (VD-2, VD-3, VF-3, and VF-5) were converted to EPs to augment the methane output. These additions were documented in Field Work Variance TII-154 to the O&M Plan (Shaw, 2011).

System monitoring includes EPs and the combined collection points at the TTU. The remedy is being performed under CERCLA; therefore, the Monterey Bay Air Resources District (Air District) does not have jurisdiction over these remedial actions and a permit for the TTU and exhaust stack is not required. However, the Air District's substantive requirements are being implemented.

OU2 ESD No. 3 (Army, 1997b) addressed the reuse of remediation waste (soil and debris with residual lead excavated from remediation areas at Fort Ord), and consolidation of the waste within the main landfill (Areas B through F) as a foundation layer rather than using clean soil for the same purpose. OU2 ESD No. 4 (Army, 2006) clarifies that the intent and purpose of OU2 ESD No. 3 was not to formally designate the OU2 Landfills as a CAMU, but to state that the substantive CAMU requirements of

California Code of Regulations (CCR) Title 22 and the Resource Conservation and Recovery Act (RCRA) are applicable to the Fort Ord Landfills. Meeting the substantive CAMU requirements allows for remediation waste to be placed within the OU2 Landfills without triggering certain disposal regulations and soil and debris from other remedial sites were incorporated into the landfill foundation layer and capped.

Due to the need for remediation at the Site 39 Inland Ranges, and the availability of additional remediation waste capacity at Area E, the Army proposed to place contaminated soil from the Site 39 Inland Ranges within the existing footprint of Area E as a vertical expansion. The Army prepared the RI Sites ROD Amendment, Site 39 Inland Ranges, Former Fort Ord, California (Army, 2009) to present the soil cleanup levels and the volume of soil to be addressed under the selected remedial action for the Site 39 Inland Ranges originally identified in the RI Sites ROD (Army, 1997a). Additional capacity at the OU2 Landfills was available by placing remediation waste within the existing Area E footprint on top of the existing engineered cover system. Construction of the vertical expansion involved placing additional remediation waste above the existing geomembrane and installing a new engineered cover consisting of a foundation layer, geomembrane, and vegetative layer over the remediation waste. The vertical expansion allows for placement of approximately 200,000 cubic yards of remediation waste in at least two phases. When the vertical expansion is complete, the additional remediation waste will be sealed above and below by a geomembrane. Phase 1 was completed in 2013 with approximately 150,000 cubic yards placed in the vertical expansion at Area E. Additional remediation of Site 39 and placement of soil in the Area E vertical expansion may be necessary for the future.

The OU2 groundwater plume, identified by eleven COCs, migrated west from the OU2 Landfills to the edge of the Fort Ord-Salinas Valley Aquitard (FO-SVA) where it entered the Upper 180-Foot Aquifer and migrated east back toward the OU2 Landfills. A groundwater treatment system (GWTS) was constructed in 1995 to remediate groundwater contaminated by discharges from the OU2 Landfills. The system was updated and expanded in 2001 and 2006-2007, and then expanded further and the GWTP replaced in 2018. The new GWTP was constructed at the Fort Ord Landfills to increase treatment capacity and efficiency as the OU2 groundwater plumes have been reduced in size significantly since groundwater extraction and treatment began in 1995.

3.1.1.3 OUCTP

Carbon tetrachloride (CT) was originally identified in groundwater in 1992 as part of the basewide groundwater monitoring activities associated with OU2. The results from the initial investigation of CT were presented in the *Draft Final Carbon Tetrachloride Investigation Report* (HLA, 1999b). Subsequent investigation activities and studies of OUCTP were conducted as part of the OUCTP RI/FS (MACTEC, 2006). The apparent former source of the CT was located in the vicinity of what is now Lexington Court, a residential area in the northern portion of the former Fort Ord (MACTEC, 2006). The groundwater contaminant plume emanating from this area ultimately extended across a large area bounded by East Garrison to the east, Del Monte Boulevard in the City of Marina to the west, Neeson Road and the Marina Municipal Airport to the north, and Abrams Drive to the south. This area encompasses the lateral extent of CT detected in groundwater within the A-Aquifer, Upper 180-Foot Aquifer, and Lower 180-Foot Aquifer.

The OUCTP ROD (Army, 2008) established the remedial criteria to be implemented for site restoration. Between 2006 and 2008, an enhanced in situ bioremediation (EISB) pilot study was completed in the A-

Aquifer of the OUCTP to enhance the natural attenuation of the plume. The pilot study confirmed the effectiveness of this approach and full implementation of active EISB at five deployment areas (Figure 10) within the A-Aquifer was completed between September 2009 and June 2012. The EISB remedial action has proven to be effective in reducing groundwater contamination in the previously treated areas of the A-Aquifer; however, CT concentrations continued to increase in the A-Aquifer groundwater divide area and show continued migration to the north towards the Marina Municipal Airport. Therefore, an additional EISB remedial action was implemented (Deployment Area 3A) in this area (AEI, 2020). Long-term monitoring is continuing as part of the remedial action to evaluate changes in contaminant concentrations and groundwater geochemistry over time.

Remedial actions for the Upper 180-Foot Aquifer included installation of one extraction well (EW-OU2-09-180) in 2010 to extract groundwater from the downgradient edge of the plume in that aquifer to remove contaminant mass and to minimize further impact to the Lower 180-Foot Aquifer by capturing the contaminated groundwater before it reaches the area of vertical communication through the Intermediate 180-Foot Aquitard (Shaw, 2012). The first confirmed detection of CT in EW-OU2-09-180 was observed in the Third Quarter 2014, with intermittent detections at concentrations below the ACL since then, demonstrating the relative inefficiency of this extraction well in removing CT mass and containing the CT plume in the Upper 180-Foot Aquifer. This indicates CT continued to migrate from the Upper 180-Foot Aquifer to the Lower 180-Foot Aquifer during the operational lifespan of EW-OU2-09-180. The submersible pump at EW-OU2-09-180 failed in 2023 and subsequent investigation found the well screen to be compromised. Due to the low remedial efficiency of EW-OU2-09-180, the compromised well screen, and nearby extraction well EW-OU2-13-180 being constructed in 2024, it was determined that rehabilitation and operation of EW-OU2-09-180 was no longer warranted. To remediate and capture the CT plume in the Upper 180-Foot Aquifer, replacement extraction well EW-OU2-13-180 was constructed within the southern CT plume and normal operation began in First Quarter 2025 (Ahtna, 2025a).

The selected remedies for the Lower 180-Foot Aquifer, as identified in the OUCTP ROD, are monitored natural attenuation (MNA) with a wellhead treatment contingency to be implemented if COCs associated with OUCTP are detected at concentrations over the ACL in potable water supply wells, and institutional controls such as Monterey County Code Title 15, Chapter 15.08.140, which prohibits construction of water wells within the Prohibition Zone of the Fort Ord Special Groundwater Protection Zone. Four OUCTP Lower 180-Foot Aquifer multi-port wells were installed to provide additional data on the potential migration of the CT plume into the Lower 180-Foot Aquifer and towards MCWD production wells FO-29, FO-30, and FO-31 (AES, 2011). The wells are monitored in the groundwater monitoring program (GWMP) for OUCTP as part of the MNA remedy.

3.1.2 Sources of Known or Suspected Hazardous Waste

3.1.2.1 Sites 2/12

When the former Fort Ord was an active military facility, Site 2 consisted of the primary sewage treatment facility for Fort Ord, and Site 12 included numerous industrial activities, including vehicle maintenance and repair, furniture repair, storage of motor oils, hazardous material storage, vehicle cleaning and degreasing, and disposal of waste and oil. Historical activities at Sites 2/12, including disposal of solvents at Site 12, resulted in releases of VOCs, primarily TCE and PCE, into soil and groundwater as identified during the original RI conducted at the site (HLA, 1995). The Upper 180-Foot

Aquifer COC plume appeared to have originated from Site 12 and was subsequently transported over 3,000 feet to the southwest by groundwater flow, passing beneath State Route 1 and into the Site 2 area (Ahtna, 2026c).

3.1.2.2 OU2

No detailed records were kept on the amount or types of wastes disposed of at the Fort Ord Landfills; however, household and commercial refuse, ash from incinerated infectious wastes, dried sewage sludge, demolition material, and small amounts of chemical waste (such as paint, waste oil, pesticides, electrical equipment, ink, and epoxy adhesives) are believed to have been disposed of in the Fort Ord Landfills (Dames & Moore, 1993). Methane emanates from decomposing organic waste and VOCs emanate from waste and infiltrate to groundwater.

3.1.2.3 OUCTP

The apparent source of the OUCTP groundwater plume is located on what is now Lexington Court in the City of Marina, a residential area in the northern portion of the former Fort Ord. Historical practices at this site included cleaning electronic equipment and radios and used CT, a very commonly used solvent from the 1940s through the 1960s, was likely disposed of to the ground over a period of years (MACTEC, 2006).

3.1.3 Known Contaminants

Known contaminants, or COCs, were identified during RIs at the sites and documented in the decision documents for each site. The COCs are listed in Worksheets #15a, #15d, and #15e and are summarized below.

3.1.3.1 Sites 2/12

There are eight COCs for groundwater at Sites 2/12, with the primary COCs (those detected at the highest concentrations over the greatest area) identified as PCE and TCE. PCE and TCE are used to define the extent of the groundwater plume and ACLs for both are 5 micrograms per liter (µg/L). The soil gas COCs are PCE and TCE, with soil gas cleanup levels (SGCLs) of 1,800 micrograms per cubic meter (µg/m^3) and 1,000 µg/m^3, respectively. Decision documents include the RI Sites ROD (Army, 1997a) for groundwater COCs and RI Sites ESD No. 1 (Army, 2016) for soil gas COCs.

3.1.3.2 OU2

There are eleven COCs for groundwater at OU2, with the primary COCs used to define the extent of the groundwater plume being 1,1-dichloroethane; 1,2-dichloroethane; cis-1,2-dichloroethene; PCE; TCE; and vinyl chloride (ACLs are listed in Worksheet #15a). Known contaminants at the OU2 Landfills are methane and VOCs in LFG. Compounds of interest in LFG are the eleven VOCs identified as COCs for groundwater in the OU2 ROD (Army, 1994).

3.1.3.3 OUCTP

The primary COC in groundwater at OUCTP is CT with an ACL of 0.5 µg/L; however, there are eight COCs for the A-Aquifer, one COC for the Upper 180-Foot Aquifer, and three COCs for the Lower 180-Foot Aquifer. Decision documents include the OUCTP ROD (Army, 2008) and OUCTP ESD No. 1 (Army, 2026).

3.1.4 Fate and Transport Considerations

3.1.4.1 Sites 2/12

There are or have been four potential migration pathways specific to Sites 2/12:

- Leaching of chemicals into underlying unsaturated zone soil
- Diffusion of vapor-phase chemicals in soil gas
- Partitioning of chemicals between soil gas and groundwater
- Migration of dissolved phase chemicals in groundwater

Based on environmental conditions, historical data at Sites 2/12, and chemical-specific properties, PCE and TCE are considered to have medium to high persistence and moderate mobility. Soil types present at the site have a low retardation factor and there is insignificant adsorption of these chemicals. Additionally, PCE and TCE water solubilities and partition coefficients indicate moderate mobility. Persistence of PCE and TCE over time and the relative absence of breakdown products indicate little or no reductive dechlorination of these compounds, particularly in soil gas. Concentration-driven diffusion is likely a continuing process at Site 12, given the variation of concentration gradients in the unsaturated zone over time. Additionally, groundwater and soil gas analytical data and modeling during the RI/FS Addendum at Sites 2/12 indicated the areas of highest concentrations of PCE and TCE in soil gas were associated with concentrations of PCE and TCE in groundwater that exceed ACLs (AES, 2015). Groundwater contamination at Sites 2/12 affected the unconfined Upper 180-Foot Aquifer.

Diffusion of the soil gas PCE plume resulted in expansion downward to the water table, where PCE moved from the vapor phase into the groundwater by dissolving into water infiltrating through the capillary fringe. PCE partitioned between soil gas and groundwater as it moved toward equilibrium in the two media.

The groundwater aquifer of interest within Sites 2/12 is the unconfined Upper 180-Foot Aquifer, which consists primarily of sandy deposits with some gravel. Depth to groundwater in the Upper 180-Foot Aquifer is between 45 and 260 feet below ground surface (bgs) across the northern part of the former Fort Ord, and between 45 and 95 feet bgs in the Sites 2/12 area. Groundwater in the Upper 180-Foot Aquifer in the Sites 2/12 area generally flows southwest. A north-trending groundwater divide in the unconfined Upper 180-Foot Aquifer occurs about midway between the FO-SVA edge and Monterey Bay. The source area of Sites 2/12 is west of this divide. Groundwater west of this Upper 180-Foot Aquifer divide flows west-southwest to discharge into Monterey Bay, and groundwater to the east flows beneath the FO-SVA (confined) toward the Salinas Valley.

3.1.4.2 OU2

VOCs remaining in waste disposed of at the Fort Ord Landfills and VOCs detected in LFG have the potential to travel through soil pore space to exposure points via several mechanisms:

- Advection: mass transport due to bulk flow of water in which contaminants are dissolved
- Dispersion: transport due to the groundwater flow, whether or not a compound is dissolved
- Diffusion: spreading of contaminants due to molecular diffusion in response to concentration gradients
- Volatilization: loss of chemical vapor to the atmosphere

VOCs naturally undergo biochemical degradation processes in soil, soil gas, and groundwater; however, the rate of such degradation is limited by oxygen and nutrient sources depending upon the type of degradation that is occurring (aerobic vs. anaerobic). Additionally, degradation of compounds is dependent on the biochemical pathway available.

Groundwater contamination at OU2 affected the A-Aquifer and the Upper 180-Foot Aquifer (Army, 1994). In the vicinity of OU2, the tops of these aquifers typically are first encountered at depths of about 60 feet bgs and 150 feet bgs, respectively. In monitoring wells located at the OU2 Landfills Area F source area (e.g., MW-OU2-02-A and MW-OU2-73-A), PCE and TCE concentrations are below their ACLs or not detected (ND), but vinyl chloride is detected at concentrations above the ACL. Vinyl chloride is a breakdown product in the natural reductive dechlorination process and may indicate this process is occurring locally at OU2 Landfills Area F.

Impacts to the underlying groundwater from the OU2 Landfills have been greatly mitigated with the implementation of the remedy as prescribed in the OU2 ROD (Army, 1994), which includes an engineered landfill cover system and the GWTS, in addition to operation of the landfill gas extraction and treatment system.

3.1.4.3 OUCTP

There are or have been four potential migration pathways specific to OUCTP:

- Leaching of chemicals into underlying unsaturated zone soil
- Diffusion of vapor-phase chemicals in soil gas
- Partitioning of chemicals between soil gas and groundwater
- Migration of dissolved phase chemicals in groundwater

The CT plume appears to have originated from a training facility referred to in 1958 as “ST-11” near what is now Lexington Court. The plume migrated through the vadose zone beneath the vicinity of this facility and into the groundwater of the A-Aquifer, the Upper 180-Foot Aquifer, and the Lower 180-Foot Aquifer; CT has not been detected in the 400-Foot Aquifer.

Hydraulic communication between the A-Aquifer and the underlying aquifers is limited to those areas west of OUCTP where the FO-SVA clay unit pinches out, or where it was penetrated by wells without adequate sanitary seals. Two such vertical conduits were identified that resulted in the migration of CT from the A-Aquifer to the underlying Upper and Lower 180-Foot Aquifers. All identified vertical conduits have been destroyed (grouted and sealed), eliminating hydraulic communication through the FO-SVA between the A-Aquifer and the underlying aquifers. Groundwater in the Upper 180-Foot Aquifer flows to the southeast toward the apparent discontinuity in the underlying Intermediate 180-Foot Aquitard, where it then recharges the Lower 180-Foot Aquifer. Groundwater in the Lower 180-Foot Aquifer primarily migrates to the east (Army, 2008).

In addition to CT, chloroform, TCE, and PCE were also present both within the vadose zone (vapor-phase) and in the A-Aquifer near the source (dissolved phase).[3] Chloroform is a biodegradation product of CT, and its presence in OUCTP suggests there are native microbial bacteria acting within the

[3] There have been no detectable concentrations of PCE and TCE breakdown products (i.e., cis-1,2-DCE and vinyl chloride) to indicate biodegradation of PCE and TCE in the source area.

subsurface to biodegrade CT. The presence of PCE and TCE in soil gas near the source area suggests these compounds were also disposed of in this area, presumably during the use of the same training facility. In addition to CT, TCE is also present in the Lower 180-Foot Aquifer, which suggests groundwater originating from OU2 in the Upper 180-Foot Aquifer may be flowing from the southwest toward the apparent discontinuity in the Intermediate 180-Foot Aquitard (Ahtna, 2026a)

3.1.5 Potential Receptors and Exposure Pathways

Groundwater at Sites 2/12, OU2, and OUCTP is not currently used for domestic household purposes by residents within the Fort Ord area. Drinking water in the Fort Ord area is provided by the MCWD and is pumped from wells that are located east of the Sites 2/12, OU2, and OUCTP areas. These supply wells are screened in the Lower 180-Foot Aquifer or deeper aquifers. Groundwater within the Sites 2/12, OU2, and OUCTP areas is located in the Prohibition Zone of the Special Groundwater Protection Zone at the former Fort Ord, and Monterey County restricts installation of new supply wells in this zone. According to Monterey County Code Title 15 Section 15.08.140 (Monterey County Code, 2024), a prohibition zone is an area overlying or adjacent to a contaminant plume where water well construction is prohibited and applications for water wells will not be accepted; therefore, direct contact groundwater exposure pathways for residents potentially exposed to groundwater from the Sites 2/12, OU2 and OUCTP areas are currently incomplete and are expected to remain so in the future. Volumes III and IV of the Basewide RI/FS (HLA, 1995) provide details on the potential receptors and exposure pathways.

The potential for vapor intrusion to the retail area overlying Site 12 was evaluated in the HHRA using indoor air and sub-slab soil gas data collected as part of the RI Addendum at Sites 2/12. Indoor shoppers and retail workers were considered as potential receptors for the vapor intrusion exposure pathway. The HHRA concluded the vapor intrusion pathway does not present an unacceptable risk to human health (AES, 2015).

A residential area is located adjacent to OU2 Landfills Area F, with the closest residence located approximately 368 feet from the OU2 Landfills perimeter. There is a potential for residents to be exposed to VOCs from inhalation of vapors in ambient air, which may enter buildings through open windows or ventilation systems. To evaluate risks associated with this scenario, the Army performed ambient air monitoring in 2000, 2001, 2002, and 2003 to determine LFG dispersion in ambient air on the east side of Area F. The 2000, 2001, and 2002 data were used to complete a screening-level HHRA, which was then updated with the 2003 data. The updated HHRA indicated that risks and hazards estimated for the downwind receptor and background areas were roughly equivalent at the time the HHRA was conducted, and the risk and hazard drivers were similar in both data sets. It was concluded in the HHRA that there is no increased risk of developing cancer or other noncancer health effects from exposure to VOCs in ambient air downwind of the OU2 Landfills over the background risk of developing cancer or other noncancer health effects within the entire Fort Ord area (Shaw, 2005c). The HHRA also noted that the LFG collection and treatment system installed at Area F prevents LFG from migrating off-site in the direction of the residential area. Since the onset of TTU operations, the methane concentrations in perimeter monitoring probes have remained below 5 percent (%) per the requirements of Title 27 California Code of Regulations (27CCR) Section 20921(a)(2) (AEI, 2017, 2018, 2019a and Ahtna, 2021a, 2021b, 2022, 2023a).

3.1.6 Land Use Considerations

Current land use is described below as a consideration in implementing the GWMP and soil gas monitoring program (SGMP) because certain land uses may require specific procedures or notifications to obtain access to monitoring points.

3.1.6.1 Sites 2/12

The Site 12 area was redeveloped into a commercial retail and mixed-use commercial/residential area identified as The Dunes on Monterey Bay, which included construction of several big-box stores, a movie theater complex, food services, limited mixed-use residential units, and a large parking area. Property owners or managers are notified via email that groundwater or soil gas monitoring personnel will be on site prior to each quarterly GWMP and SGMP event. For monitoring points in parking spaces, traffic delineators are placed the day before monitoring is scheduled to ensure vehicles do not park on the monitoring point.

The Site 2 area remains undeveloped and open to the general public as part of Fort Ord Dunes State Park. The Site 2 area was proposed for reuse as an aquaculture and oceanographic research facility, and later as a desalination plant (FORA, 1997); however, the site remains unused, with the derelict sewage treatment plant facilities still onsite. California State Parks, Monterey District, is notified via email that groundwater monitoring personnel will be on site prior to each quarterly GWMP event. Groundwater monitoring personnel receive training to familiarize them with the site restrictions necessary to minimize impacts to the habitat and special-status species at Fort Ord Dunes State Park. Additionally, groundwater monitoring personnel park vehicles on Beach Range Road and walk to monitoring points.

Fort Ord Dunes State Park includes habitat suitable for Smith's blue butterfly *(Euphilotes enoptes smithi)*, which the U.S. Fish & Wildlife Service (USFWS) listed as endangered in 1976. The Smith's blue butterfly is dependent upon its host plant species, coast buckwheat and seacliff buckwheat (*Eriogonum latifolium* and *E. parvifolium*), during all life stages, except that adults may also feed on nectar from naked buckwheat (*E. nudum*). Synchronous with peak flowering of its buckwheat hosts, adult Smith's blue butterflies emerge from their pupal cases for a single flight season extending from mid-June to early September. Between mid-August and early September, larvae pupate. Larvae overwinter as pupae and emerge as adults the following flight season (USFWS, 2017).

Vegetation within the range of the Smith's blue butterfly is very dynamic, especially where stands of seacliff buckwheat occur. Seacliff buckwheat seedlings depend upon disturbances such as landslides and other erosional features for the development of site conditions favorable for germination and establishment. Landslides and mass wasting are common along the Monterey County coast and provide the disturbances required by seacliff buckwheat; conversely, these geologic activities can also destroy existing stands of seacliff buckwheat. The Smith's blue butterfly may benefit from some human disturbances when they mimic natural processes. The general recovery needs of the Smith's blue butterfly include conserving and managing existing habitat, maintaining and improving connectivity between areas of habitat, and increasing the amount of occupied habitat through restoration efforts (USFWS, 2017).

With potential Smith's blue butterfly habitat as a land use consideration, ground-disturbing fieldwork activities at Fort Ord Dunes State Park are avoided or limited to the extent practicable during the flight season from mid-June to early September.

3.1.6.2 OU2

The OU2 area consists of the Fort Ord Landfills, which encompass approximately 120 acres of land that is undeveloped other than for use as a landfill, as well as mixed-use residential, commercial, and undeveloped areas. The Army currently uses OU2 Landfills Area E for the disposal of contaminated soil from the Site 39 Inland Ranges and other remediation and investigation-derived wastes (IDW). The Fort Ord Landfills are the apparent historical source of the OU2 groundwater COC plume, which extends across an area bounded by 3rd Avenue, Abrams Drive, Bunker Hill Drive, and Inter-Garrison Road. Property owners or managers are notified via email that groundwater monitoring personnel will be on site prior to each quarterly GWMP event.

A residential housing area for California State University Monterey Bay is located adjacent to OU2 Landfills Area F, with the closest residence located approximately 368 feet from the OU2 Landfills perimeter.

Other land immediately adjacent to the OU2 Landfills was transferred from the Army to the Fort Ord Reuse Authority in 2004 and 2006 and remains undeveloped. These parcels of land are identified in the Installation-Wide Habitat Management Plan for Former Fort Ord, California (HMP; USACE, 1997) as containing habitat occupied or potentially occupied by several sensitive wildlife and plant species, some of which are listed or proposed for listing as threatened or endangered under the federal Endangered Species Act. Accordingly, this land is categorized as "Development with Reserve Areas or Development with Restrictions" in the HMP. While the land may be developed, there are specific restrictions to protect biological resources as identified in the HMP and the quitclaim deeds associated with the land.

In 2023, the City of Marina established a conservation easement (Habitat Management Lands) within City-owned properties to mitigate impacts of the Imjin Parkway Widening Project on Monterey gilia, which USFWS listed as a federally endangered species in 1992 (USFWS, 2017). Monterey Gilia is typically associated with sandy soils of dune scrub, coastal sage scrub, and maritime chaparral vegetation types in the coastal dunes of Monterey County, California. The City of Marina Habitat Management Lands provide permanent protection and management of occupied Monterey gilia habitat in two areas: Habitat Easement Area A, which includes 43.120 acres south of OU2 Landfills Areas B and C and west of OU2 Landfills Area E, and Habitat Easement Area B, which includes 18.191 acres north of OU2 Landfills Areas D and F. With potential Monterey gilia habitat as a land use consideration, ground-disturbing activities within Habitat Management Lands adjacent to the OU2 Landfills, such as new well construction and well demolition, will occur after June 1 to allow Monterey gilia to set seed prior to disturbance. If such work is in high-quality habitat areas that are not accessible by existing roads, or in areas prone to erosion, matting will be used on access routes to minimize impact.

The quitclaim deeds for land within 1,000 feet of the OU2 Landfills also include a notification stating landowners should refer to 27CCR Section 21190, which identifies protective measures for structures built on or within 1,000 feet of a landfill.

3.1.6.3 OUCTP

The apparent source of the OUCTP is located on what is now Lexington Court, part of the Abrams Housing Development, in the northern portion of the former Fort Ord. The groundwater COC plume emanating from this area ultimately extends across an area bounded by Del Monte Boulevard, Abrams Drive, Neeson Road, and Blanco Road. The OUCTP area consists of residential, commercial, and light

industrial (including the Marina Municipal Airport), and undeveloped areas, including habitat reserve areas. Property owners or managers are notified via email that groundwater monitoring personnel will be on site prior to each quarterly GWMP event. Work within the Fort Ord Natural Reserve (FONR) is coordinated with the University of California, which manages the reserve area, to minimize impact to natural resources and ongoing research projects. To the extent possible, ground-disturbing activities in the FONR, such as new well construction and well demolition, will occur after June 1 to allow Monterey Gilia and Monterey spineflower to set seed prior to disturbance. If such work is in high-quality habitat areas that are not accessible by existing roads, or in areas prone to erosion, matting will be used on access routes to minimize impact. Field personnel receive training to familiarize them with the site restrictions necessary to minimize impacts to the habitat and special-status species at the FONR.

Work within the Marina Municipal Airport operations area (the portion of the Airport that contains the facilities necessary for the operation of aircraft; generally, everything inside the perimeter fence) is coordinated with the Airport Services Manager to prevent conflicts with aircraft.

3.1.7 Physiography and Topography

The predominant topography of the area reflects a morphology typical of the dune sand deposits that underlie the western and northern portions of the former Fort Ord. In these areas, the ground surface slopes gently to the west and northwest, draining toward Monterey Bay. Runoff is minimal because of the high rate of surface-water infiltration into the permeable dune sand. Consequently, well-developed natural drainages are absent throughout much of this area. However, erosion has primarily been observed where roads were cut into slopes. In these areas, small gullies are present but generally end shortly after the topography flattens out. Closed drainage depressions typical of dune topography are common. Elevations at the former Fort Ord range from approximately 50 feet above mean sea level (MSL) at Site 2 to 255 feet above MSL at the OU2 Landfills.

3.1.8 Geology and Hydrology

The predominant lithology is a loose, well-sorted (poorly graded) fine to medium sand. The sands represent active and recently active dunes and older Pleistocene-age dune sands. The active dune sands parallel the beach and extend several hundred feet inland. The older dune sands cover most of the northern and western portions of the former Fort Ord. Paleosols, representing former ground surfaces (silty sands), exist within these sands. These paleosols indicate that one or more cycles of dune deposition have occurred with intervening periods of soil development. The paleosols in the dunes bordering the beach indicate that older dune sand is locally present beneath the recent dune sand. Three groundwater aquifers are in the remediation phase of cleanup activities at the former Fort Ord: the unconfined A-Aquifer, the unconfined and confined Upper 180-Foot Aquifer, and the confined Lower 180-Foot Aquifer. The aquifers consist predominantly of fine to coarse-grained sands which are separated by silty clay or clayey fine-grained sand aquitards. The A-Aquifer is located within the recent dune sands and is perched above the regional FO-SVA. To the west, where the FO-SVA pinches out, the unconfined A-Aquifer and confined Upper 180-Foot Aquifer combine to form a continuous, unconfined hydrostratigraphic unit (identified as the unconfined Upper 180-Foot Aquifer). A north-trending groundwater divide in the unconfined Upper 180-Foot Aquifer exists midway between the FO-SVA and Monterey Bay. Groundwater in the unconfined Upper 180-Foot Aquifer west of the divide flows west and discharges to the Monterey Bay. Groundwater in the unconfined Upper 180-Foot Aquifer east of the divide flows under the FO-SVA (becoming confined) toward the Salinas Valley due predominantly to

agricultural pumping. The Upper and Lower 180-Foot Aquifers, and portions of the 400-Foot Aquifer (locally), are contained within valley fill deposits. The Upper 180-Foot Aquifer is separated from the Lower 180-Foot Aquifer by the Intermediate 180-Foot Aquitard, which appears to be laterally discontinuous in the eastern portion of the former Fort Ord near the OU2 and OUCTP areas, creating a natural conduit between the aquifers (Army, 2008).

3.2 Worksheet #11: Project/Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that outline the decision-making process and specify the data required to support corrective actions. DQOs specify the level of uncertainty that will be accepted in results derived from data. The DQO process for this project is implemented in a manner consistent with the DoD Quality Systems Manual for Environmental Laboratories (QSM), Version 6.0. In accordance with QSM Version 6.0, data quality is evaluated relative to the ability of the data to support project-specific decision-making objectives, rather than strict pass/fail compliance with individual quality control acceptance criteria. The DQO process consists of the following seven steps:

- Step 1: State the problem
- Step 2: Identify the goals of the study
- Step 3: Identify information inputs
- Step 4: Define the boundaries of the study
- Step 5: Develop the analytic approach
- Step 6: Specify performance or acceptance criteria
- Step 7: Develop the plan for obtaining data

The DQOs steps are presented below for the five operable units (OUs):

- Sites 2/12 Upper 180-Foot Aquifer
- OU2 A-Aquifer and Upper 180-Foot Aquifer
- OUCTP A-Aquifer
- OUCTP Upper 180-Foot Aquifer
- OUCTP Lower 180-Foot Aquifer

During cleanup, a site can be divided into a number of distinct areas depending on the complexity of the problems associated with the site. These areas, or OUs, may address geographic areas of a site, specific site problems, or areas where a specific action is required. For Sites 2/12 and OU2, the same remedy is applied to all affected aquifers; however, for OUCTP, each affected aquifer has a distinct remedy.

3.2.1 Step 1: State the Problem

3.2.1.1 Sites 2/12

Groundwater in the Upper 180-Foot Aquifer beneath Sites 2/12 has been adversely impacted by eight VOCs that are identified as COCs (Worksheet #15a) in the RI Sites ROD (Army, 1997a) and RI Sites ESD No. 1 (Army, 2016) because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the RI Sites ROD and RI Sites ESD No. 1 require remediation of the Upper 180-Foot Aquifer beneath and downgradient of Sites 2/12 using groundwater extraction with liquid-phase GAC treatment and soil gas extraction with vapor-phase GAC treatment. Figure 2 shows the Sites 2/12 monitoring and extraction well locations by sampling schedule. Figure 3

shows the Sites 2/12 GWTS configuration with current extraction well status, and Figure 4 shows the Sites 2/12 GWTP schematic and sampling locations. The SVETS comprises the extraction well network and conveyance piping connected to the soil vapor treatment unit (SVTU), which houses the vapor-phase GAC treatment equipment. In this document, SVETS refers to the overall system and SVTU to the treatment unit. Figure 13 shows the soil gas probe locations and soil vapor extraction (SVE) well locations at Site 12. Figure 14 shows the soil vapor treatment unit (SVTU) schematic and sampling locations.

Disposal of solvents from former activities in this area led to contamination of the soil gas by COCs at concentrations above SGCLs and groundwater by COCs at concentrations above ACLs. The extent of the soil gas COC plume is defined by the detectable presence of PCE and TCE in soil gas, as these are the most widespread chemical constituents in the vadose zone. The extent of the groundwater COC plume is defined by the detectable presence of PCE in groundwater, as it is the most widespread chemical constituent in this area of the unconfined Upper 180-Foot Aquifer. Additionally, groundwater wells at Sites 2/12 are subject to seawater intrusion due to their proximity to Monterey Bay; as a result, chloride concentrations are monitored annually at select wells.

Further data collection is needed in the Sites 2/12 area to:

- Monitor the nature and extent of COC contamination in groundwater and soil gas
- Assure compliance with the RI Sites ROD (Army, 1997a) and RI Sites ESD No. 1 (Army, 2016)
- Ensure compliance with air quality standards identified in Regulation II (New Sources), Rule 207 (Air District, 2011) and Regulation X (Toxic Air Contaminants), Rule 1000 (Air District, 2017)
- Support the continued remediation of the COCs in groundwater and soil gas (COCs in soil gas are a source of contamination in groundwater at Site 12)
- Evaluate and optimize GWTS and SVETS operations
- Support site closure

Project action limits for groundwater and soil gas are summarized in Worksheets #15a, #15b, #15c, #15d, and #15e.

3.2.1.2 OU2

Groundwater in the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient from the OU2 Landfills has been adversely impacted by 11 VOCs that are identified as COCs (Worksheet #15a) in the OU2 ROD (Army, 1994) because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OU2 ROD and OU2 ESD No. 1 (Army, 1995) require remediation of the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient of the OU2 Landfills using groundwater extraction with GAC treatment and treated water recharged to the aquifer or reused at the surface. Figure 5 and Figure 6 show the OU2 monitoring and extraction well locations by sampling schedule, Figure 7 shows the OU2 GWTS configuration with current extraction well status, and Figure 8 shows the OU2 GWTP schematic and sampling locations.

COC migration from the OU2 Landfills led to contamination of the groundwater by COCs at concentrations above ACLs. The extent of the A-Aquifer COC plume is defined by the detectable presence of COCs in groundwater. The extent of the Upper 180-Foot Aquifer COC plume is defined by the detectable presence of TCE in groundwater, as it is the most widespread chemical constituent in this

area. Additionally, disposal of spent small arms ammunition in the OU2 Landfills was identified as a possible source for metals (antimony, copper, and lead) contamination of the groundwater. Metals are not identified as COCs for groundwater in the OU2 ROD and therefore do not have ACLs. However, antimony, copper, and lead concentrations are monitored at select wells around the OU2 Landfills annually to validate that groundwater is not impacted by soil and spent small arms ammunition disposed of in the OU2 Landfills during the remediation of small arms firing ranges at the former Fort Ord.

The OU2 ROD states one of the primary remedial objectives for shallow soil and buried waste at the OU2 Landfills is to prevent methane off gas generated by decomposition of waste in the landfill (if necessary) through collection and treatment. Accordingly, the following regulations are relevant to control of LFG:

- 27CCR Section 20921(a)(2), which sets forth the performance standards and the minimum substantive requirements for LFG monitoring and control as it relates to proper closure, post-closure maintenance and ultimate reuse of solid waste disposal sites to assure that public health and safety and the environment are protected from pollution due to the disposal of solid waste.
- Air District Regulation II (New Sources) Rule 207 – Review of New or Modified Sources, and Regulation X (Toxic Air Contaminants) Rule 1000 – Permit Guidelines and Requirements for Sources Emitting Toxic Air Contaminants. The Air District regulations set forth the standards and requirements for sources emitting or having the potential to emit toxic air contaminants or carcinogenic toxic air contaminants to assure that public health and welfare are protected.

The LFG monitoring program at the Fort Ord Landfills was established in accordance with 27CCR, which states specifically that:

- The concentration of methane gas migrating from the landfill must not exceed 5 percent by volume (%v) in air at the facility property boundary or an alternative boundary.
- Trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.[4]

The LFG extraction and treatment system comprises the extraction well network and conveyance piping connected to the TTU, which houses the enclosed flare. In this document, LFG extraction and treatment system refers to the overall system and TTU to the treatment unit. Figure 20 shows the LFG probe locations and Figure 21 show LFG extraction point locations. Figure 22 shows the TTU schematic and sampling locations.

Further data collection is needed in the OU2 area to:

- Monitor the nature and extent of COC contamination in groundwater
- Assure compliance with the OU2 ROD (Army, 1994), OU2 ESD No. 1 (Army, 1995), and OU2 ESD No. 4 (Army, 2006)
- Ensure compliance with 27CCR Section 20921(a)(2)
- Ensure compliance with air quality standards identified in Regulation II (New Sources), Rule 207 (Air District, 2011) and Regulation X (Toxic Air Contaminants), Rule 1000 (Air District, 2017)

[4] For the purposes of this QAPP, “trace gases” means VOCs.

- Support the continued remediation of COCs in groundwater and LFG (COCs in LFG are a potential source of contamination in groundwater at OU2)
- Evaluate and optimize GWTS and LFG extraction and treatment system operations
- Support site closure

Project action limits for groundwater are summarized in Worksheets #15a – #15c.

3.2.1.3 OUCTP A-Aquifer

The A-Aquifer at OUCTP has been adversely impacted by eight VOCs that are identified as COCs (Worksheet #15a) in the OUCTP ROD (Army, 2008) because they are or may be present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OUCTP ROD requires remediation of the A-Aquifer at OUCTP using a combination of enhanced in situ bioremediation (EISB) and monitored natural attenuation (MNA). Figure 9 shows the OUCTP A-Aquifer monitoring well locations by sampling schedule.

Disposal of CT (used as a cleaning solvent for activities conducted in this area) led to contamination of the groundwater (Army, 2008). The extent of the OUCTP in the A-Aquifer is defined by the detectable presence of CT in groundwater, as it is the most widespread chemical constituent in this area.

The effectiveness of EISB treatment is determined through periodic monitoring and reporting of groundwater quality parameters in specific wells (Worksheet #18e) and VOC concentrations (Worksheet #15a). Groundwater quality parameters include dissolved oxygen (DO) and oxidation-reduction potential (ORP).

Further data collection is needed in the OUCTP A-Aquifer area to:

- Monitor the nature and extent of COC contamination in groundwater
- Assure compliance with the OUCTP ROD (Army, 2008)
- Monitor the effectiveness of EISB treatment and natural attenuation
- Support site closure

3.2.1.4 OUCTP Upper 180-Foot Aquifer

The Upper 180-Foot Aquifer at OUCTP has been adversely impacted by CT (Worksheet #15a) and is identified in the OUCTP ROD (Army, 2008) as a COC because it is present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OUCTP ROD requires remediation of the Upper 180-Foot Aquifer at OUCTP using groundwater extraction and treatment via the existing OU2 GWTS. The extent of the OUCTP in the Upper 180-Foot Aquifer is defined by the detectable presence of CT in groundwater. Figure 11 shows the OUCTP Upper 180-Foot Aquifer monitoring well locations by sampling schedule. Figure 7 shows the location of the OUCTP Upper 180-Foot Aquifer extraction well, EW-OU2-13-180.

Further data collection is needed in the OUCTP Upper 180-Foot Aquifer area to:

- Monitor the nature and extent of CT contamination in groundwater
- Assure compliance with the OUCTP ROD (Army, 2008)
- Support the continued remediation of CT in groundwater
- Evaluate and optimize extraction well operations

- Support site closure

3.2.1.5 OUCTP Lower 180-Foot Aquifer

The Lower 180-Foot Aquifer at OUCTP has been adversely impacted by COCs (Worksheet #15a) as identified in the OUCTP ROD (Army, 2008) and OUCTP ESD No. 1 (Army, 2026) because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OUCTP ROD and OUCTP ESD No. 1 require remediation of the Lower 180-Foot Aquifer using MNA and contingency wellhead treatment at the nearby MCWD supply wells if COCs associated with OUCTP are detected at concentrations over the ACL in these supply wells. The extent of the OUCTP in the Lower 180-Foot Aquifer is defined by the detectable presence of CT and TCE in groundwater. Figure 12 shows the OUCTP Lower 180-Foot Aquifer monitoring well locations by sampling schedule.

Further data collection is needed in the OUCTP Lower 180-Foot Aquifer area to:

- Monitor the nature and extent of CT contamination in groundwater
- Assure compliance with the OUCTP ROD (Army, 2008)
- Monitor the effectiveness of natural attenuation
- Evaluate the need for implementation of the wellhead treatment contingency
- Support site closure

3.2.2 Step 2: Identify the Goals of the Study

The primary goals associated with the Sites 2/12, OU2, and OUCTP remedies are presented in the relevant decision documents:

- RI Sites ROD (Army, 1997a) and RI Sites ESD No. 1 (Army, 2016)
- OU2 ROD (Army, 1994) and OU2 ESD No. 1 (Army, 1995) and OU2 ESD No. 4 (Army, 2006)
- OUCTP ROD (Army, 2008) and OUCTP ESD No. 1 (Army, 2026)

Accordingly, the principal study questions, along with alternative actions or outcomes that may result based on the answers to these key questions, are:

Principal Study Questions	Alternative Actions
Are concentrations of COCs in groundwater above the relevant ROD- or ESD-prescribed ACLs?	Continue to implement the ROD- or ESD-prescribed groundwater remedies.
	Evaluate the existing groundwater monitoring network for potential data gaps.
	Propose additional groundwater wells be added to the GWMP.
	Re-evaluate and update the conceptual site model.
	Propose the site, OU, or hydraulic zone for closure in a remedial action completion report.
	Take no action.
Are concentrations of methane at the OU2 Landfills boundary greater than 5%v?	LFG migration is not being controlled by operations of the LFG extraction and treatment system and the operational schedule of the LFG

Principal Study Questions	Alternative Actions
	extraction and treatment system needs to be modified.
	LFG migration is being controlled by operations of the LFG extraction and treatment system.
	The LFG extraction and treatment system does not need to be operated for control of LFG migration.
	Take no action.
Does the OU2 Landfills TTU operate efficiently under current operating conditions and meet Air District discharge standards?	Continue to operate the TTU per current procedures.
	Adjust TTU operation to increase its efficiency and/or to achieve target operating conditions.
	Optimize or upgrade the TTU to achieve the regulatory standards.
	Take no action.
Are trace gas concentrations at the OU2 Landfills at a level where they need to be controlled?	Trace gases need to be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.
	Trace gases do not need to be controlled.
	Take no action.

The secondary goals associated with the Sites 2/12, OU2, and OUCTP remedies are discrete elements of the remedies necessary for achieving the primary goals. Accordingly, the secondary study questions are listed below (alternative outcomes for the secondary study questions are identified in Step 5).

3.2.2.1 Sites 2/12 and OU2 GWTSs

Data collected from Sites 2/12 and OU2 GWTS will be used to perform the following assessments:

- Is the GWTS effectively and efficiently reducing COC concentrations of in the aquifers of concern?
- Does the GWTP effluent meet discharge requirements before it is used for groundwater recharge or onsite for non-potable construction purposes (dust control, soil compaction, etc.)?
- Does GWTP GAC require a change-out?
- Does the GWTS provide adequate hydraulic containment of the COC plume and prevent its migration?
- Is the current extraction well sampling frequency and operational status adequate to meet project objectives?

3.2.2.2 Sites 2/12, OU2, and OUCTP GWMP

The data collected from the Fort Ord GWMP are used to evaluate the following decisions:

- What are the vertical and lateral extents of relevant ROD- and ESD-specified COCs in groundwater?

- What are the groundwater and aquifer conditions relative to the stability of the COC plumes, and what trends and temporal changes in groundwater levels and COC concentrations are taking place?
- Does the frequency of groundwater well monitoring adequately assess site conditions within the site physical and temporal boundaries?
- Does the groundwater monitoring network adequately define the groundwater COC plume limits and maintain perimeter control within the defined study boundary area (Section 3.2.4)?
- Does the conceptual site model need to be updated or verified?
- Is closure of the site or OU, or a hydraulic zone or remedial unit within the site or OU, warranted if concentrations of COCs in groundwater are less than or equal to the relevant ROD- or ESD-prescribed ACLs?
- Are concentrations of chloride in monitoring wells at Sites 2/12 above the Monterey County Water Resources Agency threshold of 500 milligrams per liter (mg/L) for classification as "seawater intruded"?
- Are concentrations of dissolved antimony, copper, and lead above MCLs or action levels for drinking water in wells associated with the OU2 Landfills?[5]
- Do post-treatment DO and ORP measurements in the OUCTP A-Aquifer monitoring wells indicate biodegradation is still occurring in the EISB Deployment Areas?

3.2.2.3 Sites 2/12 SVETS

Data collected from Sites 2/12 SVETS will be used to perform the following assessments:

- Is the SVETS effectively and efficiently reducing PCE and TCE concentrations in the vadose zone that could partition into groundwater at concentrations exceeding ACLs?
- Does the SVTU effluent meet discharge requirements?
- Does SVTU GAC require a change-out?
- Does the SVETS provide adequate containment of the soil gas COC plume and prevent its migration?
- Is the current SVE well sampling frequency and operational status adequate to meet project objectives?

3.2.2.4 Sites 2/12 SGMP

The data collected from the Sites 2/12 SGMP are used to evaluate the following decisions:

- What are the vertical and lateral extents of PCE and TCE in soil gas?
- What are the vadose zone conditions relative to the stability of the PCE and TCE plumes, and what trends and temporal changes in PCE and TCE concentrations are taking place?

[5] Antimony, copper, and lead are the primary metals found in spent ammunition deposited in the Fort Ord Landfills, but are not identified as COCs for groundwater in the OU2 ROD and do not have ACLs; therefore, detected concentrations are compared to the MCL for antimony and the action levels for copper and lead for drinking water. The federal and California MCL for antimony and action levels for copper and lead are the same numerical value (see Worksheet #15c). The MCL is the maximum concentration of a chemical that is allowed in public drinking water systems while an action level triggers a treatment technique (a required process) intended to reduce the level of a contaminant in drinking water, though the groundwater being monitored is within the Prohibition Zone and is not intended for use as drinking water (see Section 3.1.5).

- Does the frequency of soil gas probe monitoring adequately assess site conditions within the site physical and temporal boundaries?
- Does the soil gas monitoring network adequately define the soil gas COC plume limits and maintain perimeter control within the defined study boundary area (Section 3.2.4)?
- Does the conceptual site model need to be updated or verified?
- Do soil gas PCE or TCE concentrations exceed the SGCLs at points near the groundwater interface?
- Is closure of the soil gas remedial unit within Sites 2/12 warranted if concentrations of PCE and TCE in soil are less than or equal to the SGCLs?

3.2.2.5 OU2 LFG Extraction and Treatment System

TTU Source Testing

Data collected during TTU source testing will be used to perform the following assessments:

- Does the TTU operate efficiently under current operating conditions?
- Do TTU operations meet Air District standards?

Operational Influent LFG Testing

Data collected during operational influent LFG testing will be used to perform the following assessments:

- Are methane concentrations being maintained below the lower explosive limit of 5%v based on operational influent LFG composition and characteristics?
- Is adverse acute and chronic exposure to toxic and/or carcinogenic compounds being prevented based on the composition and characteristics of operational EWs and other wells and probes?

3.2.2.6 OU2 LFG Monitoring

Compliance Perimeter Probes

The data collected from the compliance perimeter probes are used to evaluate the following decisions:

- Do the concentrations of methane in the compliance perimeter probes meet the regulatory requirement?
- Are trace gas concentrations at a level where they need to be controlled?

Monitoring Probes and Vents

The data collected from LFG monitoring probes and vents are used to evaluate the following decisions:

- Do monitoring probes and landfill vents exhibit increasing methane concentration trends that may negatively impact methane concentrations in adjacent compliance perimeter probes and require implementation of corrective actions?
- Is LFG migration is being controlled by the LFG extraction and treatment system, or does the operational schedule of the TTU need to be modified?

3.2.3 Step 3: Identify Information Inputs

3.2.3.1 Sites 2/12 and OU2 GWTSs

Decision inputs for the Sites 2/12 and OU2 GWTS are:

- COC concentration data from extraction well samples collected to assess relative concentrations in the aquifer and whether ACLs have been met for COCs.
- COC concentration data from locations within the GWTP collected to assess whether the GWTP is operating effectively and efficiently.
- COC concentration data from the discharge point of compliance (TS-212-INJ and TS-OU2-INJ) to confirm whether site-specific discharge requirements (Worksheet #15a) are met.
- COC concentration data from GAC treatment effluent collected to determine whether a GAC change-out is required.
- COC concentration data from the GWTP influent (TS-212-INF and TS-OU2-INF) to determine the amount and rate of COC mass removal from the aquifers.
- GWTS flow rate data collected to evaluate and document and optimize system operation.
- Groundwater monitoring data and/or groundwater flow modeling results to determine whether the plume is hydraulically contained.

3.2.3.2 Sites 2/12, OU2, and OUCTP GWMP

Decision inputs for the Fort Ord GWMP are:

- Historical groundwater monitoring results and archived information
- Knowledge of geologic and hydrologic conditions at Fort Ord
- Groundwater modeling data from recent trend analysis
- Statistical analysis of COC concentration trends on a well-by-well basis
- ROD- or ESD-prescribed ACLs
- State of California MCLs and action levels for drinking water
- GWTS operational data and monitoring results
- Drinking water production well data from local districts and municipalities

3.2.3.3 Sites 2/12 SVETS

Decision inputs for the Sites 2/12 SVETS are:

- PCE and TCE concentration data from SVE well samples collected to assess relative concentrations in the vadose zone and whether SGCLs have been met.
- PCE and TCE concentration data from locations within the SVTU collected to assess whether the SVTU is operating effectively and efficiently.
- PCE and TCE concentration data from the SVTU effluent (SVTU-212-EFF) to confirm whether site-specific discharge requirements (Worksheet #15e) are met.
- PCE and TCE concentration data from GAC treatment effluent collected to determine whether a GAC change-out is required.
- Soil gas monitoring data to determine whether the plume is contained.
- PCE and TCE concentrations in the SVTU influent (SVTU-212-INF) to determine the amount and rate of COC mass removal from the vadose zone.

- SVETS flow rate, vacuum, and temperature data collected to evaluate and optimize system operation.
- SVE well flow rates as a function of applied vacuum.
- Applied vacuum in the SVE wells.
- Induced vacuum in soil gas probes.

3.2.3.4 Sites 2/12 SGMP

Decision inputs for the Sites 2/12 SGMP are:

- COC concentrations in soil gas
- COC concentrations in groundwater; determined in accordance with this QAPP
- SG-SLs (Worksheet #15d)[6]
- SGCLs (Worksheet #15d)[7]
- Groundwater ACLs (identified in this QAPP and RI Sites ESD No. 1 [Army, 2016])

3.2.3.5 OU2 LFG Extraction and Treatment System

TTU Source Testing

Decision inputs for TTU source testing are:

- Stack Emissions (Effluent)
    - Gas stream volumetric flow rate
    - Nitrogen oxides (NO_X), carbon monoxide (CO), oxygen (O_2), carbon dioxide (CO_2)
    - Non-methane organic compounds (NMOCs)/total hydrocarbons (THC)
    - Sulfur dioxide (SO_2; calculated)
    - Methane
    - VOCs listed in Worksheet #15i (Section 3.6.9)
    - Flare temperature
- Influent LFG
    - Heating value (calculated based on hydrocarbon content; caloric content of gas)
    - O_2, CO_2, nitrogen (N_2)
    - Methane
    - VOCs listed in Worksheet #15i (Section 3.6.9)
    - NMOCs
    - Reduced sulfur compounds
    - LFG flow rate

[6] SG-SLs are conservative risk-based CHHSLs (Cal/EPA, 2005) or site-specific values calculated per the Vapor Intrusion Guidance (DTSC, 2011) that assume chemical concentrations in soil gas less than 5 feet below a building foundation or the ground surface (i.e., there is less risk associated with chemicals in soil gas deeper than 5 feet). SG-SLs are used to determine soil gas probe sampling frequency but are not criteria for assessing status of the remedial actions for Sites 2/12.

[7] SGCLs are the calculated concentrations of COCs in soil gas that will not partition into groundwater at concentrations exceeding ACLs and are therefore used to determine soil gas monitoring frequency, soil gas plume limits, and operational status of individual SVE wells.

- Optimum operating conditions for the type of TTU at the OU2 Landfills (per the OU2 Landfills O&M Plan, Appendix B, Section 11000; Ahtna, 2023c):
    - Minimum destruction efficiency of THC is 98% by weight, or reduction of the outlet NMOC concentration to less than 20 parts per million by volume (ppmv), dry basis as hexane, at 3% O_2.
    - Minimum destruction efficiency of methane is 99% by weight.
    - Combustion temperature is maintained at a minimum of 1,400 °F within 30 minutes of startup; minimum combustion residence time is 0.6 seconds.
    - Instrumentation records combustion temperature continuously during operation.
    - Nitrogen oxide (NO_X) emissions do not exceed 0.06 pounds per million British thermal units (lb/MMBtu).
    - CO emissions do not exceed 0.18 lb/MMBtu.
    - THC emissions do not exceed 0.03 lb/MMBtu.
    - Sulfur dioxide (SO_2) emissions do not exceed 0.2%v (2,000 ppmv).
    - Inlet sulfur content does not exceed 50 grains hydrogen sulfide per 100 cubic feet of gas.
    - Instrumentation continuously records the amount of LFG flow to the flare during operation.
    - No air contaminant which is as dark as or darker than Ringlemann 1 or equivalent (20% opacity) is discharged for more than an aggregate 3 minutes in any hour.[8]
    - No emission constitutes a public nuisance.

Influent LFG and exhaust emission concentrations and flow rates (measured under maximum available throughput loads) will be used to calculate the mass emission rates of LFG constituents and the mass emission factors for secondary pollutants that result from the combustion process.

Sample data from stack emissions and influent LFG testing, in combination with gas flow rates and other parameters, will be used to perform calculations to determine whether the TTU achieves the optimum operating conditions.

<u>Operational Influent LFG Testing</u>

The following inputs are required to determine trends in composition and characteristics present in the TTU operational influent LFG and the EWs:

- Influent LFG (using a portable LFG analyzer)
    - Methane
    - CO_2
    - O_2
    - Balance gas (a combination of the remainder of gases, but the majority is N_2)
    - Temperature
    - Flow
    - Vacuum

- Influent LFG (analysis by EPA Method TO-15 at a fixed-base laboratory)

[8] The Ringelmann scale is a scale for measuring the apparent density or opacity of smoke.

  - VOCs listed in Worksheet #15i (Section 3.6.9).

- Additional inputs include:
  - Optimal operating parameters for the TTU per the OU2 Landfills O&M Plan (Ahtna, 2023c).
  - 27CCR Section 20921(a)(2).

3.2.3.6 OU2 LFG Monitoring

Compliance Perimeter Probes

Twenty-one compliance perimeter probes are monitored for the LFG monitoring program. Decision inputs for compliance perimeter probes are:

- Annual sampling and analysis using EPA Method TO-15 for the VOCs listed in Worksheet #15j (Section 3.6.10).[9] Results will be compared to historical concentration ranges.
- Quarterly monitoring using a portable LFG analyzer to measure methane, O_2, CO_2, and balance gas. Results for methane will be compared to the 5%v regulatory requirement.

Additional inputs include:

- 27CCR Section 20921(a)(2).
- Current DTSC residential air screening level (SL) for vinyl chloride.
- Highest historical concentration of vinyl chloride observed in the probe.
- Current DTSC SL for PCE.
- Highest historical concentration of PCE observed in the probe.
- Current EPA Residential Ambient Air Regional Screening Level (RSL) for chloroform.
- Highest historical concentration of chloroform observed in the probe.

Monitoring Probes and Vents

Methane concentrations will be measured at the perimeter monitoring probes and landfill vents. A portable LFG analyzer will be used in the field to measure methane, O_2, CO_2, and balance gas. Decision inputs for compliance perimeter probes are:

- In addition to the 21 compliance perimeter probes, quarterly methane measurements at nine monitoring probes (Worksheet #18j) that have continued to exhibit concentrations of methane greater than 1%v and, per the analytic approach decision rules (Step 5), will continue to be monitored quarterly.
- Annual methane measurements at one monitoring probe (SGP-11F) that has exhibited concentrations of methane less than 1%v for over 20 consecutive quarterly monitoring events and only requires annual monitoring.[10]

[9] The annual sampling occurs during the second quarter LFG monitoring event.
[10] If the probe continues to exhibit concentrations less than 1%v for five consecutive annual monitoring events, then it will be removed from the monitoring program.

- Quarterly methane measurements at the 14 passive vents installed along the center ridgeline of each landfill area (Figure 20).[11]

3.2.4 Step 4: Define the Boundaries of the Study

3.2.4.1 Sites 2/12, OU2, and OUCTP GWMP

The physical study boundaries for the Sites 2/12, OU2, and OUCTP groundwater remedies are described below and shown in Figure 1. Study boundaries are further divided into hydraulic zones based on the zone of groundwater with COC concentrations above ACLs and influenced by the groundwater remedy; therefore, hydraulic zones and study boundaries may be revised depending on changes in the extent of groundwater with COC concentrations above ACLs and modifications to the groundwater remedies.

The overall geographic boundary for the site is the Main Garrison at the former Fort Ord, including the Fritzsche Army Airfield area,[12] and the adjacent portion of the City of Marina. The lateral boundary is defined by the zone of groundwater impacted or potentially impacted by VOCs. The vertical boundary is defined by the zone of contaminated groundwater in the following aquifers or hydrogeologic units:

- A-Aquifer
- Upper 180-Foot Aquifer
- Lower 180-Foot Aquifer

The time frame for decision-making relates to the quarterly monitoring and reporting schedule and periodic (e.g., annual) reporting and review cycles. With the exception of certain times of the year when the presence of sensitive biological resources requires modification to the site or well access procedures, practical constraints on data collection are not applicable to the GWMP.

3.2.4.2 Sites 2/12 GWMP

Study boundaries for the GWMP at Sites 2/12 are as follows:

- The overall geographic boundary for the site is within the western Main Garrison area at the former Fort Ord.
- The lateral and vertical boundaries are defined by the zone of groundwater impacted by Sites 2/12 COCs (Worksheet #15a) in the unconfined Upper 180-Foot Aquifer west of the FO-SVA.
- Because the zone of contaminated groundwater is relatively small, limited to a single aquifer, and within the capture area of the existing extraction well network, there is currently only one hydraulic zone at Sites 2/12.
- The long-term temporal boundaries for the Sites 2/12 remedy are defined by initiation of the groundwater remedy in 1999 and achieving groundwater remedial action objectives (RAOs) in approximately 38 years (i.e., remedy completion is estimated to be in 2037); however, the GWMP should continue in accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

[11] Methane concentrations in all passive vents are consistently above 5%v; however, there is no regulatory standard for methane concentration in passive vents, nor are there any regulatory actions for methane concentrations exceeding 5%v in passive vents in solid waste landfills. Vents are not intended to be representative sampling locations for LFG conditions in the waste, and monitoring results are used as only a non-quantitative indicator of trends in LFG accumulation in the foundation cover soils.

[12] Now the Marina Municipal Airport.

3.2.4.3 OU2 GWMP

Study boundaries for the GWMP at OU2 are as follows:

- The overall geographic boundary for the site is the Main Garrison area and the OU2 Landfills at the former Fort Ord.
- The lateral and vertical boundaries are defined by the zone of groundwater impacted by OU2 COCs (Worksheet #15a) in the A-Aquifer and Upper 180-Foot Aquifer.
- The study boundaries for OU2 are further divided into eight hydraulic zones based on the historical maximum extent of the COC plumes in the A-Aquifer and Upper 180-Foot Aquifer and groundwater extraction well network capture areas (Figure 15 and Figure 16).
- The long-term temporal boundaries for the OU2 remedy are defined by improvements to the groundwater remedy completed in 2019 and achieving groundwater RAOs in approximately 17 years (i.e., remedy completion is estimated to be in 2036); however, the GWMP should continue in accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

3.2.4.4 OUCTP GWMP

Study boundaries for the GWMP at OUCTP are as follows:

- The overall geographic boundary for the site is the Main Garrison area north and east of the OU2 Landfills at the former Fort Ord.
- The lateral and vertical boundaries are defined by the zone of groundwater impacted by COCs (Worksheet #15a) in the A-Aquifer, Upper 180-Foot Aquifer, and Lower 180-Foot Aquifer.
- The study boundaries for OUCTP are further divided into nine hydraulic zones based on the extent of the COC plumes in the A-Aquifer, Upper 180-Foot Aquifer, and Lower 180-Foot Aquifer, and the areas of groundwater remedy influence for each aquifer (Figures 17, 18, and 19).
- The long-term temporal boundaries for the OUCTP remedy are defined by initiation of the groundwater remedies for the Upper and Lower 180-Foot Aquifers in 2011 and achieving groundwater RAOs in approximately 30 years (i.e., remedy completion is estimated to be in 2041); however, the GWMP should continue in accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

3.2.4.5 Sites 2/12 SGMP

Study boundaries for the SGMP at Sites 2/12 are as follows:

- The overall geographic boundary for the site is defined by the development tracts east of State Route 1, south of Imjin Parkway, west of 2nd Avenue, and north of the former 10th Street (Figure 13).
- The lateral and vertical boundaries are defined by the zone of soil gas impacted by COCs (Worksheet #15d) in the vadose zone.
- The time frame for decision-making relates to the quarterly monitoring and reporting schedule and periodic (e.g., annual) reporting and review cycles.
- The long-term temporal boundaries for the Sites 2/12 remedy are defined by initiation of the groundwater remedy in 1999 and achieving groundwater RAOs in approximately 38 years (i.e., remedy completion is estimated to be in 2037); however, the SGMP should continue in

accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

Soil gas probes and SVE wells are located in public parking areas and parking aisles; therefore, there are no practical constraints that could interfere with sampling.

3.2.4.6 OU2 LFG Monitoring

Study boundaries for LFG monitoring at the OU2 Landfills are as follows:

- The overall geographic boundary for the site for compliance with 27CCR is defined by the facility property boundary (Figure 20).
- The lateral and vertical boundaries are defined by the zone of LFG with methane concentrations greater than 5%v or the presence of trace gases (Worksheet #15j).
- The time frame for decision-making relates to the quarterly monitoring and reporting schedule and periodic (e.g., annual) reporting and review cycles.
- The long-term temporal boundary for the OU2 Landfills remedy is indefinite; however, LFG monitoring should continue in accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

With the exception of certain times of the year when the presence of sensitive biological resources requires modification to the site or LFG probe access procedures, practical constraints on data collection are not applicable to the LFG monitoring program.

3.2.5 Step 5: Develop the Analytic Approach

The analytic approach has been developed by using decision rules on information inputs to support the goals of the project for the GWTSs and GWMP.

3.2.5.1 Sites 2/12 and OU2 GWTSs

Decision rules for Sites 2/12 and OU2 GWTS have been developed to address the five major components of treatment system operation: discharge limit compliance, GAC change-out, hydraulic containment, sampling frequency, and plume remediation. Each of these components is described below.

<u>Discharge Limit Compliance</u>

- If analytical results indicate COC discharge limits (Worksheet #15a) are being met, then the system will continue to operate and GWTS effluent will be recharged to the aquifer.
- If analytical results indicate the discharge limit for any COC other than methylene chloride[13] is not met, then a confirmation sample will be collected and analyzed with a 24-hour turnaround time (TAT).
- If analytical results indicate the discharge limit for methylene chloride is not met, then the analytical results will be evaluated against QC sample analytical results associated with the same sampling event.

[13] Methylene chloride is a COC for OU2 and OUCTP in the A-Aquifer. EPA Method 8260-SIM, Analysis of Volatile Organics by GC/MS, Select Ion Monitoring (SIM) (Appendix A, SGS SOP# MS010) identifies methylene chloride as a common laboratory contaminant detected in the analysis for volatile organics.

  - If the evaluation indicates the presence of methylene chloride above the discharge limit is not representative of groundwater conditions due to associated QC sample detections, then the OU2 GWTS will continue to operate, and effluent will be recharged to the aquifer.
  - If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions, then a confirmation sample will be collected from the OU2 GWTS discharge point of compliance and analyzed with a 24-hour TAT.

- If confirmation sample analytical results indicate the discharge limit for any COC is not met, then the affected GWTS will be shut down, operating conditions and GAC loading evaluated, extraction well flow rates adjusted as necessary, and a variance report issued for any out-of-limits operation. Following operational changes, which may include GAC change-out, the GWTS will be restarted and re-sampled to verify compliance.
- If verification sample analytical results indicate discharge limits for COCs are being met, then the system will continue to operate, and system effluent will be recharged to the aquifer.
- If verification sample analytical results indicate the discharge limit for any COC is not met, then the affected GWTS will be shut down, and operating conditions and GAC loading re-evaluated. Following operational changes, the GWTS will be restarted and resampled to verify compliance.

<u>GAC Change-out</u>

The decision rules for determining when a GAC change-out is needed at the Sites 2/12 GWTP are:

- If analytical results for TCE and PCE from a process sample collected immediately downstream of the GAC vessel (upstream of the air stripper) are less than or equal to 90% of ACLs, then a GAC change-out is not necessary. The Sites 2/12 system will continue to operate, and the final effluent stream will continue to be recharged to the aquifer.
- If the analytical result for TCE or PCE from a process sample collected immediately downstream of the GAC vessel (upstream of the air stripper) is greater than 90% of ACLs, then a GAC change-out will be scheduled.

At the OU2 GWTP, the average concentration of each COC in the lead GAC vessel effluent will be calculated based on analytical results from process samples collected immediately downstream of the lead GAC vessel (upstream of the second GAC vessel) during each process sampling event (where such samples are collected). Decision rules for determining when a GAC change-out at OU2 is necessary are:

- If the average concentration of each COC is less than 90% of its respective ACL (Worksheet #15a), then a GAC change-out is not necessary. The OU2 system will continue to operate, and the final effluent stream will continue to be recharged to the aquifer.
- If the average concentration of any COC other than methylene chloride is equal to or greater than 90% of its ACL, then a GAC change-out will be scheduled.
- If the average concentration of methylene chloride is equal to or greater than 90% of its ACL, then the analytical results for the lead GAC vessel effluent sample will be evaluated against the analytical results for QC samples associated with the same sampling event.

  - If the evaluation indicates an average concentration of methylene chloride greater than 90% of its ACL is not representative of groundwater conditions due to associated QC sample

detections, then a GAC change-out is not necessary. The system will continue to operate, and OU2 GWTS effluent will be recharged to the aquifer.

- If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions and the average concentration of methylene chloride is equal to or greater than 90% of its ACL, then a GAC change-out will be scheduled.

Hydraulic Containment

During remediation system operation, specific decision rules must be followed to demonstrate COC plume capture:

- If groundwater monitoring and/or groundwater flow modeling demonstrate plume capture is occurring, then system operation will continue as currently configured. During operation, extraction well flow rates may be optimized to reduce O&M costs while maintaining plume capture.
- If the system flow rate data, in conjunction with the groundwater flow model, indicates the plume is being hydraulically contained, then the system will continue to operate.
- If groundwater monitoring and/or groundwater flow modeling indicate plume capture is not occurring, then additional groundwater flow modeling will be conducted immediately following such indication to determine whether adjustment of either extraction or recharge flow rates will improve capture or whether additional extraction wells or recharge points are required. Based on this evaluation, system reconfiguration may be recommended. The results of such additional groundwater flow modeling and corresponding recommendations will be included in the subsequent relevant annual report.

Plume Remediation

Assessment of aquifer cleanup resulting from Sites 2/12 and OU2 GWTS is conducted through a GWMP that evaluates plume migration and COC concentrations. Extraction well monitoring data will be used for evaluating the operational status of individual extraction wells and for statistical evaluations of remediation progress. The decision rules for determining the operational status of groundwater extraction wells with respect to plume remediation are:

- An extraction well will continue to operate if any COC detected is greater than the corresponding ACL (Worksheet #15a).
- An extraction well will continue to operate if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is necessary for hydraulic containment of the plume.
- An extraction well will be shut off if COCs detected are less than the ACL for two consecutive quarterly monitoring events, and if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is no longer necessary for hydraulic containment of the plume.
- Following termination of pumping at an extraction well, the well will be incorporated into the GWMP.

Sampling Frequency

Extraction wells will be sampled quarterly when operating as part of the GWTS. The decision rules for determining the sampling frequency and monitoring status for groundwater extraction wells following termination of operation are:

- If four consecutive quarters of monitoring data show concentrations of COCs are below their respective limits of quantitation (LOQs; Worksheet #15a) or below 10% of their respective ACLs (Worksheet #15a), whichever is greater, then an annual monitoring schedule may be proposed.
- If two annual monitoring results show concentrations of COCs are below their respective LOQs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed for removal from the sampling program.
- If wells adjacent to a well sampled annually (or no longer sampled) show detections of any COCs equal to or greater than their ACLs, then the well monitoring frequency may be increased to quarterly.
- If an annual well monitoring result shows a detection of any COC equal to or greater than its ACL, then the well monitoring frequency may be increased to quarterly.
- If a well is no longer needed for the program, it will be proposed for decommissioning.
- If operation of an extraction well is terminated due to submersible pump failure and it is determined through review of extraction well flow rate data and analytical date from nearby wells, in conjunction with groundwater flow modeling, that:
    - Operation of the extraction well is no longer necessary for hydraulic containment of the plume, and
    - Data from this well are not needed to define the COC plume nor groundwater elevations in this area due to the proximity of surrounding wells.

  Then the extraction well will be removed from the GWMP; however, the failed pump will be removed from the extraction well as expeditiously as possible and, at such time that the failed pump is removed from the extraction well, the need for incorporating this well into the GWMP will be reevaluated.

Implementation of agency-approved exit strategies for Sites 2/12, OU2, and OUCTP, or portions thereof, may result in modification of these decision rules.

The statistical parameter of interest is the maximum value detected in the well or monitoring point compared to the ACLs or historical trend for that well or monitoring point. For perimeter control, the minimum value detected in the monitoring point (e.g., non-detect [ND] at the limit of detection [LOD]) is the statistical parameter of interest.

3.2.5.2 Sites 2/12, OU2, and OUCTP GWMP

Sampling Frequency

The decision rules for determining the sampling frequency and monitoring status for groundwater monitoring wells are:

- If four consecutive quarters of monitoring data show concentrations of COCs below their respective LOQs or below 10% of their respective ACLs (Worksheet #15a), whichever is greater, then an annual sampling schedule may be proposed.[14]
- If two consecutive annual monitoring results show concentrations of COCs below their respective LOQs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed for removal from the sampling program.[15]
- If wells adjacent to a well sampled annually (or no longer sampled) show detections of any COCs equal to or greater than their ACLs, then the well monitoring frequency may be increased to quarterly.
- If an annual well monitoring result shows a detection of any COC equal to or greater than its ACL, then the well monitoring frequency may be increased to quarterly.
- If monitoring or modeling input indicates the groundwater monitoring network no longer provides vertical or lateral control of COCs, then additional groundwater wells may be proposed to be added to the program.
- If a groundwater monitoring well is no longer needed for the program, then it will be proposed for decommissioning.

Groundwater Plume Limits

For defining groundwater plume limits, the parameter of interest is the maximum COC concentrations detected in a well as compared to the ACLs or historical COC concentration trends at the well.

- If the COC concentration detected in a well is greater than or equal to the ACL, then that monitoring point is within the groundwater plume limits.
- If the COC concentration detected in a well is less than the ACL, then that monitoring point is outside the groundwater plume limits.

Groundwater Plume Perimeter Control

For perimeter control, the minimum value detected in the monitoring point (e.g., ND at the LOD) is the parameter of interest.

- If COCs are ND in a well and COCs are ND in all adjacent monitoring points, then that well is outside the study area boundary as defined in Section 3.2.4 and not needed for perimeter control.
- If COCs are ND in a well, but COCs are detected in adjacent monitoring points, then that well defines the outer perimeter of the study area, and that well may continue to be monitored for perimeter control in accordance with the decision rules for groundwater monitoring described above.

[14] The annual sampling occurs during the third quarter GWMP event.
[15] The well will continue to be monitored for depth to water until it is decommissioned or determined to be redundant or unnecessary water elevation data.

Seawater Intrusion at Sites 2/12

If a monitoring well in Sites 2/12 is determined to be intruded by seawater based on chloride data, the GWTS operator and Ahtna Project Manager will be notified to implement possible GWTS changes.

Dissolved Metals at OU2

If concentrations of dissolved antimony, copper, or lead in select A-Aquifer wells (Worksheet #18d) exceed MCLs or action levels, the BCT will be notified.

Decisions regarding the application of passive diffusion bags (PDBs) are described in the Technical Memorandum Passive Diffusion Bag Pilot Study Results and Recommendations (Harding ESE, 2001).

3.2.5.3 OUCTP A-Aquifer EISB Post-Treatment Water Quality Parameter Monitoring

The parameters of interest for the OUCTP A-Aquifer are DO and ORP levels compared to the baseline values or historical trend for that well or monitoring point to evaluate the effectiveness of EISB. The decision rules for determining the monitoring frequency for post-treatment groundwater quality parameters are:

- Continue quarterly monitoring of post-treatment groundwater quality parameters if measurements indicate continued aquifer conditions are affected by the associated EISB treatment at the well; or measurements at one or more adjacent wells indicate aquifer conditions are affected by the associated EISB treatment; or measurements at one or more wells in an immediately upgradient Deployment Area indicate aquifer conditions are affected by the associated EISB treatment;
- If two consecutive quarters of post-treatment water quality parameter monitoring data show both DO and ORP measurements have returned to the approximate levels of recorded baseline conditions,[16] then water quality parameter monitoring may be reduced to an annual frequency at the well; or,
- If four consecutive quarters of post-treatment water quality parameter monitoring data show there has been no effect on the well by EISB treatment (i.e., there has been no significant deviation from recorded baseline conditions),[17] then water quality parameter monitoring may be reduced to an annual frequency at the well.
- If two consecutive annual monitoring periods of post-treatment water quality monitoring at an OUCTP A-Aquifer well show both DO and ORP have returned to the approximate levels of recorded baseline conditions,[18] then water quality parameter monitoring may be discontinued.
- If sampling a well for VOC analyses has been discontinued in accordance with the decision rules for the GWMP, then discontinuing post-treatment water quality parameter monitoring may be considered on a case-by-case basis in consultation with the BCT.

[16] As presented in the *Final OUCTP Remedial Action Work Plan, Former Fort Ord, California; Appendix A OUCTP A-Aquifer Remedial Design Addendum* (OUCTP RAWP RD Addendum; AES, 2014).
[17] As presented in the OUCTP RAWP RD Addendum (AES, 2014).
[18] As presented in the OUCTP RAWP RD Addendum (AES, 2014).

Measurement of post-treatment groundwater quality parameters in an OUCTP A-Aquifer well may be reinstated or increased in frequency should conditions change in an adjacent well or immediately upgradient Deployment Area, including additional EISB treatment.

3.2.5.4 Completion of Groundwater Restoration Remedial Actions[19]

The decision rules for determining when groundwater remedial actions are complete in a particular site or OU, or a hydraulic zone or remedial unit within the site or OU, are:

- If data collected during the GWMP indicate potential uncertainties regarding the remedy's effectiveness and/or current site conditions, or potential key data gaps, then the conceptual site model will be re-evaluated and updated.
- If COC concentrations in a well are above ACLs, then the well and its respective hydraulic zone will remain in the remediation monitoring phase.[20]
- If four consecutive quarters of monitoring data show concentrations of COCs in a well are less than or equal to their respective ACLs, the well may be evaluated for completion of the remediation monitoring phase.
    - If non-statistical data review shows all COCs in the well are ND, all detected COC concentrations are less than or equal to the ACLs, or a combination of the two, then the remediation monitoring phase is complete in the well.
    - If groundwater monitoring data do not lend themselves to a non-statistical review, then statistical analysis of the data set may be used (e.g., mean test or trend test).
    - If the selected statistical method demonstrates the 95% upper confidence limit value is equal to or less than the ACL for the COCs where statistical analysis was used, then the remediation monitoring phase is complete in the well.
- If a well has completed the remediation monitoring phase, then the well will enter the attainment monitoring phase.[21]
- If monitoring data show concentrations of COCs in a well are less than or equal to their respective ACLs, and it can be demonstrated that COC concentrations will continue to be less than or equal to ACLs in the future, then the attainment monitoring phase is complete under any of the following conditions.
    - If all COCs in the well are ND, the LOQ is below the ACL, or a combination of ND sampling results and all detected COC concentrations are below the ACLs for eight consecutive

[19] Adapted from EPA, 2014a and EPA, 2014b.

[20] The remediation monitoring phase refers to the phase of the remedy where remedial activities are being implemented to reach groundwater cleanup levels selected in a remedy decision document. During this phase, groundwater sampling and monitoring data are collected to evaluate COC migration and changes in COC concentrations over time. The completion of this phase at a monitoring well typically occurs when the data collected and evaluated demonstrate that the groundwater has reached the cleanup levels for all COCs, as they are stated in the remedy decision document (EPA, 2013).

[21] The attainment monitoring phase typically occurs after it is determined the remediation monitoring phase is complete. When the attainment phase begins, data are collected to evaluate if the well has reached post remediation conditions (i.e., steady state conditions) where remediation activities, if employed, are no longer influencing the groundwater in the well (EPA, 2013).

sampling events, then a non-statistical or visual review of the COC data will be sufficient to conclude the attainment monitoring phase is complete in the well.
    - If all COCs in the well are less than or equal to their respective ACLs for eight consecutive sampling events, and statistical analysis (i.e., trend analysis) demonstrates COCs will remain less than or equal to ACLs in the future (the trend line has a statistically significant zero [steady state] or negative [decreasing] slope, and the 95% upper confidence limit value is less than or equal to the ACL), then the attainment monitoring phase is complete in the well.
    - If the well is removed from the sampling program in accordance with the decision rules applicable to GWMP decision rules presented above, then the attainment monitoring phase is complete in the well.

- If a well has completed the attainment monitoring phase and it is not needed for groundwater elevation data, then it will be proposed for decommissioning.
- If all the wells at a particular site or OU, or a hydraulic zone or remedial unit within the site or OU, have completed the attainment monitoring phase, then the attainment monitoring phase is complete for the particular site or OU, or hydraulic zone or remedial unit within the site or OU, and the decision rules for GWMP no longer apply (i.e., sampling for COC analysis may be discontinued and the wells may be proposed for decommissioning unless needed for groundwater elevation data).
- If the attainment monitoring phase is complete at all the hydraulic zones or remedial units within a site or OU, then the site or OU will be proposed for closure in a remedial action completion report.

The decision rules for the GWMP and for Completion of Groundwater Restoration Remedial Actions will be implemented concurrently; however, the decision rules for determining when groundwater remedial actions are complete take precedence over the decision rules applicable to groundwater monitoring (e.g., if the attainment monitoring phase is complete at all wells in a hydraulic zone, then sampling for COC analysis is no longer necessary).

Exit strategy decision logic related to remedial process optimization and contingency measures (should the remedies not progress as expected) are presented in the Final Technical Memorandum, Groundwater Remediation Exit Strategy, Sites 2/12 and OU2, Former Fort Ord, California (MACTEC, 2009).

3.2.5.5 Sites 2/12 SVETS

Discharge Limit Compliance

Discharge limit compliance is determined when the requirements of both Rule 207 (Air District, 2011) and Rule 1000 (Air District, 2017) are met. Non-compliance with either rule indicates a discharge exceedance.

Under Rule 207 (Air District, 2011), Best Available Control Technology is required for any new or modified stationary source with a potential to emit specific pollutants at rates greater than or equal to those listed in Table 4.1.1 of Rule 207 or Section 5.2 of Rule 207, whichever is more stringent. Of the 13

pollutant categories listed in Table 4.1.1 and Section 5.2 of Rule 207, only VOCs are expected to be emitted.[22] The more stringent requirement for VOCs is in Section 5.2 at 25 pounds per day (lbs/day).

For each quarterly period, the total VOC emission rate shall be calculated using the maximum detected total VOC concentration at the SVTU effluent for the quarter and the average SVTU influent flow rate for the quarter.[23] The following decision rules shall then be applied to determine whether discharge limits are being met at the SVTU effluent with respect to Rule 207:

- If the calculated total VOC emission rate at the SVTU effluent is less than 25 lbs/day, then the SVTU will continue to operate.
- If the calculated total VOC emission rate is greater than or equal to 25 lbs/day, then a confirmation sample will be collected from the SVTU effluent and analyzed with a 24-hour turnaround time (TAT).
- If the total VOC emission rate calculated using analytical results from the confirmation sample is greater than or equal to 25 lbs/day, then the SVTU will be shut down, operating conditions and GAC loading evaluated, SVE well flow rates adjusted as necessary, and a variance report issued for out-of-limits operation. Following operational corrective actions, which may include a GAC change-out, the SVETS will be restarted and a verification sample will be collected and analyzed to ensure compliance post-adjustment.
- If the total VOC emission rate calculated using analytical results from the verification sample and calculated SVETS flow rates is less than 25 lbs/day, then the SVETS will continue to operate.
- If the total VOC emission rate calculated using analytical results from the verification sample is greater than or equal to 25 lbs/day, then the SVTU will be shut down and operating conditions and GAC loading will be re-evaluated. Following operational corrective actions, the SVTU will be restarted and resampled to verify compliance.

The SVTU is a new or modified source that has the potential to emit very low levels of carcinogenic toxic air contaminants or toxic air contaminants; therefore, emissions from the SVTU are subject to Rule 1000 (Air District, 2017). For each quarterly period, the hazard index (HI) and risk to a hypothetical receptor 50 meters away from the SVTU discharge point will be calculated using output from AERSCREEN modeling, and the following decision rules shall be used to determine whether discharge limits are being met at the SVTU effluent with respect to Rule 1000:[24]

- If the calculated HI is less than 1 and the excess cancer risk is less than 10 per million (1×10^{-5}), then the SVETS will continue to operate.
- If the calculated HI is greater than or equal to 1 or the risk is greater than 1×10^{-5}, then a confirmation sample will be collected from the SVTU effluent and analyzed with a 24-hour TAT.
- If the HI is greater than or equal to 1 or the risk is greater than 1×10^{-5} as calculated using analytical results from the confirmation sample, then the SVTU will be shut down, operating conditions and GAC loading evaluated, SVE well flow rates adjusted as necessary, and a variance

[22] Based on the results of the RI/FS (HLA, 1995) and the RI/FS Addendum (AES, 2015), and the determinations of the RI Sites ROD (Army, 1997a) and RI Sites ESD No. 1 (Army, 2016).
[23] Total VOCs includes PCE and TCE, the Sites 2/12 soil gas COCs (Army, 2016).
[24] The AERSCREEN will produce estimates of "worst-case" 1-hour concentrations for a single source and includes conversion factors to estimate "worst-case" 3-hour, 8-hour, 24-hour, and annual concentrations. See https://www.epa.gov/scram/air-quality-dispersion-modeling-screening-models for more information.

report issued for out-of-limits operation. Following operational corrective actions, which may include a GAC change-out, the SVTU will be restarted and resampled to verify compliance.

- If the HI is less than 1 and the risk is less than or equal to 1×10^{-5} as calculated using analytical results from the verification sample and calculated SVETS flow rates, then the SVETS will continue to operate.
- If the HI is greater than or equal to 1 or the risk is greater than 1×10^{-5} as calculated using analytical results from the verification sample, then the SVTU will be shut down and operating conditions and GAC loading re-evaluated. Following operational corrective actions, the SVTU will be restarted and resampled to verify compliance.

GAC Change-out

The decision to do a GAC change-out will be made on a case-by-case basis, taking into consideration the SVETS operating conditions, including, but not limited to:

- Online operational time in the current GAC cycle
- SVTU influent and effluent COC concentrations and concentration trends
- SVETS operating flow rates
- Operating SVE well COC concentrations and concentration trends
- Historical, current, and planned future SVETS operations

Generally, if the SVTU effluent total VOC emission rate is greater than or equal to 22.5 lbs/day (90% of the maximum emission rate of 25 lbs/day), then the need for a GAC change-out will be determined by the USACE Technical Lead and the Ahtna Project Manager based on SVETS operating conditions.

SVE Well Operation – Soil Gas Plume Remediation

Assessment of COC removal from the vadose zone resulting from operation of the SVETS is conducted through the SGMP that evaluates plume migration and COC concentrations. SVE well and soil gas probe monitoring data will be used to evaluate the operational status of individual SVE wells and for the evaluation of remediation progress. The decision rules for determining the operational status of SVE wells with respect to soil gas plume remediation is:

- An SVE well will continue to be operated if any COC detected in the SVE well is greater than the corresponding SGCL (Worksheet #15e).
- An SVE well will continue to be operated if any COC is detected in a soil gas probe within the radius of influence (ROI) of the SVE well and within 20 feet of the groundwater interface has a concentration greater than the corresponding SGCL (Worksheet #15e).
- An SVE well will continue to operate if its ROI and analytical data from nearby SVE wells and/or soil gas probes indicate that operation of the SVE well is necessary for completion of the groundwater restoration remedial action.
- An SVE well will be shut off if COCs detected in the SVE well are less than or equal to the SGCL for two consecutive quarterly monitoring events and if its ROI and analytical data from nearby SVE wells and/or soil gas probes indicate operation of the SVE well is no longer necessary for completion of the groundwater restoration remedial action.

Site closure is dependent on decision rules for completion of the groundwater restoration remedial action as described in this QAPP. Additionally, the HHRA conducted as part of the RI Addendum at Sites 2/12 concluded the vapor intrusion pathway does not present an unacceptable risk to human health (AES, 2015). Therefore, soil gas monitoring is only relevant for determining whether soil gas may be a continuing source of COCs to groundwater, and this analytic approach may be subordinated by the analytic approach for groundwater plume remediation described below.

SVE Well Operation – Groundwater Plume Remediation

Assessment of groundwater cleanup resulting from operation of the Sites 2/12 groundwater treatment system is conducted through the GWMP that evaluates plume migration and COC concentrations, as described in this QAPP. Soil gas remediation was established to prevent COCs in soil gas from partitioning into groundwater at concentrations exceeding ACLs. As the operation of the SVETS reduces COC mass in soil gas, the process may be reversed, and COCs will partition from groundwater into soil gas, where they may be removed by the SVETS; therefore, groundwater well data will also be used to evaluate the operational status of individual SVE wells. The decision rules for determining the operational status of SVE wells with respect to groundwater plume remediation are:

- An SVE well will be operated if it is located within an area where any groundwater COC detected in a monitoring well is greater than the corresponding ACL. However:
    - If analytical data from the operating SVE well and nearby groundwater monitoring wells indicate the SVE well is not facilitating groundwater remediation, then a recommendation will be presented for regulatory agency approval to discontinue operation of the SVE well.
    - If a groundwater monitoring well has COC concentration trends that are statistically decreasing but has adjacent soil gas probes with concentrations of COCs greater than SGCLs within 20 feet of the groundwater interface, then a recommendation will be presented for regulatory agency approval to discontinue operation of the SVE well.
    - If COC concentrations in one or more soil gas probes within 20 feet of the groundwater interface and within the ROI of an SVE well are on a statistically increasing trend toward an exceedance of the SGCL, but groundwater COC concentrations in an adjacent monitoring well are below the ACLs, the SVE well may continue to be operated to mitigate potential groundwater impact.
- An SVE well will be operated if the SVE ROI and analytical data from nearby groundwater wells indicate that operation of the SVE well may supplement groundwater plume remediation.
- An SVE well will be shut off if the SVE ROI and analytical data from nearby groundwater wells indicate that operation of the SVE well is no longer necessary for groundwater plume remediation.

SVE Well Sampling Frequency

SVE wells will be sampled a minimum of quarterly when operating as part of the SVETS; however, due to the density of soil gas probes in the Site 12 area, it is not necessary to sample an SVE well after its operation has been terminated in accordance with the analytic approach for plume remediation. If an SVE well is no longer needed for plume remediation, then it may be proposed for decommissioning.

3.2.5.6 Sites 2/12 SGMP

Sampling Frequency

The decision rules for determining the sampling frequency and monitoring status for soil gas probes are:[25]

- If two consecutive quarters of monitoring data from a soil gas probe show concentrations of COCs are less than or equal to their respective SGCLs, but greater than or equal to their SG-SLs, then the soil gas probe shall be evaluated for annual sampling.[26]
    - If it is determined that quarterly data from the soil gas probe is necessary for defining the soil gas plume and/or evaluating remedy status, then the soil gas probe shall continue to be sampled quarterly.
    - If it is determined that soil gas probes laterally or vertically adjacent to the soil gas probe have detections of COCs greater than their respective SGCLs, then the soil gas probe shall continue to be sampled quarterly.
    - If it is determined that annual data from the soil gas probe is sufficient for defining the soil gas plume and/or evaluating remedy status, then the soil gas probe shall be sampled annually.
- If two consecutive annual monitoring results from a soil gas probe show concentrations of COCs less than or equal to their respective SG-SLs, then the soil gas probe will be evaluated for removal from the sampling program.
- If an annual monitoring event shows COC concentrations above their respective SG-SLs at an annual soil gas probe, then the soil gas probe sampling frequency may be increased to quarterly.
- If soil gas probes laterally or vertically adjacent to a soil gas probe sampled annually have detections of COCs greater than their respective SGCLs, then the soil gas probe may be returned to a quarterly monitoring schedule.
- If monitoring indicates the soil gas monitoring network no longer provides vertical or lateral control of COCs, then additional soil gas probes may be proposed for sampling.
- If all individual soil gas probes in a soil gas probe cluster meet the criteria above for removal from the soil gas monitoring program, and it is determined that the soil gas probe cluster is no longer needed for the soil gas monitoring program based on an evaluation of remedy status, then it will be proposed for decommissioning subject to concurrence by the regulatory agencies.

Exceptions to the decision rules for sampling frequency that may be implemented based on decision inputs are:

- If a soil gas probe is located vertically and laterally adjacent to a storefront and is in an area with concentrations of soil gas COCs historically greater than SGCLs,[27] then it will be sampled quarterly or at an appropriate frequency based on historical data and anticipated data needs as determined by the Army and concurred with by the regulatory agencies.

[25] An individual soil gas probe is at a specific depth and is part of a cluster of probes (all different depths) at the same location.
[26] The annual sampling occurs during the third quarter SGMP event.
[27] Probes SG-12-02-10, SG-12-04-10 and SG-12-06-10 currently meet these criteria.

- If a soil gas probe is located vertically adjacent to groundwater with concentrations of groundwater COCs greater than ACLs, then it will be sampled quarterly or at an appropriate frequency based on historical data and anticipated data needs as determined by the Army and concurred with by the regulatory agencies.

3.2.5.7 Sites 2/12 Soil Gas Plume Limits

For defining soil gas plume limits, the parameter of interest is the maximum COC concentrations detected in a soil gas probe as compared to the SGCLs, SG-SLs, or historical COC concentration trends at the soil gas probe.

- If the COC concentration detected in a soil gas probe is greater than or equal to the SGCL, then that monitoring point is within the soil gas plume limits.
- If the COC concentration detected in a soil gas probe is less than the SGCL, then that monitoring point is outside the soil gas plume limits.

3.2.5.8 Sites 2/12 Soil Gas Plume Perimeter Control

For perimeter control, the minimum value detected in the monitoring point (e.g., ND at the LOD) is the parameter of interest.

- If COCs are ND in a soil gas probe and COCs are ND in all adjacent monitoring points, then that soil gas probe is outside the study area boundary as defined in Section 3.2.4 and not needed for perimeter control.
- If COCs are ND in a soil gas probe, but COCs are detected in adjacent monitoring points, then that soil gas probe defines the outer perimeter of the study area, and that soil gas probe may continue to be monitored for perimeter control in accordance with the decision rules for soil gas monitoring described above.

3.2.5.9 OU2 LFG Extraction and Treatment System

TTU Source Testing

TTU stack emissions and the influent LFG concentrations for specific gases are measured to determine the TTU's efficiency, its ability to achieve optimum operating conditions, and its ability to meet regulatory standards.

- If mathematical calculations and direct measurement data obtained from stack emissions and influent LFG testing demonstrate that it meets the target operating conditions, then the TTU will be considered to be operating efficiently.
- If mathematical calculations and direct measurement data obtained from stack emissions and operational influent LFG testing do not demonstrate that it meets the target operating conditions, then the TTU may require adjustments to increase its efficiency and meet target operating conditions.
- If stack emission data show that the system does not achieve regulatory standards, then the TTU may require optimization or upgrading to achieve the regulatory standards.
- If stack emission data show that the system meets regulatory standards, then the TTU will not require further optimization.

- If a VOC has not been detected in any of the samples associated with the LFG extraction system (TTU influent, extraction legs, stack) for five consecutive annual monitoring events, the VOC will be removed from the TO-15 target analyte list (TAL; Worksheet #15i) for operational extraction system sampling only.
- The eleven VOCs identified as COCs for groundwater in the OU2 ROD will remain on the TO-15 TAL, regardless of whether they have been ND for five consecutive annual monitoring events.
- If the list of VOCs identified as COCs for groundwater is revised in a subsequent OU2 decision document, then the most current list of COCs for groundwater will remain on the TO-15 TAL.
- To confirm compliance with regulatory standards, the full TO-15 list of VOCs will be reported once every five years for samples associated with the TTU system.[28] If a VOC that was previously removed from the TO-15 TAL is detected, then this VOC will be added to the TO-15 TAL (Worksheet #15j).
- These criteria are applied retroactively as part of a previous QAPP revision to include VOC analytical data collected since TTU operations began in April 2006 (AEI, 2016b).

Operational Influent LFG Testing

The composition of gases from the operational EWs and perimeter probes will be monitored.

- If the concentration of methane is below 40%v, and the flow rate is below 30 standard cubic feet per minute (scfm), or if methane is below 30%v and the flow rate is below 50 scfm as measured in the influent LFG, then the system parameters will be adjusted (e.g., EW flow rates may be adjusted, the TTU may be shut down and operated intermittently, or supplemental fuel may be added to operate the TTU continuously).
- If the concentration of methane is greater than 50%v, and the flow rate is 180 scfm or greater, or if the concentration of methane is greater than 30%v, and the flow rate is 300 scfm or greater, resulting in maximum influent conditions greater than 5 million Btu per hour (Btu/hr), then the system may be adjusted or shut down.
- If the methane concentrations exhibit a downward trend, possibly due to short-term overextraction of the available LFG, then the TTU may be operated intermittently or shut down, or fuel may be added to avoid permanently damaging the methane-generating potential of the waste and substantially reducing the long-term availability of fuel for self-sustaining TTU operations.
- If methane concentrations in the compliance perimeter monitoring probes associated with the eastern perimeter leg are greater than the regulatory compliance concentration of 5%v, then the eastern perimeter leg will be operated more frequently to maintain compliance.
- If methane concentrations in the eastern perimeter probes are below 5%v, then this leg may be shut down.
- If methane concentrations in the northern or southern perimeter leg are less than 10%v, then the leg(s) may be shut down.
- If methane concentrations in individual interior EWs at Area F are below 40%v, then the individual wells may be shut down.

[28] The full TO-15 list of VOCs was last reported in the 2024 Annual Report (Ahtna, 2025e) and will next be reported in the 2029 Annual Report. The full TO-15 list of certified compounds is provided in Appendix B, Analytical Laboratory Information.

- If methane concentrations in individual interior EWs at Area D are below 30%v, then the individual wells may be shut down.
- If methane concentrations in the interior legs of Area D or Area F are below 50%v, then operation of the TTU will be intermittent rather than continuous.
- If EW temperatures are greater than 120 °F, then the individual well(s) or the leg will be shut down.
- If a VOC has not been detected in any of the samples collected from the LFG extraction system for five consecutive annual monitoring events, then the VOC will be removed from the TO-15 TAL (Worksheet #15i) for LFG extraction system sampling only.
- The eleven VOCs identified as COCs for groundwater in the OU2 ROD will remain on the TO-15 TAL, regardless of whether they have been ND for five consecutive annual monitoring events.
- If the list of VOCs identified as COCs for groundwater is revised in a subsequent OU2 decision document, then the most current list of COCs for groundwater will remain on the TO-15 TAL.
- The full TO-15 list of VOCs will be reported once every five years for samples associated with the operational LFG extraction legs.[29] If a VOC that was previously removed from the TO-15 TAL is detected, then this VOC will be added to the TO-15 TAL (Worksheet #15i).
- These criteria will be applied retroactively as part of a previous QAPP revision to include VOC analytical data collected since TTU operations began in April 2006 (AEI, 2016b).

3.2.5.10 OU2 LFG Monitoring

Compliance Perimeter Probes

The parameters of interest are the concentrations of the methane and trace gases at the OU2 Landfills perimeter. Compliance perimeter probes (Figure 20) will be monitored quarterly for methane and annually for VOCs. The following decision rules apply to methane in the compliance perimeter probes:

- If the concentration of methane is less than 5%v, then there is no LFG migration and the OU2 Landfills are in compliance with the regulatory requirements.
- If the concentration of methane is greater than 5%v, then there is a potential for LFG migration, and corrective actions need to be implemented.

The following decision rules relate to VOCs and are based on comparison of current analytical data with historical data since startup of the pilot LFG extraction and treatment system:

- For compliance perimeter probes with previously measured detections greater than 1,000 times the DTSC SL for vinyl chloride (1,000 times the DTSC SL equals 9.5 µg/m^3 or 3.7 parts per billion by volume (ppbv) based on the current DTSC SL (DTSC, 2022)): if the concentration of vinyl chloride exceeds the previous maximum recorded value, then the probe will be sampled quarterly until two successive measurements show declining or constant concentrations.
- For compliance perimeter probes with previously measured detections greater than 1,000 times the current DTSC SL for PCE (1,000 times the DTSC SL equals 460 µg/m^3 or 67.8 ppbv based on the current DTSC SL (DTSC, 2022)): if the concentration of PCE exceeds the previous maximum

[29] The full TO-15 list of VOCs was last reported in the 2024 Annual Report (Ahtna, 2025e) and will next be reported in the 2029 Annual Report. The full TO-15 list of certified compounds is provided in Appendix B, Analytical Laboratory Information.

recorded value, then the probe will be sampled quarterly until two successive measurements show declining or constant concentrations.

- For compliance perimeter probes with previous measured detections greater than 100 times the EPA RSL for chloroform (100 times the EPA RSL equals 12 µg/m^3 or 2.5 ppbv based on the current EPA RSL (EPA, 2024)): if the concentration of chloroform exceeds the previous maximum recorded value, then the probe will be sampled quarterly until two successive measurements show declining or constant concentrations.
- For compliance perimeter probes with no previous measured detections greater than 1,000 times the most current DTSC SL for vinyl chloride or PCE in gas: if the concentration remains less than 1,000 times the DTSC SL, then no action is required.
- For compliance perimeter probes with no previous measured detections greater than 100 times the most current EPA RSL for chloroform in gas: if the concentration remains less than 100 times the EPA RSL, then no action is required.
- For compliance perimeter probes with no previous measured detections greater than 1,000 times the most current DTSC SL for vinyl chloride or PCE in gas: if the concentration exceeds 1,000 times the DTSC SL, then the probe will be sampled quarterly until two successive measurements show declining or constant concentrations.
- For compliance perimeter probes with no previous measured detections greater than 100 times the most current EPA RSL for chloroform in gas: if the concentration exceeds 100 times the EPARSL, then the probe will be sampled quarterly until two successive measurements show declining or constant concentrations.
- If a VOC has not been detected in any of the samples collected from compliance perimeter probes for five consecutive annual monitoring events, then the VOC will be removed from the TO-15 TAL (Worksheet #15j) for compliance perimeter probes only.
- The eleven VOCs identified as COCs for groundwater in the OU2 ROD will remain on the TO-15 TAL, regardless of whether they have been ND for five consecutive annual monitoring events.
- If the list of VOCs identified as COCs for groundwater is revised in a subsequent OU2 decision document, then the most current list of COCs for groundwater will remain on the TO-15 TAL.
- To confirm compliance with regulatory standards, the full TO-15 list of VOCs will be reported once every five years for samples collected from compliance perimeter probes.[30] If a VOC that was previously removed from the TO-15 TAL is detected, then this VOC will be added to the TO-15 TAL (Worksheet #15j).
- These criteria will be applied retroactively to include VOC analytical data collected since TTU operations began in April 2006 (AEI, 2016b).

Monitoring Probes and Vents

The parameters of interest are the concentrations of the methane at the OU2 Landfills. The following decision rules apply to methane in the perimeter probes:

- If the concentration of methane is greater than 5%v and an upward trend in concentration is observed, then there is a potential for LFG migration and corrective actions need to be implemented.

[30] The full TO-15 list of VOCs was last reported in the 2024 Annual Report (Ahtna, 2025e) and will next be reported in the 2029 Annual Report.

- If methane concentrations along the eastern perimeter of Area F, where residential housing is located closest to the OU2 Landfills, are less than 5%v, then LFG migration is being controlled by operations of the TTU.
- If methane concentrations along the eastern perimeter of Area F, where residential housing is located closest to the OU2 Landfills, are greater than 5%v, then LFG migration is not being controlled by operations of the TTU and the operational schedule of the TTU needs to be modified.

The following decision rules apply to the monitoring frequency of the perimeter probes:

- Probes designated as Additional LFG Monitoring Probes (Figure 20) will be monitored quarterly for methane except:
    - If methane concentrations in the probe are less than 1%v for 20 consecutive quarterly monitoring events, then the probe will be moved to an annual monitoring schedule.
    - If methane concentrations in the probe are less than 1%v for five consecutive annual monitoring events, then the probe will be removed from the monitoring program.

These decision rules will be applied retroactively as part of a previous QAPP revision to include methane concentration data collected since TTU operations began in April 2006 (AEI, 2016b).

If the TTU is unintentionally nonoperational for technical reasons or other unforeseen circumstances for more than 2 months, additional LFG monitoring probes in Area F that are on an annual monitoring schedule will be monitored for methane concentrations in the next quarterly monitoring event. Additional probes may be added to the monitoring program depending upon the results from the additional annual probes. These data will be used to determine TTU operational parameters when the TTU is online again.

The following decision rules apply to methane in the utility trench probes:

- If the concentration of methane is less than 5%v, then there is no potential for LFG migration via the utility trench and the OU2 Landfills are in compliance with regulatory requirements.
- If the concentration of methane is greater than 5%v, then there is a potential for LFG migration via the utility trench and corrective actions need to be implemented.

3.2.6 Step 6: Specify Performance or Acceptance Criteria

3.2.6.1 Sites 2/12 and OU2 GWTSs

The null hypotheses for the Sites 2/12 and OU2 GWTS are:

1. Concentrations of VOCs in groundwater entering the GWTS exist above the action levels
2. Concentrations of VOCs at the discharge points of compliance for the GWTS effluents are below discharge limits

The two types of decision errors that could result are a false acceptance decision error and a false rejection decision error. A false acceptance decision error for each null hypothesis would be to:

1. Assume a measured concentration is above the action level when in fact it is not.

2. Assume a measured concentration at a discharge point of compliance is below discharge limits when in fact it is not.

Consequences of the first false acceptance error might include unnecessarily treating groundwater that is not above action levels or continuation of remediation system operation after applicable ACLs have been met.

Consequences of the second false acceptance error might include delay of timely GAC change-out, resulting in discharge of water from the GWTS above discharge limits, or discontinuation of remediation system operation when applicable ACLs have not been met.

A false rejection error for each null hypothesis would be to:

1. Assume a measured concentration is not above the action level when in fact it is.
2. Assume a measured concentration at a discharge point of compliance is above the discharge limit when in fact it is not.

Consequences of the first false rejection error might include premature removal of extraction wells from the remediation system program before ACLs have been met.

Consequences of the second false rejection error might include unnecessarily performing or initiating confirmation sampling of GWTS effluent that actually met discharge limits during normal operation or remediation system shutdown, GAC change-out, and variance report issuance for effluent that met discharge limits after GAC vessel backwashing activities.

Decision errors are most likely to occur when the measured concentration is near the action level, or in the case of NDs, when the LOQ is near the action level. To control decision errors when the LOQ is near the action level, the laboratory is required to report any detections below the LOQ (but above the detection limit [DL]), thereby giving the data user additional information regarding trace level contamination. To control decision errors when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual sampling events and will require data from additional sampling or subsequent sampling events before modifying the treatment system network.

3.2.6.2 Sites 2/12, OU2, and OUCTP GWMP

The null hypothesis for this project is that concentrations of VOCs in groundwater exist above the action levels. A false acceptance decision (i.e., false positive decision error) would be to assume a measured concentration is above the action level, when in fact it is not. The consequences of this decision error would be to incur unnecessary expense to study and potentially modify the monitoring network to address an extent of contamination that does not exist.

A false rejection decision error (i.e., false negative decision error) would be to assume a measured concentration is not above the action level when in fact it is. The consequences of this decision error would be to not study or potentially modify the monitoring network, thereby resulting in an incomplete understanding of the extent of contamination and the potential threat to groundwater quality.

Decision errors are most likely to occur when the measured concentration is near the action level, or, in the case of NDs, when the LOQ is near the action level. To control decision errors when the LOQ is near

the action level, the laboratory is required to report any detections below the LOQ (but above the DL), thereby giving the data user additional information regarding trace level contamination. To control decision errors when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual monitoring events and will require data from additional sampling or subsequent sampling events before modifying the monitoring network.

In addition, trend analysis provides a valuable tool for assessing the reliability of reporting concentrations. Furthermore, data are subjected to automated data review using an electronic system of QC checks, under the direction of a qualified chemist, using USACE and industry standards of analytical QC.

The null hypothesis is that EISB is not occurring in the Deployment Areas. A false acceptance decision (i.e., false positive decision error) would be to assume measured DO and ORP indicate there are no reducing conditions in the aquifer, when in fact there are. The consequences of this decision error would be to incur unnecessary expense to potentially perform additional EISB to establish reducing conditions in areas where they already exist.

A false rejection decision error (i.e., false negative decision error) would be to assume measured DO and ORP indicate there are reducing conditions in the aquifer, when in fact there are not. The consequences of this decision error would be not performing additional EISB, thereby resulting in a longer period to achieve remedial action objectives.

Decision errors are most likely to occur when measured DO and ORP are near zero. To control such decision errors, the program is very conservative about making recommendations or changes based on individual monitoring events and will require data from additional sampling or subsequent sampling events before modifying the monitoring network. In addition, trend analysis provides a valuable tool for assessing the reliability of reporting groundwater quality parameters.

3.2.6.3 Sites 2/12 SGMP

The null hypothesis is COC concentrations in samples are greater than the SGCLs. Potential consequences of a false positive detection might include:

- Unnecessarily performing remediation activities where COC concentrations are lower than SGCLs.
- Increasing or maintaining the sampling frequency when it is not necessary.

The potential consequence of a false negative result is COCs remaining in soil gas at levels that are potentially a source of groundwater COC concentrations above ACLs.

Decision errors are most likely to occur when the measured concentration is near the SGCL or, in the case of NDs, when the LOQ is near the SGCL. To control decision errors when the LOQ is near the SGCL, the laboratory is required to report any detections below the LOQ (but above the LOD), thereby giving the data user additional information regarding trace level contamination. This may be the case when sample dilution raises the LOQ to a level near the cleanup level.

False negatives or positives could occur due to laboratory error, contamination, or dilution. False negatives or positives could occur if ambient air containing, respectively, lower or higher concentrations

of COCs compared to the soil gas is inadvertently introduced during sample collection. All soil gas probes and sampling assemblies are leak-tested with helium in the field prior to and during sampling to mitigate the possibility of accidental ambient air contamination. In addition, field samples will be analyzed for helium to verify that no leaks were present.

Definitive data are required to support project decisions. It is assumed that, if the precision, accuracy, and sensitivity requirements specified in the QAPP are met, the data will be usable for decision-making purposes.

3.2.6.4 OU2 LFG Extraction and Treatment System and LFG Monitoring

Decisions could be affected adversely by errors in field measurements and/or fixed laboratory measurements. By adhering to standard procedures and approved methods to obtain the most reliable data, decision errors will be minimized and should not be a factor in making decisions.

3.2.7 Step 7: Develop the Plan for Obtaining Data

3.2.7.1 Groundwater Monitoring at Sites 2/12, OU2 and OUCTP

As a result of the DQO process, the optimum sampling design is derived for the Sites 2/12, OU2, and OUCTP remedies. Sample collection locations, rationales, and frequencies were established to achieve discharge compliance and provide a cost-effective means to evaluate the treatment of the impacted groundwater and can be found in Worksheets #18a1 and #18a2 for Sites 2/12, and Worksheets #18b1 and #18b2 for OU2 and OUCTP. The overall sampling network design is described in Worksheets #18c1 through #18c5.

The EPA Method 8260-SIM (selected ion monitoring) analytical procedure for this project was selected to accurately quantify the chemicals of interest at the levels of concern. Method performance criteria for EPA Method 8260-SIM are presented in Worksheets #24 and #28.

Sampling design considerations regarding application of PDBs are described in the Technical Memorandum Passive Diffusion Bag Pilot Study Results and Recommendations (Harding ESE, 2001).

3.2.7.2 Soil Gas Monitoring at Sites 2/12

The sampling approach is non-random and based on professional judgment. To limit uncertainty in obtained environmental data, criteria for precision, accuracy, representativeness, completeness, comparability parameters, and reporting limits for the parameters have been developed and are presented in this QAPP. Measurement errors will be controlled by using the appropriate sampling and analytical methods, adhering to the requirements of QSM Version 6.0 (DoD, 2023), and data validation/review to verify laboratory processes and measurement quality objectives. The data that meet these criteria will be of definitive quality.

The optimal sampling design is derived for the Sites 2/12 soil gas remedy as a result of the DQO process. The overall sampling network design, including sample collection locations, rationales, and frequencies, was established to achieve discharge limit compliance and provide a cost-effective means to evaluate the treatment of the impacted soil gas (Worksheet #17). The EPA Method TO-15 analytical procedure for this project was selected to accurately quantify the chemicals of interest at the levels of concern. Worksheets #19 & 30, #20, and #24-#28 specify analysis design requirements for EPA Method TO-15.

3.2.7.3 OU2 LFG Extraction and Treatment System

TTU Source Testing

The TTU will be operated and maintained properly to achieve continuous optimum performance and efficiency per the requirements of the O&M Plan (Ahtna, 2023c). The field test methods, parameters, numbers of tests, durations of tests for stack emission testing, and information inputs for effluent LFG are:

Sample Parameter	Test Method	Number of Runs/Samples	Test Duration	Information Input Source
Flow Rate	EPA Method 19	3	40 minutes	Mobile Laboratory
O_2, CO_2	EPA Method 3A	3	40 minutes	Mobile Laboratory
Methane/NMOC/THC	EPA Method 25A	3	40 minutes	Mobile Laboratory
CO	EPA Method 10	3	40 minutes	Mobile Laboratory
NO_X	EPA Method 7E	3	40 minutes	Mobile Laboratory
VOCs	EPA Method TO-15	1	40 minutes	Fixed Laboratory

Access to the stack will be through a shared sample line provided by the source testing contractor. For sample parameters except VOCs, a heated and filtered stainless steel probe will be used to extract the gas sample from the stack. A heated, ⅜-inch Teflon® line will transport the sample from the point of extraction to the non-contact gas conditioning chiller system. The gas conditioning system and analytical equipment will be provided by the source testing contractor in a self-contained mobile test laboratory. The moisture will be condensed and removed from the gas stream, while the pollutants pass through to the analytical equipment. The analyzer will be in a temperature-controlled area to minimize thermal effects on the calibration of the instrument used in taking the measurements. For VOCs, the sample is collected at the sample port on the stack, using a vacuum pump and Tedlar™ bag, and shipped to the fixed laboratory (Eurofins) for analysis.

The laboratory test methods, parameters, numbers of tests, and information inputs for influent LFG are as follows:

Landfill Gas Influent Test Methods

Sample Parameter	Test Method	Number of Samples	Information Input Source
Heating Value (calculated), O_2, CO_2, NMOC	ASTM International (ASTM) D1945	1	Fixed Laboratory
VOCs	EPA Method TO-15	1	Fixed Laboratory
Total Reduced Sulfurs	South County Air Quality Management District (SCAQMD) Method 307-91	1	Fixed Laboratory
LFG rate	Field measurement	Continuous	Flow meter
Flare temperature	Field measurement	Continuous	Thermocouple

Source testing will be performed annually to demonstrate that the TTU is operating within the substantive requirements of Air District emission limits.

Operational Influent LFG Testing

The TTU should be operated and maintained properly to achieve continuous optimum performance and efficiency. As required, field measurements will be performed using a portable LFG analyzer.

TTU Test Methods

Sample Parameter	Location	Test Method	Frequency
Methane, O_2, CO_2, balance gas, temperature, flow rate, vacuum	Interior Extraction Legs, and points (wells and vents) in operation	Portable LFG analyzer	Biweekly or when system is in operation
	Influent	Portable LFG analyzer	Biweekly or when system is in operation
VOCs	Influent	EPA Method TO-15	Annual (during source testing)
VOCs	Interior Extraction Legs	EPA Method TO-15	Annual

3.2.7.4 OU2 LFG Monitoring

Compliance Perimeter Probes

The compliance perimeter probes were installed at approximately 1,000 feet apart at the perimeter of the OU2 Landfills.

Monitoring Probes and Vents

The probes along the northern and eastern perimeters of Area F, which are closer to residential areas, are spaced a maximum of 500 feet apart due to the landfill proximity to the housing area. Additional investigations, such as the installation of permanent or temporary perimeter probes or ambient air monitoring, may also be conducted to characterize methane and trace gas concentrations.

3.3 Worksheet #12: Measurement Performance Criteria

The following sections provide measurement performance criteria for the fixed laboratory methods. The measurement performance criteria are consistent with EPA-approved analytical methods, laboratory accreditation requirements, and DoD QSM Version 6.0 (DoD, 2023). These criteria are retained to maintain consistency and comparability with historically approved Fort Ord datasets and are evaluated in the context of project-specific decision objectives rather than strict pass/fail application of individual quality control elements.

3.3.1 Worksheet #12a: VOCs in Groundwater

Analytical Group/Method: VOCs by EPA Method 8260-SIM
Matrix: Groundwater (µg/L)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Recovery Measurement Performance Criteria	
Precision	Field Duplicates	RPD < 30%	
Precision	Laboratory Control Sample/ Laboratory Control Sample Duplicate (LCS/LCSD) / Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	RPD < 20%	
Accuracy	Surrogate	1,2-Dichloroethane-d4	81-118%
		Toluene-d8	89-112%
Accuracy	LCS/LCSD, MS/MSD, and Proficiency Samples[31]	1,1-DCA	77-125%
		1,1-DCE	71-131%
		1,2-DCA	73-128%
		1,2-DCE (total)	79-121%
		1,2-DCPA	78-122%
		1,3-DCPE (total)	77-123%
		Benzene	79-120%
		CT	72-136%
		Chloroform	79-124%
		cis-1,2-DCE	78-123%
		Methylene chloride	74-124%
		PCE	74-129%
		TCE	79-123%
		Vinyl chloride	58-137%
Representativeness	Cooler Temperature Blank	> 0°C ≤ 6°C	
	Measure pH of samples after analysis	Samples preserved to pH < 2.0	
Completeness	Number of samples collected out of total samples planned	≥ 95% field completeness	

[31] If requested by the Ahtna Project Manager.

Data Quality Indicator	QC Sample or Measurement Performance Activity	Recovery Measurement Performance Criteria
	Evaluation of number of unqualified results out of the total results reported[32]	≥ 90% analytical completeness
Comparability	Historical data	Reasonableness
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures
Bias/Sensitivity	Method blank, field blank, and trip blank	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or > ⅒ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.[1]
	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:

[1] See Worksheet #15a for LOQs and project action limits

<: less than
≤: less than or equal to
>: greater than
≥: greater than or equal to
%: percent
°C: degrees Celsius
CCAL: continuing calibration
1,1-DCA: 1,1-dichloroethane
1,1-DCE: 1,1-dichloroethene
1,2-DCA: 1,2-dichloroethane
1,2-DCE (total): total 1,2-dichloroethene
1,2-DCPA: 1,2-dichloropropane
1,3-DCPE (total): 1,3-dichloropropene
cis-1,2-DCE: cis-1,2-dichloroethene
CT: carbon tetrachloride
ICAL: initial calibration
LCS: laboratory control sample
LCSD: laboratory control sample duplicate
LOQ: limit of quantitation
MS: matrix spike
MSD: matrix spike duplicate
PCE: tetrachloroethene
QC: quality control
RPD: relative percent difference
SIM: selected ion monitoring
TCE: trichloroethene
trans-1,2-DCE: trans-1,2-dichloroethene
VOC: volatile organic compound

3.3.2 Worksheet #12b: Metals in Groundwater

Analytical Group/Method: Metals by EPA Method 6010D
Matrix: Groundwater (µg/L)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Recovery Measurement Performance Criteria
Precision	Field Duplicate	RPD ≤ 30%
	LCS/LCSD and MS/MSD	RPD ≤ 20%
Accuracy / Bias	LCS/LCSD, MS/MSD and Proficiency Samples	Antimony 88-113% Copper 86-114%

[32] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

Data Quality Indicator	QC Sample or Measurement Performance Activity	Recovery Measurement Performance Criteria
		Lead 86-113%
	Method blank and field blank	The absolute values of all analytes must be < ½ LOQ or < ⅒ the amount measured in any sample or ⅒ the regulatory limit, whichever is greater.
Representativeness	Measure pH of samples upon receipt	Samples preserved to pH < 2.0
	Cooler temperature blank	> 0°C ≤ 6°C
Comparability	Historical data	Reasonableness
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures
Completeness	Number of samples collected out of total samples planned	≥ 95% field completeness
	Evaluation of number of unqualified results out of the total results reported[33]	≥ 90% analytical completeness
Sensitivity	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:
≤: less than or equal to
≥: greater than or equal to
°C: degrees Celsius
CCAL: continuing calibration
ICAL: initial calibration
LCS/LCSD: laboratory control sample/laboratory control sample duplicate
LOQ: limit of quantitation
MS/MSD: matrix spike/matrix spike duplicate
RPD: relative percent difference

[33] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

3.3.3 Worksheet #12c: Chloride in Groundwater

Analytical Group/Method: Chloride by EPA Method 9056A
Matrix: Groundwater (mg/L)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Recovery Measurement Performance Criteria
Precision	Field Duplicate	RPD ≤ 30%
	Laboratory duplicates and MS/MSD (chloride only)	RPD ≤ 15%
Accuracy / Bias	LCS/LSD, MS/MSD and Proficiency Samples (chloride only)	87-111%
	Method blank and field blank	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or > 1/10 the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.
Representativeness	Cooler Temperature Blank	> 0°C ≤ 6°C
Comparability	Historical data	Reasonableness
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures
Completeness	Number of samples collected out of total samples planned	≥ 95% field completeness
	Evaluation of number of unqualified results out of the total results reported[34]	≥ 90% analytical completeness
Sensitivity	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:
≤: less than or equal to
≥: greater than or equal to
°C: degrees Celsius
CCAL: continuing calibration
ICAL: initial calibration
LCS/LCSD: laboratory control sample/laboratory control sample duplicate
LOQ: limit of quantitation
MS/MSD: matrix spike/matrix spike duplicate
RPD: relative percent difference

[34] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

3.3.4 Worksheet #12d: VOCs in Soil Gas

Analytical Group/Method: VOCs by TO-15
Matrix: Soil Gas (ppbv)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria	
Precision	Field Duplicates	RPD < 30%	
Precision	Laboratory Duplicate	RPD < 25%	
Accuracy	Surrogate	1,2-dichloroethane-d4	50–150 %R
		Toluene-d8	50–150 %R
		4-Bromofluorobenzene	50–150 %R
Accuracy	Laboratory Control Sample (LCS)	Tetrachloroethene	66–124 %R
		Trichloroethene	71–123 %R
Bias/Sensitivity	Method Blanks	< LOQ (common laboratory contaminants) and < ½ LOQ (all other compounds) 1	
Completeness	Data Assessment	≥ 90%	
Comparability	Data Review: compare results to previous sampling events	Same unit of measure and LOQs meet PDLs[1]	

Notes:
[1] See Worksheet #15d/e for LOQs and project action limits

3.3.5 Worksheet #12e: Helium Soil Gas

Analytical Group/Method: Helium by ASTM D1946
Matrix: Soil Gas (ppbv)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD < 30%
Precision	Laboratory Duplicate	RPD < 25%
Accuracy	Laboratory Control Sample (LCS)	85-115% Recovery
Bias/Sensitivity	Method Blanks	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit (if applicable), whichever is greater. Common contaminants must not be detected > LOQ[1]
Completeness	Data Assessment	≥ 90%
Comparability	Data Review: compare results to previous sampling events	Same unit of measure and LOQs are consistent with previously collected data

Notes:
[1] See Worksheet #15f for LOQs and project action limits

3.3.6 Worksheet #12f: Fixed Gases in Landfill Gas

Analytical Group/Method: Fixed Gases by ASTM D1945
Matrix: Landfill Gas (ppmv)

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	Relative Percent Difference (RPD) < 30%
Precision	Laboratory Duplicate	RPD < 25%
Accuracy	Laboratory Control Sample	85-115% Recovery (%R)
Bias/Sensitivity	Method Blanks	No analytes detected > ½ the limit of quantitation (LOQ) or > ⅒ the amount measured in any sample or ⅒ the regulatory limit (if applicable), whichever is greater. Common contaminants must not be detected > LOQ[1]
Completeness	Data Assessment	≥ 90%
Comparability	Data Review: compare results to previous sampling events	Same unit of measure and LOQs are consistent with previously collected data

Notes:
[1] See Worksheet #15g for LOQ values.

3.3.7 Worksheet #12g: Sulfur Gases in Landfill Gas

Analytical Group/Method: Sulfur Gases by SCAQMD Method 307-91
Matrix: Landfill Gas (ppbv)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD < 30%
Precision	Laboratory Duplicate	RPD < 25%
Accuracy	Laboratory Control Sample	70–130 %R
Bias/Sensitivity	Method Blanks	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit (if applicable), whichever is

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
		greater. Common contaminants must not be detected > LOQ[1]
Completeness	Data Assessment	≥ 90%
Comparability	Data Review: compare results to previous sampling events	Same unit of measure and LOQs meet project decision limits (PDLs)[1]

Notes:
[1] See Worksheet #15h for LOQ values.

3.3.8 Worksheet #12h: VOCs in Landfill Gas

Analytical Group/Method: VOCs by TO-15
Matrix: Landfill Gas (ppbv)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria	
Precision	Field Duplicates	RPD < 30%	
Precision	Laboratory Duplicate	RPD < 25%	
Accuracy	Surrogate	1,2-dichloroethane-d4	50–150 %R
		Toluene-d8	50–150 %R
		4-Bromofluorobenzene	50–150 %R
Accuracy	Laboratory Control Sample (LCS)[1,2]	Benzene	69–119 %R
		Carbon Tetrachloride	68–132 %R
		Chloroform	68–123 %R
		1,1-Dichloroethane	68–126 %R
		1,2-Dichloroethane	65–128 %R
		cis-1,2-Dichloroethene	70–121%R
		1,2-Dichloropropane	69–123%R
		Dichloromethane (Methylene chloride)	62–115 %R
		Tetrachloroethene	66–124 %R
		Trichloroethene	71–123 %R

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria	
		Vinyl chloride	64–127 %R
Bias/Sensitivity	Method Blanks	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit (if applicable), whichever is greater. Common contaminants must not be detected > LOQ[3]	
Completeness	Data Assessment	≥ 90%	
Comparability	Data Review: compare results to previous sampling events	Same unit of measure and LOQs meet PDLs[3]	

Notes:

[1] Samples will be spiked for all compounds on the TO-15 project reporting list(s) (presented in Sections 3.6.9 and 3.6.10); however, only the compounds presented will be controlled per the requirements presented in the table. Compounds presented are those listed as COCs for groundwater in Table 1 of the OU2 ROD (Army, 1994). VOCs in LFG are not identified as COCs in the OU2 ROD (Army, 1994); however, ARARs identified in the OU2 ROD require control of trace gases to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds; therefore, the comprehensive project report list(s) of TO-15 analytes are reported to ensure the substantive requirements of these ARARs are met.

[2] The remaining compounds need to meet the requirements of DoD QSM 6.0.

[3] See Worksheet #15 for LOQs

3.4 Worksheet #13: Secondary Data Uses and Limitations

Secondary data and information that will be used, including originating sources, are identified below. How the secondary data will be used and the limitations on their uses are specified. Data from these documents will be utilized as appropriate.

Data Type	Data Source (originating organization, report title and date)	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
Groundwater Monitoring Reports, Figures, Analytical Data	Final Sites 2 and 12 Fourth Quarter 2023 through Third Quarter 2024 Groundwater and Soil Gas Monitoring and Treatment System	Historical data used to evaluate GWTS performance over time	None

Data Type	Data Source (originating organization, report title and date)	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
	Report, Former Fort Ord, California (Ahtna, 2026c)		
Groundwater Monitoring Reports, Figures, Analytical Data	Final Operable Unit 2 Remedy Monitoring and Operations and Maintenance Fourth Quarter 2023 through Third Quarter 2024, Former Fort Ord, California (Ahtna, 2026b)	Historical data used to evaluate GWTS performance over time	None
Groundwater Monitoring Reports, Figures, Analytical Data	Final Operable Unit Carbon Tetrachloride Plume Fourth Quarter 2023 through Third Quarter 2024 Groundwater Monitoring Report, Former Fort Ord, California (Ahtna, 2026a)	Historical data used to evaluate concentration trends	None
LFG, Inspection Reports, Figures, Analytical Data	Gilbane Company, Final Annual Report, 2014, Operations and Maintenance, Operable Unit 2 Landfills. July 2015 (Gilbane, 2015)	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	AEI, Final Annual Report, 2015, Operations and Maintenance, Operable Unit 2 Landfills. April 2016	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	AEI, Final Annual Report, 2016, Operations and Maintenance, Operable Unit 2 Landfills. July 2017	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	AEI, Final Annual Report, 2017, Operations and Maintenance, Operable Unit 2 Landfills. May 2018	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	AEI, Final Annual Report, 2018, Operations and Maintenance, Operable Unit 2 Landfills. May 2019	Trend analysis, design optimization	None

Data Type	Data Source (originating organization, report title and date)	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
LFG, Inspection Reports, Figures, Analytical Data	Ahtna, Final Operable Unit 2 Annual Report Volume I, Fourth Quarter 2018 through Third Quarter 2019, Landfill Gas Monitoring and Landfills Operations and Maintenance. February 2021	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	Ahtna, Operable Unit 2 Remedy Monitoring and Operations and Maintenance, Fourth Quarter 2019 through Third Quarter 2020. October 2021	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	Ahtna, Operable Unit 2 Remedy Monitoring and Operations and Maintenance Fourth Quarter 2020 through Third Quarter 2021. June 2022	Trend analysis, design optimization	None
LFG, Inspection Reports, Figures, Analytical Data	Ahtna, Operable Unit 2 Remedy Monitoring and Operations and Maintenance Fourth Quarter 2021 through Third Quarter 2022. June 2023	Trend analysis, design optimization	None
USACE, soil gas results at temporary probes 5 feet bgs, collected 2012-2013	USACE – Final Soil Gas Investigation Interim Report, June 2013	Data will be used to evaluate magnitude and extent of soil gas COC concentrations and historical trends.	Published data are available for past 19 years. No known limitations.
Ahtna Engineering Services (AES), soil gas results at permanent probes 10 to approximately 70 feet bgs, collected 2013-2014	AES – Final Remedial Investigation/Feasibility Study Addendum at Sites 2 and 12, February 2015	Data will be used to evaluate magnitude and extent of soil gas and groundwater COC	Published data are available for past 18 years. No known limitations.

Data Type	Data Source (originating organization, report title and date)	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
		concentrations and historical trends.	
Ahtna, groundwater and soil gas wells sample results, quarterly data collection ongoing	Sites 2/12 Quarterly and Annual Groundwater and Soil Gas Monitoring and Treatment System Reports	Data will be used to evaluate magnitude and extent of soil gas and groundwater COC concentrations and historical trends.	No known limitations.

3.5 Worksheet #14 & 16: Project Tasks & Schedule

3.5.1 Project Tasks

Applicable SOPs for the project tasks outlined in this Worksheet are listed in Worksheet #21 and provided in Appendix A, with project-specific fieldwork details provided in Worksheet #21. The sampling tasks are described in Worksheets #17 and #18. Project activities will be conducted in accordance with the Accident Prevention Plan (APP) (Ahtna, 2024). Tasks will be conducted in a manner that protects the safety and health of employees and members of the public and that complies with Occupational Health and Safety Administration and USACE Health and Safety Requirements (EM 385-1-1; USACE, 2024).

3.5.2 Project Schedule

A general project schedule for remedial systems O&M and long-term monitoring is presented below. Activity-specific schedules for well installation, well decommissioning, etc. will be developed as needed.

Activity	Responsible Party	Frequency	Deliverable(s)	Deliverable Due Date
OU2 GWTS O&M	Ahtna	Ongoing	Quarterly and Annual Reports	Quarterly Report (Final only) due 60 days after sampling event concludes Annual Report (Preliminary Draft) due to the Army 60 days after sampling event concludes*
OU2 GWMP		Quarterly		
Sites 2/12 GWTS O&M	Ahtna	Ongoing	Quarterly and Annual Reports	Quarterly Report (Final only) due 60 days after sampling event concludes Annual Report (Preliminary Draft) due to the Army 60 days after sampling event concludes*
Sites 2/12 SVETS O&M				
Sites 2/12 GWMP		Quarterly		
Sites 2/12 SGMP		Quarterly		
OUCTP GWMP	Ahtna	Quarterly	Quarterly and Annual Reports	Quarterly Report (Final only) due 60 days after sampling event concludes Annual Report (Preliminary Draft) due to the Army 60 days after sampling event concludes*
Landfill O&M	Ahtna	After major rain events and as needed	Annual Report	Annual Report (Preliminary Draft) due to the Army 60 days after sampling event concludes*
Landfill Inspections		Annually		
VOC Monitoring		Annually		

Activity	Responsible Party	Frequency	Deliverable(s)	Deliverable Due Date
TTU Monitoring		Biweekly or during TTU operation		
TTU Inspection/ maintenance		During operation, Quarterly		
Landfill methane monitoring		Quarterly		
Landfill Inspections	Monterey County Department of Health	Quarterly		

Notes:
* The conclusion of the sampling event is defined as the last day samples are collected for the event.

General non-fieldwork and non-sampling project activities are described below.

3.5.3 Quality Control Tasks

Field SOPs will be implemented, and field QC samples will be collected at the frequency indicated in Worksheet #20. Samples will be analyzed by the laboratory in accordance with this QAPP, DoD QSM, and the stated method. For items related to QC, see Worksheets #11, #12, #15, #22, #24, #25, #27, and #28.

3.5.4 Data Management Tasks

The following are the team members and their responsibilities for the data management process:

1. Task Manager. Responsible for reviewing chain of custody forms and establishing the sample tracking system. Oversees proper use of Ahtna's sample management system and accuracy of the information entered. Reviews laboratory data for accuracy and quality, and compares electronic outputs for accuracy to laboratory electronic copies. Conducts tracking of samples, forwards tracking information and received data to the Database Manager, and identifies the data inputs (for example, sample numbers) to use in generating tables and figures.
2. Database Manager. Responsible for setting up the data management system in consultation with the Project Chemist/Project Manager at the beginning of the data evaluation task. Oversees the data management process, including data conversion/manual entry into the data management system, QC of the entered data, and preparation of the required tables and plots of the data. Coordinates with the person responsible for reviewing the entered data for QC purposes. Forwards deliverables to the Project Manager.
3. Geographic Information Systems (GIS) Manager. Responsible for coordinating with the Project Manager to set up the geodatabase prior to sampling. Maintains spatial layers and overall geodatabase integrity and accuracy. Provides GIS-related outputs for reports.

3.5.5 Sample Tracking

The Project Manager is responsible for tracking samples in the sample tracking database to ensure that the analytical results for samples sent for analysis are received. Copies of chains of custody from the field team are used to enter sample identifications (IDs), collect data, and are used for analyses. Upon receipt of a sample receipt notice from the laboratory, the date received by the laboratory, and the date the electronic copy is due will be entered. Likewise, upon receipt of the electronic copy and electronic data deliverable (EDD), the date they are received will also be entered. The EDDs will be uploaded when received from the laboratory and will be tracked in the sample tracking table. Validation qualifiers will be added to the database, and results qualified accordingly.

3.5.6 Data Types

The data will be added to the project database as they become available. The data will include new data collected in the laboratory and validated by Ahtna. The data source will be noted in the database.

3.5.7 Data Tracking and Management

Data sets received from analytical laboratories will be tracked individually and will be assigned a unique identifier. Analytical laboratory reports of chemical analysis results will be tracked in a consistent fashion. The date of receipt, status of data validation, and status of database entry for each data set will be tracked and recorded in the project database. Hard/Electronic Copy. Measurements made during field data collection activities will be recorded in field logbooks and sample processing logs. Field data will be reduced and summarized, tabulated, and stored along with the field logbooks and sample processing logs. All raw analytical laboratory data are stored electronically. Data Input Procedures. Sampling information, analytical results, applicable QA/QC data, data validation qualifiers, and other field-related information will be entered into the project database for storage and retrieval during data evaluation and report development. The analytical data will be loaded into the database using EDD files received from the analytical laboratory. Validation qualifiers will be entered manually. Other available field-related data collected will be manually entered onto standard EDD templates for loading into the database. Historical data, either in hard copy or electronic form, will be manually entered on or formatted to standard EDD templates for database loading.

3.5.8 Computer Database

The technical data, field observations, laboratory analytical results, and analytical data validation will be managed using Ahtna's database (EQuIS™) to store and analyze project data submissions. EQuIS is a front-end user interface for data management using a back-end Structured Query Language (SQL) Server™ database. Servers that house the database are stored and managed by EarthSoft, Inc. Secure database access is performed through EQuIS or SQL Server Management Studio software. Data validation is performed by Laboratory Data Consultants, Inc., and validation information is ultimately stored in the EQuIS database. Access and privileges are provided to database support staff on an as needed basis by the Ahtna Data Manager. This protects the database from unauthorized access and data modification. Privileges may range from read-only to loading, modifying, or querying the database. Backups of the primary database are performed by EarthSoft, Inc. to ensure no data loss. In addition to the internal computer database, EDDs will be uploaded to the BRAC Fort Ord Data Integration System (FODIS) database and the CCRWQCB GeoTracker database (as required).

3.5.9 Geographic Information Systems

A project geodatabase will be set up prior to sampling by the Task Manager and GIS Manager. Ahtna will adhere to applicable Army geospatial data standards for tasks and deliverables in this QAPP and will meet the minimum requirements for spatial data in accordance with Spatial Data Standards for Facilities, Infrastructure, and Environment, current version whenever possible. Ahtna will submit to the Army the native GIS files that will include ArcGIS Project File (.aprx) and geodatabase (.gdb) format. Ahtna will provide validated geospatial data to the Army for submission to the FODIS database. Each geospatial data set shall be accompanied by metadata conforming to the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata and the Army Installation Geospatial Information & Services Metadata Standard, v1. The horizontal accuracy of geospatial data created shall be tested and reported in accordance with the National Standard for Spatial Data Accuracy, and the results shall be recorded in the metadata. Data will have a datum of GCS_North American_1983 and a projection of North American Datum 1983 State Plane California Zone 4. The sea level datum used will be the North American Vertical Datum 1988. In addition to laboratory data, other physical data will be collected during field efforts. The information will be stored in the project database. Other types of data elements may be added as the field investigation needs and activities evolve.

3.5.10 Data Management Documentation

Documentation of data management activities is critical because it demonstrates that data is being managed in a consistent and organized fashion. EQuIS software, developed by EarthSoft, Inc., is an industry standard for the management of environmental data. EQuIS software is the user interface that accesses data stored in a SQL Server database. This database is managed and housed by EarthSoft. SQL Server updates, database backups, and customer support are provided to Ahtna by EarthSoft. EarthSoft also has an extensive community group and documentation regarding their application.

3.5.11 Presentation of Data

Depending on data user needs, data presentation may consist of any of the following formats:

- Tabulated results of data summaries or raw data
- Figures showing concentration isopleths or location-specific concentrations
- Tables providing statistical evaluation or calculation results
- Presentation tools, such as ArcMap or similar analysis/presentation aids

In addition to laboratory data, other physical data will be collected during field efforts. The information will be stored in the project database. Other types of data elements may be added as the field investigation needs and activities evolve.

The extent of groundwater with COC concentrations above ACLs is represented by the COC concentration contours shown on the figures presented in quarterly and annual reports. COC analytical data are grouped by site for COC concentrations above ACLs, and ArcGIS Pro (Esri International, LLC) is used to generate shapefiles depicting the COC concentration contours. Adjustments are made to the contours based on comparative evaluation of current COC concentrations and contours from previous quarters. If more than one sample is collected from a well in a quarterly monitoring event, the sample with the highest detected COC concentration will be used for generating the contour. The COC

concentration contours can be compared to historical contours and used to optimize hydraulic zones and study boundaries, and interpret progress toward achieving remedial action objectives (RAOs).

Groundwater elevations in each aquifer are represented by groundwater elevation contours shown on figures presented in quarterly and annual reports. Groundwater levels are measured each quarter at the wells listed in Worksheet #18 and compared to the wells' known top of casing elevation to determine the groundwater elevation at each well. For multi-port wells that have multiple ports in one aquifer, the groundwater level data from the ports in that aquifer are averaged to determine the groundwater elevation at that location. Groundwater elevation data sets are imported into the Surfer® 15 (Golden Software, LLC) software application. Within Surfer 15, the geostatistical gridding method (i.e., kriging) is used to interpolate a gridded surface from the groundwater elevation data. Point kriging, with a circular search ellipse and without a drift type (i.e., ordinary kriging), is used to estimate grid node values based on the known data points near the node with the data points weighted by their distance from the node. The size of the grid cells is set to approximately 30 feet by 30 feet. Once the grid is constructed, Surfer 15 uses linear interpolation to generate contour lines of equal elevation based on the grid node values. Contour lines for each aquifer are exported from Surfer 15 as shapefiles and imported into ArcGIS Pro for final manual adjustments, such as trimming the extents of the contours and smoothing curves. Finally, extraction well operation data are compared to measured groundwater levels at those wells and cones of depression are added manually around operating extraction wells. Groundwater elevation contours can then be used to interpret the flow characteristics of groundwater in each of the aquifers.

3.5.12 Assessment and Audit Tasks

See Worksheet #31, 32 & 33.

3.5.13 Data Review Tasks

The laboratory will make sure that the data are complete for all samples received. Laboratory data will be validated by Laboratory Data Consultants, Inc. Validated data and field logs will be reviewed to assess total measurement error and determine the overall usability of the data for project purposes. Final data are placed in the database with qualifiers. See Worksheets #34 through #37 for the tasks.

3.5.14 Documentation and Records

Records and field measurements of samples will be collected in notebooks. Chains of custody and sample logs will be prepared and retained for each sample. A copy of the final QAPP will be kept at the Ahtna Monterey office. Field forms are shown in Appendix B.

3.6 Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

3.6.1 Worksheet #15a: VOCs by EPA Method 8260-SIM

Matrix: Groundwater (µg/L)
Analyzing Laboratory: SGS, Orlando, Florida[1]

		Project Action Limits[2] (µg/L)								Achievable Laboratory Limits[3] (µg/L)		
						OUCTP						
		Sites 2/12		OU2		A-Aquifer	Upper 180-Foot Aquifer		Lower 180-Foot Aquifer			
Analyte	CAS #	ACL	DCL[4]	ACL	DCL	ACL	ACL	DCL	ACL	DL	LOD	LOQ
1,1-Dichloroethane	75-34-3	-	-	5	5[5]	-	-	-	-	0.10	0.25	0.50
1,1-Dichloroethene	75-35-4	6	6	-	-	6	-	-	-	0.10	0.25	0.50
1,2-Dichloroethane	107-06-2	0.5	0.5	0.5	0.5	-	-	-	0.5	0.10	0.25	0.50
1,2-Dichloroethene (total)[6]	540-59-0	-	-	-	-	6	-	-	-	0.10	0.25	0.50
1,2-Dichloropropane	78-87-5	-	-	1	0.5	-	-	-	-	0.10	0.25	0.50
1,3-Dichloropropene (total)[6]	542-75-6	0.5	0.5	-	-	-	-	-	-	0.10	0.25	0.50
Benzene	71-43-2	-	-	1	0.5	-	-	-	-	0.10	0.25	0.50
Carbon Tetrachloride	56-23-5	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.10	0.25	0.50
Chloroform	67-66-3	2	2	2	2[5]	2	-	-	-	0.10	0.25	0.50
cis-1,2-Dichloroethene	156-59-2	6	6	6	6[5]	-	-	-	-	0.10	0.25	0.50
Methylene chloride	75-09-2	-	-	5	0.5	5	-	-	-	0.50	0.50	2.0
Tetrachloroethene	127-18-4	5	5	3	0.5	5	-	-	-	0.10	0.25	0.50
Trichloroethene	79-01-6	5	5	5	0.5	5	-	-	5	0.10	0.25	0.50
Vinyl Chloride	75-01-4	0.1	0.1	0.1	0.1	0.1	-	-	-	0.050	0.10	0.10

Notes:
µg/L: micrograms per liter
ACL: Aquifer Cleanup Level
CAS #: Chemical Abstracts Service Number
DCL: discharge limit

DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
OU: Operable Unit
OUCTP: Operable Unit Carbon Tetrachloride Plume

[1] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).

[2] ACLs and DCLs are site-specific and identified in the relevant decision documents (Army, 1994; Army, 1995; Army, 1997a; Army, 2008; Army, 2016; and Army, 2026).

[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated ("J-qualified").

[4] Discharge limit for the applicable groundwater treatment system using groundwater extraction and treatment with GAC. For Sites 2/12 GWTS, discharge to areas overlying the contaminated groundwater plume need only meet ACLs (HLA, 1999a).

[5] Discharge limit revised to ACL for this COC to optimize GAC usage (HLA, 1999a).

[6] Total of cis- and trans-isomers

3.6.2 Worksheet #15b: Chloride by EPA Method 9056A

Matrix: Groundwater (mg/L)
Analyzing Laboratory: SGS, Orlando, Florida[1]

Analyte	CAS Number	Project Action Limits[2] (mg/L) Sites 2/12	Achievable Laboratory Limits[3] (mg/L)		
			DL	LOD	LOQ
Chloride	16887-00-6	250	0.60	1.0	2.0

Notes:
CAS: Chemical Abstracts Service
DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
mg/L: milligrams per liter
[1] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).
[2] Project Action Limits are National Secondary MCLs for Drinking Water Quality.
[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated ("J-qualified").

3.6.3 Worksheet #15c: Dissolved Metals by ICP by EPA Method 6010D

Matrix: Groundwater (µg/L)
Analyzing Laboratory: SGS, Orlando, Florida[1]

Analyte	CAS Number	Project Action Limits[2] (µg/L) OU2	Achievable Laboratory Limits[3] (µg/L)		
			DL	LOD	LOQ
Antimony	7440-36-0	6.0	1.0	5.0	6.0
Copper	7440-50-8	1,300	1.0	2.0	25
Lead	7439-92-1	10	1.1	2.0	5.0

Notes:
CAS: Chemical Abstracts Service
DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
µg/L: micrograms per liter

[1] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).

[2] Project Action Limits are state or federal MCLs (whichever is lower) for antimony and action levels for copper and lead for drinking water in wells associated with the OU2 Landfills. Antimony, copper, and lead are the primary metals found in spent ammunition deposited in the OU2 Landfills. The MCL for antimony and the action levels for copper and lead are used to evaluate concentrations of these dissolved metals in groundwater near the OU2 Landfills; however, the groundwater being monitored is not intended for use as drinking water.

[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated ("J-qualified").

3.6.4 Worksheet #15d: VOCs by TO-15 5&20 (Soil Gas)

Matrix: Soil Gas
Analytical Method: TO-15 5&20[1]
Analyzing Laboratory: Eurofins, Folsom, California[2]

Analyte (CAS #)	Soil Gas Screening Level[3] (SG-SL) µg/m³	SG-SL Reference	Soil Gas Cleanup Level[4] (SGCL) µg/m³	Laboratory Limits[5]		
				DL (µg/m³)	LOD[6] (µg/m³)	LOQ (µg/m³)
Tetrachloroethene (127-18-4)	603	CHHSL	1,800	17	17	34
Trichloroethene (79-01-6)	888	Calculated	1,000	9.1	13.4	27

Notes:
µg/m³ = micrograms per cubic meter
Calculated = see RI/FS Addendum (AES, 2015)
CAS #: Chemical Abstracts Service Number
CHHSL = California Human Health Screening Levels Table 3: Soil-Gas Screening Numbers for Volatile Chemicals below Buildings Constructed without Engineered Fill below Sub-slab Gravel (September 23, 2010; https://oehha.ca.gov/chhsltable).
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
[1] See Worksheet #19 & 30 for descriptions of modified TO-15 methods.
[2] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).
[3] SG-SL data from the RI/FS Addendum (AES, 2015). SG-SLs are conservative and based on a 5-foot sample depth.
[4] SGCLs are based on soil gas as a source of groundwater contamination and are presented in the RI/FS Addendum (AES, 2015) and RI Sites ESD No. 1 (Army, 2016).
[5] Laboratory limits listed are base values. The final laboratory limits are determined by applying a dilution factor calculated from the SUMMA® canister pressurization measured upon receipt by the laboratory (see FSOP E2).
[6] The LODs listed are Eurofins instrument specific.

3.6.5 Worksheet #15e: VOCs by TO-15 PPTV (Soil Gas)

Matrix: Soil Gas
Analytical Method: TO-15 PPTV[1] (SVTU influent and treated soil gas at SVTU effluent)
Analyzing Laboratory: Eurofins, Folsom, California[2]

Analyte (CAS #)	Discharge Limit Compliance (total VOCs)			Laboratory Limits[3]		
	lbs/day	HI	Risk	DL ($\mu g/m^3$)	LOD[4] ($\mu g/m^3$)	LOQ ($\mu g/m^3$)
Tetrachloroethene (127-18-4)	<25	<1	$<1x10^{-5}$	0.0339	0.0678	0.678
Trichloroethene (79-01-6)				0.0269	0.0537	0.537

Notes:
$\mu g/m^3$ = micrograms per cubic meter
CAS #: Chemical Abstracts Service Number
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
[1] There are no chemical-specific screening levels for treated soil gas at the SVTU effluent; discharge requirements are defined in Worksheet #11, Section 3.2.5.4.
[2] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).
[3] Laboratory limits listed are base values. The final laboratory limits are determined by applying a dilution factor calculated from the SUMMA® canister pressurization measured upon receipt by the laboratory (see FSOP E2).
[4] The LODs listed are Eurofins instrument specific.

3.6.6 Worksheet #15f: Helium by ASTM D1946 (Soil Gas)

Matrix: Soil Gas
Analytical Method: ASTM D1946
Analyzing Laboratory: Eurofins, Folsom, California[1]

Analyte (CAS #)	Laboratory Limits[2]		
	DL (%)	LOD (%)	LOQ (%)
Helium (7440-59-7)	0.0170	0.0250	0.0500

Notes:
CAS #: Chemical Abstracts Service Number
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
[1] Laboratories used for sample analysis maintain DoD Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix C).
[2] Laboratory limits listed are base values. The final laboratory limits are determined by applying a dilution factor calculated from the SUMMA® canister pressurization measured upon receipt by the laboratory (see Appendix A, FSOP-E2).

3.6.7 Worksheet #15g: Fixed Gases by ASTM D1945 (Landfill Gas)

Matrix: Landfill Gas (ppmv)
Analyzing Laboratory: Eurofins, Folsom, California

Analyte	CAS Number	Laboratory DL	Laboratory LOD	Laboratory LOQ
O_2	7782-44-7	490	NA[1]	1500
N_2	7727-37-9	2500	NA[1]	5000
CO	630-08-0	33.0	51.0	100
Methane	74-82-8	0.330	0.500	1.00
CO_2	124-38-90	33.0	50.0	100
Ethane	74-84-0	3.30	4.80	10.0
Ethene	74-85-1	3.30	4.80	10.0
Acetylene	74-86-2	3.30	4.80	10.0
Propane	74-98-6	3.30	4.80	10.0
Isobutane	75-28-5	3.30	4.80	10.0
Butane	106-97-8	3.30	4.80	10.0
Neopentane	463-82-1	3.30	4.80	10.0
Isopentane	78-78-4	3.30	4.80	10.0
Pentane	109-66-0	3.30	4.80	10.0
C6+	NA	33.0	NA	100
Hydrogen	1333-74-0	33.0	50.0	100
NMOC ref. to Methane (MW=16)	NA	100	NA	100

Notes:
CAS = Chemical Abstracts Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
NA = not applicable
NMOC = non-methane organic compound (quantified using calibration of hexane and heptane)
Project action limits are not listed in Worksheet #15i because there are no action limits for LFG constituents identified in the OU2 ROD (Army, 1994); however, these analyses are performed to meet the substantive requirements of ARARs identified in the OU2 ROD.
[1] LOD analysis requires dilution of the lowest concentration standard, but O_2 and N_2 cannot be reported from a diluted analysis.

3.6.8 Worksheet #15h: Sulfur Gases by SCAQMD Method 307-91

Matrix: Landfill Gas (ppbv)
Analyzing Laboratory: Atmospheric Analysis and Consulting

Analyte	CAS Number	DL (ppbv)	LOD (ppbv)	LOQ (ppbv)
Hydrogen Sulfide	7783-06-4	1.90	3.80	10.0
Carbonyl Sulfide / SO_2	463-58-1 / 7446-09-5	1.90	3.80	10.0
Methyl Mercaptan	74-93-1	1.28	2.56	10.0
Ethyl Mercaptan	75-08-1	1.28	2.56	10.0
Dimethyl Sulfide	75-18-3	1.28	2.16	10.0
Carbon Disulfide	75-15-0	1.90	3.80	10.0
Isopropyl Mercaptan	75-33-2	1.28	2.56	10.0
tert-Butyl Mercaptan	75-66-1	1.28	2.56	10.0
n-Propyl Mercaptan	107-03-9	1.28	2.56	10.0
Methylethylsulfide	624-89-5	1.90	3.80	10.0
sec-Butyl Mercaptan / Thiophene	513-53-1 / 110-02-1	1.28	3.80	10.0
iso-Butyl Mercaptan	513-44-0	1.28	2.56	10.0
Diethyl Sulfide	352-93-2	1.90	3.80	10.0
n-Butyl Mercaptan	109-79-5	1.28	2.56	10.0
Dimethyl Disulfide	624-92-0	1.90	3.80	10.0
2-Methylthiophene	554-14-3	1.90	3.80	10.0
3-Methylthiophene	616-44-4	1.90	3.80	10.0
Tetrahydrothiophene	110-01-0	1.90	3.80	10.0
Bromothiophene	1003-09-4	1.90	3.80	10.0
Thiophenol	108-98-5	1.90	3.80	10.0
Diethyl Disulfide	110-81-6	1.08	2.16	10.0

Notes:
CAS = Chemical Abstracts Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
Project action limits are not listed in Worksheet #15i because there are no action limits for LFG constituents identified in the OU2 ROD (Army, 1994); however, these analyses are performed to meet the substantive requirements of ARARs identified in the OU2 ROD.

3.6.9 Worksheet #15i: VOCs by TO-15 (Source Testing and Influent LFG Testing)

Estimated Concentration Level: Low
Matrix: Landfill Gas (ppbv)
Analyzing Laboratory: Eurofins, Folsom, California

Analyte	CAS Number	Laboratory DL	Laboratory LOD	Laboratory LOQ
1,1-Dichloroethane	75-34-3	0.170	0.250	0.500
1,2,4-Trimethylbenzene	95-63-6	0.170	0.250	0.500
1,2-Dichlorobenzene	95-50-1	0.170	0.250	0.500
1,2-Dichloroethane	107-06-2	0.170	0.250	0.500
1,2-Dichloropropane	78-87-5	0.170	0.250	0.500
1,3,5-Trimethylbenzene	108-67-8	0.170	0.250	0.500
1,4-Dichlorobenzene	106-46-7	0.170	0.250	0.500
2,2,4-Trimethylpentane	540-84-1	0.170	0.250	0.500
2-Butanone[1]	78-93-3	0.670	1.00	2.00
2-Propanol	67-63-0	0.670	1.00	2.00
4-Ethyltoluene	622-96-8	0.170	0.250	0.500
4-Methyl-2-pentanone	108-10-1	0.170	0.250	0.500
Acetone[1]	67-64-1	1.67	2.50	5.00
Benzene	71-43-2	0.170	0.250	0.500
Carbon disulfide	75-15-0	0.670	1.00	2.00
Carbon tetrachloride	56-23-5	0.170	0.250	0.500
Chlorobenzene	108-90-7	0.170	0.250	0.500
Chloroethane	75-00-3	0.670	1.00	2.00
Chloroform	67-66-3	0.170	0.250	0.500
cis-1,2-Dichloroethene	156-59-2	0.170	0.250	0.500
Cumene	98-82-8	0.170	0.250	0.500
Cyclohexane[1]	110-82-7	0.170	0.250	0.500
Ethanol	64-17-5	1.67	2.50	5.00
Ethyl benzene	100-41-4	0.170	0.250	0.500
Freon 11	75-69-4	0.170	0.250	0.500
Freon 114	76-14-2	0.170	0.250	0.500
Freon 12	75-71-8	0.170	0.250	0.500
Heptane	142-82-5	0.170	0.250	0.500
Hexane	110-54-3	0.170	0.250	0.500
m,p-Xylene	108-38-3	0.330	0.500	1.00
Methyl tert-butyl ether	1634-04-4	0.670	1.00	2.00
Methylene chloride[1]	75-09-2	0.330	0.500	1.00
o-Xylene	95-47-6	0.170	0.250	0.500
Propylbenzene	103-65-1	0.170	0.250	0.500
Tetrachloroethene	127-18-4	0.170	0.250	0.500
Tetrahydrofuran	109-99-9	0.170	0.250	0.500

Analyte	CAS Number	Laboratory DL	Laboratory LOD	Laboratory LOQ
Toluene	108-88-3	0.330	0.500	1.00
Trichloroethene	79-01-6	0.170	0.250	0.500
Vinyl chloride	75-01-4	0.170	0.250	0.500

Notes:

CAS = Chemical Abstracts Service

DL = detection limit

LOD = limit of detection

LOQ = limit of quantitation

[1] Common laboratory contaminant

Project action limits are not listed because there are no action limits for LFG constituents identified in the OU2 ROD (Army, 1994); however, these analyses are performed to meet the substantive requirements of ARARs identified in the OU2 ROD.

VOCs in LFG are not identified as COCs in the OU2 ROD (Army, 1994); however, Title 14 CCR Chapter 3, Article 8 (since superseded by 27CCR Chapter 3, Article 6 [Section 20921]) and Air District Rule 207 and Rule 1000 are identified as ARARs. These ARARs require control of trace gases to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds; therefore, the full list of TO-15 analytes is reported once every 5 years (next in 2029) to ensure the substantive requirements of these ARARs are met. The list presented contains VOCs that have been consistently detected in samples associated with TTU source testing and operational influent testing (AEI, 2017, 2018, 2019 and Ahtna, 2021a, 2021b, 2022b, 2023a). Reduction of VOCs from this list (or addition) is per the analytic approach in Worksheet #11 (Section 3.2.5.7).

3.6.10 Worksheet #15j: VOCs by TO-15 (Compliance Perimeter Probes)

Estimated Concentration Level: Low
Matrix: Gas (ppbv)
Analyzing Laboratory: Eurofins, Folsom, California

Analyte	CAS Number	Screening Level[1]	Laboratory DL	Laboratory LOD	Laboratory LOQ
1,1,1-Trichloroethane	71-55-6	--	0.170	0.250	0.500
1,1-Dichloroethane	75-34-3	--	0.170	0.250	0.500
1,2-Dichloroethane	107-06-2	--	0.170	0.250	0.500
1,2-Dichloropropane	78-87-5	--	0.170	0.250	0.500
2-Butanone[1]	78-93-3	--	0.670	1.00	2.00
2-Propanol	67-63-0	--	0.670	1.00	2.00
Acetone[1]	67-64-1	--	1.67	2.50	5.00
Benzene	71-43-2	--	0.170	0.250	0.500
Carbon disulfide	75-15-0	--	0.670	1.00	2.00
Carbon tetrachloride	56-23-5	--	0.170	0.250	0.500
Chloroform	67-66-3	2.5	0.170	0.250	0.500
Chloromethane	74-87-3	--	1.67	2.50	5.00
cis-1,2-Dichloroethene	156-59-2	--	0.170	0.250	0.500
Ethanol	64-17-5	--	1.67	2.50	5.00
Freon 11	75-69-4	--	0.170	0.250	0.500
Freon 113	76-13-1	--	0.170	0.250	0.500
Freon 114	76-14-2	--	0.170	0.250	0.500
Freon 12	75-71-8	--	0.170	0.250	0.500
Hexane	110-54-3	--	0.170	0.250	0.500
m,p-Xylene	108-38-3	--	0.330	0.500	1.00
Methylene chloride[2]	75-09-2	--	0.330	0.500	1.00
Tetrachloroethene	127-18-4	67.8	0.170	0.250	0.500
Toluene	108-88-3	--	0.330	0.500	1.00
Trichloroethene	79-01-6	--	0.170	0.250	0.500
Vinyl chloride	75-01-4	3.7	0.170	0.250	0.500

Notes:
CAS = Chemical Abstracts Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
[1] Section 3.2.3.6 (OU2 LFG Monitoring) provides details on the established screening levels.
[2] Common laboratory contaminant

VOCs in LFG are not identified as COCs in the OU2 ROD (Army, 1994); however, Title 14 CCR Chapter 3, Article 8 (since superseded by 27CCR Chapter 3, Article 6 [Section 20921]) and Air District Rule 207 and Rule 1000 are identified as ARARs. These ARARs require control of trace gases to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds; therefore, the full list of TO-15 analytes is reported once every 5 years (next

in 2029) to ensure the substantive requirements of these ARARs are met. The list presented contains VOCs that have been consistently detected in samples associated with compliance perimeter probe testing. Removal of VOCs from this list (or addition) is per the analytic approach in Worksheet #11 (Section 3.2.5.8).

3.6.11 Worksheet #15k: Mobile Laboratory Analytical Group/Methods (TTU Source Testing)

Matrix: Gas (ppmv)
Laboratory: Best Environmental, Livermore, California

Analyte	EPA Method	CAS Number	Laboratory LOQ
CO	10	630-08-0	0.5
NO_X	7E	10024-97-2/10102-44-0	0.5
O_2	3A	7782-44-7	0.25
CO_2	3A	124-38-9	0.25
Methane/NMOC/THC	25A	Various	1.0

Notes:
CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency
LOQ = limit of quantitation
NMOC = non-methane organic compounds
THC = total hydrocarbons
[1] Project action limits are not listed in Worksheet #15i because there are no action limits for LFG constituents identified in the OU2 ROD (Army, 1994); however, these analyses are performed to meet the substantive requirements of ARARs identified in the OU2 ROD.

4.0 Sample Design

4.1 Worksheet #17: Sampling Design and Rationale

4.1.1 Sites 2/12, OU2, and OUCTP GWMP and GWTS

The GWMP is designed to provide chemical data that is representative of subsurface conditions to monitor changes in chemistry and groundwater flow as it relates to the contaminant plumes, the effectiveness of the existing groundwater remedies, and identification of potential additional problem areas. To achieve these objectives, sample types and locations are selected to provide suitable spatial coverage to be representative of overall conditions as well as select local conditions or specific problem areas.

The installed groundwater monitoring locations were selected to delineate groundwater COC plumes identified initially during the RIs for Sites 2/12 (HLA, 1995), OU2 (Dames & Moore, 1993), and OUCTP (MACTEC, 2006), and includes locations installed after the RIs to implement remedies and address identified data gaps or changes in the conceptual site model. A summary of existing groundwater monitoring locations is presented in Worksheet #18, separated by site and aquifer accordingly. Sample collection locations, rationales, and frequencies were established to achieve discharge compliance and provide a cost-effective means to evaluate the treatment of the impacted groundwater and can be found in Worksheets #18a1 and #18a2 for Sites 2/12, and Worksheets #18b1 and #18b2 for OU2 and OUCTP. The overall sampling network design is described in Worksheets #18c1 through #18c5. Water level measurements are collected during sample collection and samples are analyzed for volatile and inorganic compounds as presented in Worksheet #18.

Samples will be analyzed for COCs by EPA Method 8260-SIM. The sample analytical results will be assessed via the analytic approach in Worksheet #11 and referred to in project tasks in Worksheet #14 & 16 to determine:

- The lateral and vertical groundwater plume extents
- Modifications to the sampling design
- Discharge limit compliance
- The schedule for GAC change-outs
- Site closure

Based on sampling results and implementation of the analytic approach to date, the number of groundwater samples collected annually is summarized in Table 2.

4.1.2 Sites 2/12 SGMP

A total of 167 permanent soil gas probes were installed at Site 12 in 24 locations, with seven nested probes at each location.[35] The nested probes were installed at approximately 10-foot intervals from 10 feet bgs to a depth of approximately 70 feet bgs (Figure 13).[36] The installed soil gas probe locations were

[35] One location has six nested probes (SG-12-09) due to a shallower saturated soil depth.
[36] Several locations have different depths of the deepest two probes due to shallower or deeper saturated soil depth.

selected to delineate the PCE and TCE soil gas plumes identified initially in 1992 (HLA, 1995) and expanded upon the initial soil gas investigations (USACE, 2013), as summarized below.

Locations of the wells SG-12-19 through SG-12-24 were partly determined through modeling the vertical and lateral extent of the PCE and TCE soil gas plumes using data collected from SG-12-01 through SG-12-16 and GMS Software Version 9.03. Inverse Distance Weighted Gradient Plane interpolation.

All 167 soil gas probes were sampled during the RI Addendum at Sites 2/12, and quarterly sampling was initiated in 2015.[37] Two nested probe locations (SG-12-10 and SG-12-21; 14 probes total) were decommissioned in 2016. Five other probes (SG-12-04-30, SG-12-07-10, SG-12-12-50, SG-12-13-70, and SG-12-17-75) are no longer functional and cannot be sampled due to an obstruction or the screen interval becoming submerged in groundwater.

Ten permanent SVE wells were installed during pilot study construction and SVETS construction. The SVE pilot study well locations were selected to provide data to support the design and construction of the full-scale SVETS. The SVETS well locations were selected to maximize COC removal from the vadose zone based on the results of the pilot study. The SVTU was installed to apply vacuum to the SVE wells and process extracted soil gas for treatment through GAC (Figure 14 and Table 3). The sampling design rationale for SVE wells and the SVTU is described in detail in Worksheet 18.

Samples will be analyzed for TCE and PCE by EPA Method TO-15. The sample analytical results will be assessed via the analytic approach in Worksheet #11 and referred to in project tasks in Worksheet #14 & 16 to determine:

- The lateral and vertical soil gas plume extent
- Modifications to the sampling design
- Discharge limit compliance
- The schedule for GAC change-outs
- Site closure

Site 12 SVETS sampling locations and soil gas probes are listed in Worksheet #18h and Worksheet #18i, respectively. After the First Quarter 2015 soil gas monitoring event, the locations to be sampled either quarterly or annually are determined through application of the analytic approach presented in Worksheet #11 to the soil gas analytical results from the previous monitoring event. The quarterly and annual events also include 10% duplicate soil gas sampling. The initial SVETS sampling schedule after startup of the SVETS is described in RAWP Addendum (AEI, 2015b), with subsequent sampling to be determined through application of the analytic approach presented in Worksheet #11 (Section 3.2) to analytical results from the previous sampling events. Based on sampling results and implementation of the analytic approach to date, the number of soil gas samples collected annually is summarized in Table 3.

[37] RI soil gas analytical results are presented in the RI/FS Addendum report (AES, 2015).

4.1.3 OU2 LFG Extraction and Treatment System

The O&M Plan (Ahtna, 2023c) provides procedures for monitoring the operation of the TTU, including vents, probes, and EWs. Section 5.0 of the O&M Plan describes the perimeter monitoring system that is used to test the operational influent and effluent LFG.

Passive vents were installed at 19 locations to minimize the potential for gas buildup beneath the geomembrane (Figure 20). Five vents (VD-2, VD-3, VF-3, VF-4, and VF-5) were converted to EPs to provide supplemental methane to the TTU. Other vents, with the exception of VE-7 and VE-8, were capped in 2001 to mitigate a potential fire hazard. VE-7 and VE-8 were placed in the vertical expansion portion of Area E and were initially left open because this is a sealed area of the landfill. These vents were subsequently capped in 2017. The 14 passive vents are not monitored for compliance, but are monitored quarterly for methane using a portable LFG analyzer. The vents that were converted to EPs are monitored during TTU operations.

To monitor LFG migration, 46 monitoring, 21 compliance, and two (2) utility trench probes are located around Areas B through F. Twenty-one compliance probes were installed at a spacing of approximately 1,000 feet around the property boundary as required by 27CCR. The monitoring probes are used to measure Methane, O_2, CO_2, and balance gas (collectively termed LFG) at additional points around the OU2 Landfills at depths ranging from 12 to 32 feet bgs. A LANDTEC GEM™ 5000 instrument is used to measure these parameters. The utility trench probes are 4 feet deep. Samples collected from the 21 compliance probes are sent to an off-site laboratory annually for VOC analysis by EPA Method TO-15.

Two types of testing are conducted for the TTU: source testing and operational influent LFG testing. The primary objective of the source testing is to determine whether the TTU operates efficiently. A certified mobile laboratory conducts the source test, which includes analysis of the TTU influent and effluent for the parameters listed below.

Analytical Protocols for Landfill O&M Sampling

Parameter	Monitoring and Analytical Protocols
NO_X, CO, O_2, and CO_2	EPA Methods 7E, 10, and 3A
Outlet Methane/NMOC/THC and Speciated VOCs	EPA Method 25A and TO-15
Inlet NMOC and Speciated VOCs	ASTM D1945 and EPA Method TO-15
Inlet Total Reduced Sulfurs	SCAQMD Method 307-91
LFG Higher Heating Value and Outlet Volumetric Flow Rate	ASTM D1945 and EPA Method 19

Operational influent LFG testing is used to establish the schedule of operations for optimum operation of the TTU. Operational influent LFG testing also aids in quantifying the amounts of VOCs that are being removed from the OU2 Landfills. Figure 21 presents the locations of the EWs/vents, the collection system, and the TTU system. Section 4.2.13, Worksheet #18k lists the sampling locations and methods.

4.2 Worksheet #18: Sampling Locations and Methods

4.2.1 Worksheet #18a1: Sites 2/12 GWTS Sampling Locations

Sample Point	Activity	Test Method	Comments	SOP Reference

TS-212-INF	GWTS monitoring[1]	EPA Method 8260-SIM	Sampled to measure influent COC concentrations and evaluate GWTS efficiency.	FSOP-A6
TS-212-GAC-A			Sampled to measure COC concentrations downstream from the GAC vessel and evaluate GAC efficiency.	
TS-212-EFF			Sampled to measure COC concentrations downstream from the air stripper unit and evaluate air stripper efficiency.[2]	
TS-212-INJ			Sampled to comply with discharge limits.	
EW-12-03-180U[3]	Groundwater Monitoring[6]	EPA Method 8260-SIM EPA Method 9056A	Sampled to measure changes in groundwater COC concentrations. To evaluate general inorganic constituents.	
EW-12-03-180M[4]				
EW-12-04-180U[3]				
EW-12-04-180M[3]				
EW-12-05-180M[5]				
EW-12-06-180M[4]				
EW-12-07-180M[4]				
EW-12-08-180U[5]				

Notes:

COC: chemical of concern
EFF: effluent
EW: extraction well
GAC: granular activated carbon
INF: influent
INJ: injection
S: treatment system sampling port
SOP: standard operating procedure

[1] The sampling frequency is variable based on historical GAC breakthrough rates, as shown on Worksheet #18a2.

[2] TS-212-EFF is only sampled when the air stripper is online.

[3] Well no longer sampled per decision rules (Worksheet #11).

[4] Pump removed from the inoperable extraction well, groundwater sampling conducted with PDBs as identified in Worksheet #18c.

[5] During the 3rd Quarter (Annual) sampling event, chloride is analyzed.

[6] Samples and water level measurements are collected quarterly or annually from the extraction wells based on the decision rules identified in Worksheet #11.

4.2.2 Worksheet #18a2: Sites 2/12 GWTP Sampling Locations

Sites 2/12 GWTS Sampling Frequencies[3]									
	Weeks after GAC change-out[4]								
Sample Point	**0**	**12**	**21**	**30**	**36**	**42**	**44**	**46**	**48**
TS-212-INF			xx		x	xx	x	xx	x
TS-212-GAC-A[1]	x[2]		x	x	x	x	x	x	x
TS-212-EFF[5]						x	x	x	x
TS-212-INJ		x	x	x	x	x	x	x	x

Notes:

x: sample collected

xx: sample and duplicate collected

[1] Sample point immediately downstream of the GAC vessel.

[2] Sample collected no less than 2 hours after bringing a newly repacked GAC vessel online.

[3] The sampling frequency is determined based on historical COC breakthrough rates; however, the sampling frequency may be altered if there are significant operational changes.

[4] If GAC change-out is not indicated by Week 48, further sampling will be performed weekly, or at a frequency determined by the Project Manager, until GAC effluent PCE or TCE concentration is ≥ 90% of the discharge limit.

[5] TS-212-EFF is only sampled when the air stripper is online.

4.2.3 Worksheet #18b1: OU2 GWTS Sampling Locations

Sample Point	Activity	Test Method	Comments	SOP Reference
TS-OU2-INF-01	GWTS Monitoring[1]	EPA Method 8260-SIM	Sampled to measure influent COC concentrations and evaluate GWTS efficiency.	FSOP-A6
TS-OU2-INF-02				
TS-OU2-EFF-1A			Sampled to measure COC concentrations downstream from a GAC vessel and evaluate GAC efficiency.	
TS-OU2-EFF-1B				
TS-OU2-EFF-1C				
TS-OU2-EFF-2A				
TS-OU2-EFF-2B				
TS-OU2-EFF-2C				
TS-OU2-INJ-01			Sampled to measure COC concentrations downstream from the GAC vessels to comply with discharge limits (point of compliance).	
EW-OU2-02-A	Groundwater Monitoring[2]	EPA Method 8260-SIM	Sampled to evaluate changes in groundwater COC concentrations.	FSOP-A6
EW-OU2-03-A[4]				
EW-OU2-04-A				
EW-OU2-06-A				
EW-OU2-09-A				
EW-OU2-10-A				
EW-OU2-11-AR				
EW-OU2-12-A				
EW-OU2-13-A				
EW-OU2-16-A				
EW-OU2-17-A				
EW-OU2-18-A				
EW-OU2-19-A				
EW-OU2-20-A				
EW-OU2-01-180[3]				
EW-OU2-02-180R				
EW-OU2-03-180				
EW-OU2-04-180[4]				
EW-OU2-05-180				
EW-OU2-06-180				
EW-OU2-07-180[3]				
EW-OU2-08-180	Groundwater Monitoring[2]	EPA Method 8260-SIM	Sampled to evaluate changes in groundwater COC concentrations.	FSOP-A6
EW-OU2-10-180				
EW-OU2-12-180				
EW-OU2-13-180[5]				

Notes:
COC: chemical of concern
EFF: effluent
EW: extraction well
GAC: granular activated carbon
INF: influent
INJ: injection
TS: treatment system sampling port
[1] The sampling frequency is variable based on historical GAC breakthrough rates, as shown in Worksheet #18b2.
[2] Groundwater samples and water level measurements are collected quarterly or annually from the extraction wells based on the decision rules identified in Worksheet #11.
[3] Pump removed from the inoperable extraction well, groundwater sampling conducted with PDBs as identified in Worksheet #18c5.
[4] Well no longer sampled per decision rules (Worksheet #11).
[5] Well operated to remediate the OUCTP Upper 180-Foot Aquifer as listed in Worksheet #18c4.

4.2.4 Worksheet #18b2: OU2 GWTP Sampling Locations

Sample Point	Weeks after GAC change-out[5]										
	0	8	16	24	28	32	36	40	44	48	52
TS-OU2-INF-01		x	x	x	x	x	x	x	x	x	x
TS-OU2-INF-02		xx	xx	xx	xx	xx	x	xx	x	x	xx
Primary Vessel 1[1]		x	x	x	x	x	x	x	x	x	x
Primary Vessel 2[1]		x	x	x	x	x	x	x	x	x	x
Secondary Vessel 1[2]		x		x		x			x		x
Secondary Vessel 2[2]		x		x		x			x		x
Polishing Vessel 1[3]		x		x		x			x		x
Polishing Vessel 2[3]		x		x		x			x		x
TS-OU2-INJ-01	x[4]	x	x	x	x	x	x	x	x	x	x

Notes:

TS-OU2-INF-01 = Eastern Main influent

TS-OU2-INF-02 = Western Main influent

TS-OU2-INJ-01 = discharge point of compliance

x: sample collected

xx: sample and duplicate collected

[1] Sample point to be immediately downstream of the lead GAC vessel.

[2] Sample point to be immediately downstream of the second GAC vessel in series.

[3] Sample point to be immediately downstream of the third GAC vessel in series.

[4] Sample collected no less than 2 hours after bringing a newly repacked GAC vessel online.

[5] If GAC change-out is not indicated by Week 52, further sampling will be performed biweekly or at a frequency determined by the direction of the Project Manager.

4.2.5 Worksheet #18c: Sites 2/12 GWMP Sampling Locations

Sample Point	Cl (9056A)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
EW-12-05-180M	A	Q	Q	Pump Spigot/FSOP-A6	
EW-12-06-180M		Q	Q	PDB/FSOP -A6, -USGS1	
EW-12-07-180M		Q	Q	PDB/FSOP -A6, -USGS1	
EW-12-08-180U	A	Q	Q	Pump Spigot/FSOP-A6	
MW-02-13-180M	A	Q	Q	HydraSleeve™, PDB/FSOP -A6, -GE1, -USGS1	
MW-12-09R-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-14-180M		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-15-180M		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-16-180M		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-19-180M		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-18-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-20-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-21-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-24-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-25-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-28-180U		A	Q	PDB/FSOP -A6, -USGS1	
MW-12-29-180U		Q	Q	PDB/FSOP -A6, -USGS1	
MW-12-32-180U		A	Q	PDB/FSOP -A6, -USGS1	
The following wells are measured for groundwater elevation data only:					
EW-12-03-180M			Q	FSOP-A6	
EW-12-03-180U			Q	FSOP-A6	
EW-12-04-180M			Q	FSOP-A6	
EW-12-04-180U			Q	FSOP-A6	
MW-02-05-180			Q	FSOP-A6	
MW-02-06-180			Q	FSOP-A6	
MW-02-10-180			Q	FSOP-A6	

Sample Point	Cl (9056A)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-02-13-180U			Q	FSOP-A6	
MW-12-01-180			Q	FSOP-A6	
MW-12-07-180			Q	FSOP-A6	
MW-12-17-180U			Q	FSOP-A6	
MW-12-19-180U			Q	FSOP-A6	
MW-12-22-180U			Q	FSOP-A6	
MW-12-23-180U			Q	FSOP-A6	
MW-12-26-180U			Q	FSOP-A6	
MW-12-27-180U			Q	FSOP-A6	
MW-12-30-180U			Q	FSOP-A6	
MW-12-31-180M			Q	FSOP-A6	

Notes:

A: sampled on an annual basis
ESD: Explanation of Significant Differences
Q: sampled on a quarterly basis
RI/FS: Remedial Investigation/Feasibility Study
SIM: selected ion monitoring
VOCs: volatile organic compounds
Cl: chloride
PDB: passive diffusion bag
RI: Remedial Investigation
ROD: Record of Decision
SOP: standard operating procedure

4.2.6 Worksheet #18d: OU2 GWMP Sampling Locations

Sample Point	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
EW-OU2-01-180		Q	Q	PDB/FSOP -A6, -USGS1	
EW-OU2-02-180R		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-02-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-03-180		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-04-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-05-180		Q	Q	Sampling Port/SOP #2,5	
EW-OU2-06-180		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-06-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-08-180		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-09-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-10-180		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-10-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-11-180		Q	Q	PDB/FSOP -A6, -USGS1	
EW-OU2-11-AR		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-12-180		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-12-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-13-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-14-A		Q	Q	PDB/FSOP -A6, -USGS1	
EW-OU2-15-A		Q	Q	PDB/FSOP -A6, -USGS1	
EW-OU2-16-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-17-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-18-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-19-A		Q	Q	Pump Spigot/FSOP-A6	
EW-OU2-20-A		Q	Q	Pump Spigot/FSOP-A6	
MW-BW-13-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-14-180		Q	Q	PDB/FSOP -A6, -USGS1	

Sample Point	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-BW-50-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-71-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-01-A	A	Q	Q	HydraSleeve™, PDB/FSOP -A6, -GE1, -USGS1	
MW-OU2-02-A	A	Q	Q	HydraSleeve™, PDB/FSOP -A6, -GE1, -USGS1	
MW-OU2-03-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-04-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-05-AR		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-06-180R2		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-06-AR		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-07-A		Q	Q	Pump Spigot/FSOP-A6	
MW-OU2-08-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-12-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-20-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-23-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-24-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-25-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-27-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-28-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-28-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-30-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-39-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-40-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-43-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-44-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-44-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-45-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-46-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-46-180		Q	Q	PDB/FSOP -A6, -USGS1	

Sample Point	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-OU2-47-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-50-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-51-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-53-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-56-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-57-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-61-180		A	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-62-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-63-180		A	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-73-A	A	Q	Q	HydraSleeve™, PDB/FSOP -A6, -GE1, -USGS1	
MW-OU2-74-A	A	Q	Q	HydraSleeve™, PDB/FSOP -A6, -GE1, -USGS1	
MW-OU2-75-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-76-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-79-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-80-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-81-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-81-180		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-83-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-84-180		Q	Q	PDB/FSOP -A6, -USGS1	
The following wells are measured for groundwater elevation data only:					
EW-OU2-03-A			Q	FSOP-A6	
EW-OU2-07-A			Q	FSOP-A6	
EW-OU2-04-180			Q	FSOP-A6	
MW-10-07-180			Q	FSOP-A6	
MW-14-03-180			Q	FSOP-A6	
MW-BW-01-A			Q	FSOP-A6	
MW-BW-02-180			Q	FSOP-A6	
MW-BW-11-A			Q	FSOP-A6	

Sample Point	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-BW-12-180			Q	FSOP-A6	
MW-OU2-09-A			Q	FSOP-A6	
MW-OU2-09-180R			Q	FSOP-A6	
MW-OU2-13-A			Q	FSOP-A6	
MW-OU2-21-A			Q	FSOP-A6	
MW-OU2-23-A			Q	FSOP-A6	
MW-OU2-29-180			Q	FSOP-A6	
MW-OU2-29-A			Q	FSOP-A6	
MW-OU2-31-180R			Q	FSOP-A6	
MW-OU2-32-A			Q	FSOP-A6	
MW-OU2-34-A			Q	FSOP-A6	
MW-OU2-35-A			Q	FSOP-A6	
MW-OU2-36-180			Q	FSOP-A6	
MW-OU2-49-180			Q	FSOP-A6	
MW-OU2-54-180			Q	FSOP-A6	
MW-OU2-55-180			Q	FSOP-A6	
MW-OU2-58-A			Q	FSOP-A6	
MW-OU2-77-A			Q	FSOP-A6	
PZ-OU2-06-180			Q	FSOP-A6	

Notes:

A: sampled on an annual basis
Cu: copper
ESD: Explanation of Significant Differences
Pb: lead
PDB: passive diffusion bag
Q: sampled on a quarterly basis
ROD: Record of Decision
Sb: antimony
SIM: selected ion monitoring
SOP: standard operating procedures
VOCs: volatile organic compounds

4.2.7 Worksheet #18e: OUCTP A-Aquifer GWMP Sampling Locations

Sample Point	DO-ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
EISB-EW-01		A	Q	PDB/FSOP -A6, -USGS1	
EISB-EW-09		Q	Q	PDB/FSOP -A6, -USGS1	
EISB-EW-12	Q		Q	PTM/FSOP -A6, -A9, -A12	
EISB-EW-15	Q		Q	PTM/FSOP -A6, -A9, -A12	
EW-BW-109-A		Q	Q	PDB/FSOP -A6, -USGS1	
EW-BW-124-A	Q	Q	Q	PTM/FSOP -A6, -A9, -A12; PDB/FSOP-USGS1	
EW-BW-129-A		Q	Q	PDB/FSOP -A6, -USGS1	
EW-BW-135-A	Q	Q	Q	PTM/FSOP -A6, -A9, -A12; PDB/FSOP-USGS1	
EW-BW-140-A		A	Q	PDB/FSOP -A6, -USGS1	
EW-BW-144-A	Q	A	Q	PTM/FSOP -A6, -A9, -A12	
EW-BW-155-A	Q	Q	Q	PTM/FSOP -A6, -A9, -A12; PDB/FSOP-USGS1	
EW-BW-159-A	Q		Q	PTM/FSOP -A6, -A9, -A12	
EW-BW-160-A	Q	Q	Q	PTM/FSOP -A6, -A9, -A12; PDB/FSOP-USGS1	
EW-BW-161-A	Q		Q	PTM/FSOP -A6, -A9, -A12	
EW-BW-164-A	Q		Q	PTM/FSOP -A6, -A9, -A12	
EW-BW-165-A		A	Q	PDB/FSOP -A6, -USGS1	
EW-BW-166-A	Q		Q	PTM/FSOP -A6, -A9, -A12	
MW-40-01-A		A	Q	PDB/FSOP -A6, -USGS1	
MW-40A-02-A		A	Q	PDB/FSOP -A6, USGS1	
MW-B-12-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-B-14-A		A	Q	PDB/FSOP -A6, -USGS1	
MW-BW-17-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-26-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-27-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-28-A		A	Q	PDB/FSOP -A6, -USGS1	
MW-BW-30-A		A	Q	PDB/FSOP -A6, -USGS1	

Sample Point	DO-ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-BW-31-A		A	Q	PDB/FSOP -A6, -USGS1	
MW-BW-32-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-35-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-36-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-44-A		A	Q	PDB/FSOP -A6, -USGS1	
MW-BW-48-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-49-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-58-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-65-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-66-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-74-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-75-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-77-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-78-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-79-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-80-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-81-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-82-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-83-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-85-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-87-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-88-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-89-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-90-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-91-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-92-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-93-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-94-AR		Q	Q	PDB/FSOP -A6, -USGS1	

Sample Point	DO-ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-BW-95-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-96-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-97-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-101-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-102-A		Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-103-A		Q	Q	PDB/FSOP -A6, -USGS1	
The following wells are measured for groundwater elevation data only:					
EISB-EW-02			Q	FSOP-A6	
EISB-MW-01			Q	FSOP-A6	
EW-BW-119-A			Q	FSOP-A6	
EW-BW-132-A			Q	FSOP-A6	
EW-BW-149-A			Q	FSOP-A6	
EW-BW-150-A			Q	FSOP-A6	
EW-BW-167-A			Q	FSOP-A6	
EW-BW-168-A			Q	FSOP-A6	
EW-BW-169-A			Q	FSOP-A6	
MP-BW-46-080			Q	Westbay Port / FSOP-S1	
MP-BW-46-095			Q	Westbay Port / FSOP-S1	
MP-BW-48-113			Q	Westbay Port / FSOP-S1	
MP-BW-48-133			Q	Westbay Port / FSOP-S1	
MW-40A-01-A			Q	FSOP-A6	
MW-BW-15-A			Q	FSOP-A6	
MW-BW-16-A			Q	FSOP-A6	
MW-BW-18-A			Q	FSOP-A6	
MW-BW-24-A			Q	FSOP-A6	
MW-BW-25-A			Q	FSOP-A6	
MW-BW-34-A			Q	FSOP-A6	
MW-BW-38-A			Q	FSOP-A6	

Sample Point	DO-ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
MW-BW-39-A			Q	FSOP-A6	
MW-BW-41-A			Q	FSOP-A6	
MW-BW-42-A			Q	FSOP-A6	
MW-BW-43-A			Q	FSOP-A6	
MW-BW-45-A			Q	FSOP-A6	
MW-BW-46-A			Q	FSOP-A6	
MW-BW-51-A			Q	FSOP-A6	
MW-BW-53-A			Q	FSOP-A6	
MW-BW-54-A			Q	FSOP-A6	
MW-BW-56-A			Q	FSOP-A6	
MW-BW-57-A			Q	FSOP-A6	
MW-BW-59-A			Q	FSOP-A6	
MW-BW-60-A			Q	FSOP-A6	
MW-BW-63-A			Q	FSOP-A6	
MW-BW-67-A			Q	FSOP-A6	
MW-BW-86-A			Q	FSOP-A6	

Notes:

A: sampled on an annual basis
DO: dissolved oxygen
ORP: oxidation-reduction potential
PDB: passive diffusion bag
PTM: post-treatment monitoring
Q: sampled on a quarterly basis
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures

4.2.8 Worksheet #18f: OUCTP Upper 180-Foot Aquifer GWMP Sampling Locations

Sample Point	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
EW-OU2-09-180	Q	Q	PDB/SOP #2, #5	
EW-OU2-13-180	Q	Q	Pump Spigot/SOP #5	
MP-BW-33-272	Q	Q	Westbay Port /SOP #1	
MP-BW-46-170	Q	Q	Westbay Port/SOP #1	
MW-BW-21-180	Q	Q	PDB/SOP #2, #5	
MW-BW-43-180	A	Q	PDB/SOP #2, #5	
MW-BW-52-180	Q	Q	PDB/SOP #2, #5	
MW-BW-57-180	A	Q	PDB/SOP #2, #5	
MW-BW-58-180	A	Q	PDB/SOP #2, #5	
MW-OU2-30-180	A	Q	PDB/SOP #2, #5	
MW-OU2-64-180	Q	Q	PDB/SOP #2, #5	
MW-OU2-67-180	Q	Q	PDB/SOP #2, #5	
MW-OU2-70-180	A	Q	PDB/SOP #2, #5	
The following wells are measured for groundwater elevation data only:				
MP-BW-30-282		Q	Westbay Port /SOP #1	
MP-BW-32-287		Q	Westbay Port /SOP #1	
MP-BW-35-242		Q	Westbay Port /FSOP-S1	
MP-BW-37-178		Q	Westbay Port /FSOP-S1	
MP-BW-41-231		Q	Westbay Port /FSOP-S1	
MP-BW-42-215		Q	Westbay Port /FSOP-S1	
MW-B-05-180		Q	FSOP-A6	
MW-BW-26-180		Q	FSOP-A6	
MW-BW-44-180		Q	FSOP-A6	
MW-BW-45-180		Q	FSOP-A6	
MW-BW-47-180		Q	FSOP-A6	
MW-BW-49-180		Q	FSOP-A6	
MW-BW-50-180		Q	FSOP-A6	
MW-BW-51-180		Q	FSOP-A6	
MW-BW-53-180		Q	FSOP-A6	
MW-BW-54-180		Q	FSOP-A6	
MW-BW-55-180		Q	FSOP-A6	
MW-BW-56-180		Q	FSOP-A6	

Notes:
A: sampled on an annual basis
PDB: passive diffusion bag
PTM: post-treatment monitoring
Q: sampled on a quarterly basis
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures

4.2.9 Worksheet #18g: OUCTP Lower 180-Foot Aquifer GWMP Sampling Locations

Sample Point	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Comments
EW-OU2-07-180	Q	Q	PDB/FSOP -A6, -USGS1	
FO-29[1]	Q		Sampling Port/FSOP-A7	
FO-30[1]	Q		Sampling Port/FSOP-A7	
FO-31[1]	Q		Sampling Port/FSOP-A7	
MP-BW-41-318	A	Q	Westbay Port/FSOP-S1	
MP-BW-41-353	Q	Q	Westbay Port/FSOP-S1	
MP-BW-42-345	Q	Q	Westbay Port/FSOP-S1	
MP-BW-49-287	Q	Q	Westbay Port/FSOP-S1	
MP-BW-49-316	Q	Q	Westbay Port/FSOP-S1	
MP-BW-49-368	Q	Q	Westbay Port/FSOP-S1	
MP-BW-49-400	Q	Q	Westbay Port/FSOP-S1	
MP-BW-50-339	Q	Q	Westbay Port/FSOP-S1	
MP-BW-50-384	Q	Q	Westbay Port/FSOP-S1	
MP-BW-51-405	Q	Q	Westbay Port/FSOP-S1	
MW-BW-04-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-BW-59-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-66-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-69-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-72-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-78-180	Q	Q	PDB/FSOP -A6, -USGS1	
MW-OU2-82-180	Q	Q	PDB/FSOP -A6, -USGS1	
The Following Wells Are Measured for Groundwater Elevation Data Only:				
Airfield		Q	PDB/FSOP-USGS1	
MP-BW-30-397		Q	Westbay Port /FSOP-S1	
MP-BW-31-407		Q	Westbay Port /FSOP-S1	
MP-BW-32-412		Q	Westbay Port /FSOP-S1	
MP-BW-33-352		Q	Westbay Port /FSOP-S1	
MP-BW-34-422		Q	Westbay Port /FSOP-S1	
MP-BW-35-402		Q	Westbay Port /FSOP-S1	
MP-BW-37-368		Q	Westbay Port /FSOP-S1	
MP-BW-38-353		Q	Westbay Port /FSOP-S1	
MP-BW-39-330		Q	Westbay Port /FSOP-S1	
MP-BW-40-353		Q	Westbay Port /FSOP-S1	
MP-BW-52-363		Q	Westbay Port /FSOP-S1	
MW-OU2-07-400		Q	FSOP-A9	
Test 2		Q	FSOP-A9	

Notes:
A: sampled on an annual basis
MCWD: Marina Coast Water District collects data
PDB: passive diffusion bag
PTM: post-treatment monitoring
Q: sampled on a quarterly basis
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures
[1] Well owned by MCWD

4.2.10 Worksheet #18h: SVETS Monitoring Locations

Ten permanent SVE wells were installed during SVETS construction (SVE wells listed in Worksheet #18i). The SVE well locations were selected to maximize COC removal from the vadose zone. The SVTU was installed to apply vacuum to the SVE wells and process extracted soil gas for treatment through GAC (Figure 14 and Table 4).

Sample Location[1]	Matrix	Type	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
SVTU-212-INF	SG	Sample Port	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2	NA	Sampled to measure influent COC concentrations and evaluate SVTU efficiency.
SVTU-212-EFF						Sampled to comply with discharge limits and schedule GAC change-outs.
VE-12-01						Not operated – COC concentrations are below the SGCLs.
VE-12-02						Operated if COC concentrations in the southern soil gas plume exceed the SGCLs.
VE-12-03						Not operated – COC concentrations are below the SGCLs.
VE-12-04						Not operated – COC concentrations are below the SGCLs.
VE-12-05						Not operated – COC concentrations are below the SGCLs.
VE-12-06						Operated if COC concentrations in the northern soil gas plume exceed the SGCLs.
VE-12-07						Operated if COC concentrations in the northern soil gas plume exceed the SGCLs.
VE-12-08						Operated if COC concentrations in the northern soil gas plume exceed the SGCLs.
VE-12-09						Operated if COC concentrations in the northern soil gas plume exceed the SGCLs.
VE-12-10						Not operated – air flow short-circuited by adjacent storm water infiltration basin.

Notes:
COCs – PCE and TCE
NA – not applicable
SG – soil gas
[1] Sample locations are shown on Figure 13 and Figure 14.
[2] Field SOPs are listed on Worksheet #21.
[3] The sampling frequency is based on the decision rules identified in Worksheet #11.

4.2.11 Worksheet #18i: Sites 2/12 Soil Gas Monitoring

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
SG-12-01	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	A	Sampled for plume perimeter control.
			20			A	Sampled for plume perimeter control.
			30			A	Sampled for plume perimeter control.
			40			A	Sampled for plume perimeter control.
			50			A	Sampled for plume perimeter control.
			58			A	Sampled for plume perimeter control.
			65			Q	
SG-12-02	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	Q	
			20			A	
			30			A	
			40			A	
			50			A	
			57			A	
			65			A	Sampled for partitioning analysis.
SG-12-03	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	A	Sampled for plume perimeter control.
			20.5			A	Sampled for plume perimeter control.
			30			A	Sampled for plume perimeter control.
			39.5			A	Sampled for plume perimeter control.
			50			A	Sampled for plume perimeter control.
			58			A	Sampled for plume perimeter control.
			65			A	Sampled for plume perimeter control.
SG-12-04	SG	Sample Port	10	COCs Helium	FSOP-408, FSOP-E1, FSOP-E2, FSOP-E3	Q	
			20			Q	
			30	NA	NA	NA	No longer functional and cannot be sampled due to an obstruction.
			40			Q	

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
			50	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	Q	
			58			Q	
			65			Q	
SG-12-05	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-06	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	Q	
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			Q	
SG-12-07	SG	Sample Port	10	NA	NA	NA	No longer functional and cannot be sampled due to an obstruction.
			20	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			57.5			NA	Removed from the SGMP.
			65			Q	Sampled for partitioning analysis.
SG-12-08	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
			30		FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-09	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			59			NA	Removed from the SGMP.
SG-12-11	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-12	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50	NA	NA		No longer functional and cannot be sampled due to an obstruction.
			60		FSOP-408, FSOP-E1, FSOP-E2, FSOP-E3	NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-14	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
			30		FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-15	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-16	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-17	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			Q	Sampled for partitioning analysis.
			75	NA	NA	NA	No longer functional and cannot be sampled due to an obstruction or the screen interval becoming submerged in groundwater.

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
SG-12-19	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-20	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	A	
			20			A	
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			Q	Sampled for partitioning analysis.
SG-12-22	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.
SG-12-23	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	No longer functional and cannot be sampled due to deteriated sample tube.

Sample Location[1]	Matrix	Type	Depth (feet bgs)	Analytical Group	Sampling SOPs[2]	Frequency[3]	Comments
			70			NA	Removed from the SGMP.
SG-12-24	SG	Sample Port	10	COCs Helium	FSOP-408 FSOP-E1 FSOP-E2 FSOP-E3	NA	Removed from the SGMP.
			20			NA	Removed from the SGMP.
			30			NA	Removed from the SGMP.
			40			NA	Removed from the SGMP.
			50			NA	Removed from the SGMP.
			60			NA	Removed from the SGMP.
			70			NA	Removed from the SGMP.

Notes:

NA – not applicable

SG – soil gas

SGMP – soil gas monitoring program

[1] Locations of the wells are shown in Figure 1.

[2] Field SOPs are listed on Worksheet #21.

[3] The soil gas probe monitoring frequency is based on decision rules presented in Worksheet #11.

4.2.12 Worksheet #18j: OU2 LFG Monitoring

Area	Probe ID	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency[2]	Comments
B	SGP-1B	LFG	Sample Port	12	Fixed Gases[3]	FSOP-L1	NA	Monitoring Point
B	SGP-2B	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
B	SGP-3B	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
B	SGP-4B	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
B	SGP-5B	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
B	VB-1	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
B	VB-2	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
B	VB-3	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
C	SGP-1C	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
C	SGP-2C	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOC	FSOP-E1, -E2	Annually – Fixed Lab	
C	SGP-3C	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
C	VC-1	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
C	VC-2	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
C	VC-3	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
D	SGP-1D	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
D	SGP-1D	LFG	Sample Port	22	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
D	SGP-2D	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
D	SGP-2D	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
D	SGP-3D	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
D	SGP-3D	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
D	SGP-4D	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
D	SGP-4D	LFG	Sample Port	22	Fixed Gases	FSOP-L1	Quarterly	Compliance

Area	Probe ID	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency[2]	Comments
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
D	SGP-5D	LFG	Sample Port	4	Fixed Gases	FSOP-L1	NA	Monitoring Point
D	SGP-6D	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
D	SGP-6D	LFG	Sample Port	22	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
D	VD-1	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
D	VD-4	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	SGP-1E	LFG	Sample Port	12	Fixed Gases	FSOP-E2	Quarterly	Monitoring Point
E	SGP-2E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	SGP-3E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	SGP-4E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	SGP-5E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
E	SGP-6E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
E	SGP-7E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
E	SGP-8E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
E	SGP-9E	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
E	VE-1	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	VE-7	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
E	VE-8	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
F	SGP-1F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-1F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-2F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-2F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
F	SGP-3F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-3F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point

Area	Probe ID	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency[2]	Comments
F	SGP-4F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
F	SGP-4F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-5F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-5F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-6F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-6F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-7F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-7F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-8F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-8F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-9F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-10F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-10F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-11F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-11F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	Annually	Monitoring Point
F	SGP-12F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-13F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-13F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-14F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-14F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-15F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-15F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-16F	LFG	Sample Port	4	Fixed Gases	FSOP-L1	NA	Monitoring Point

Area	Probe ID	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency[2]	Comments
F	SGP-17F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-17F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	SGP-18F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-18F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-19F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-19F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-20F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-20F	LFG	Sample Port	32	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-21F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-21F	LFG	Sample Port	22	Fixed Gases	FSOP-L1	NA	Monitoring Point
F	SGP-22F	LFG	Sample Port	12	Fixed Gases	FSOP-L1	Quarterly	Compliance
					VOCs	FSOP-E1, -E2	Annually – Fixed Lab	
F	VF-1	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
F	VF-2	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point
F	VF-6	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Quarterly	Monitoring Point

Notes:

LFG = landfill gas

NA = not applicable (the probe is no longer monitored per decision rules presented in Worksheet #11, Section 3.2.5.8)

SGP = soil gas probe

SOP = standard operating procedure

TTU = thermal treatment unit

[1] SOPs are listed on Worksheet #21.

[2] The landfill gas probe monitoring frequency is based on decision rules presented in Worksheet #11, Section 3.2.5.8.

[3] Fixed Gases include methane, CO_2, O_2, and balance gas. Barometric pressure data is collected during probe monitoring, and induced vacuum is measured during system monitoring.

4.2.13 Worksheet #18k: OU2 LFG Extraction and Treatment System

Area	Sample Point	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency	Comments
D	VD-3	LFG	Sample Port	6	Fixed Gases[2]	FSOP-L1	Biweekly	
D	EW-35	LFG	Sample Port	75	Fixed Gases	FSOP-L1	Biweekly	
D	VD-2	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Biweekly	
F	VF-3	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Biweekly	
F	EW-34	LFG	Sample Port	60	Fixed Gases	FSOP-L1	Biweekly	
F	VF-4	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Biweekly	
F	EW-33	LFG	Sample Port	70	Fixed Gases	FSOP-L1	Biweekly	
F	EW-32	LFG	Sample Port	60	Fixed Gases	FSOP-L1	Biweekly	
F	VF-5	LFG	Sample Port	6	Fixed Gases	FSOP-L1	Biweekly	
F	EW-31	LFG	Sample Port	60	Fixed Gases	FSOP-L1	Biweekly	
F	EW-30	LFG	Sample Port	60	Fixed Gases	FSOP-L1	Biweekly	
TTU	Area F Header	LFG	Sample Port	NA	Fixed Gases	FSOP-L1	Biweekly	
TTU	Mixed	LFG	Sample Port	NA	Fixed Gases	FSOP-L1	Biweekly	Source Test Calculation of quantity of VOCs removed
					VOCs Fixed Gases Sulfur	FSOP-L1 FSOP-E2 FSOP-A5	Annually – Fixed Lab	
TTU	Stack Outlet	LFG	Sample Port	NA	VOCs	FSOP-E2 FSOP-A5	Annually – Fixed Lab	Source Test
TTU	Area D Vents	LFG	Sample Port	NA	Fixed Gases	FSOP-L1	Biweekly	Trend analysis
					VOCs	FSOP-E2	Annually – Fixed Lab	
TTU	Area F EWs	LFG	Sample Port	NA	VOCs	FSOP-E2	Annually – Fixed Lab	Trend analysis
TTU		LFG	Sample Port	NA	Fixed Gases	FSOP-L1	Biweekly	Trend analysis

Area	Sample Point	Matrix	Type	Depth (feet)	Analytical Group	Sampling SOP[1]	Frequency	Comments
	Area E Header				VOCs	FSOP-E2	Annually – Fixed Lab	
TTU	Area F Extraction Vents	LFG	Sample Port	NA	VOCs	FSOP-E2	Annually – Fixed Lab	Trend analysis

Notes:

EW = Extraction Well

LFG = landfill gas

NA = not applicable

SGP = soil gas probe

SOP = standard operating procedure

TTU = thermal treatment unit

VD = Passive Vent in Area D

VF = Passive Vent in Area F

[1] SOPs are listed on Worksheet #21.

[2] Fixed Gases include methane, CO_2, O_2, and balance gas. Barometric pressure data is collected during probe monitoring, and induced vacuum is measured during system monitoring.

5.0 Sampling Requirements

5.1 Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times

5.1.1 Worksheet #19 & 30a: Groundwater Sampling

Laboratory: SGS
4405 Vineland Rd, Suite C-15
Orlando, FL 32811
Telephone: (407) 425-6700
Point of Contact: Svetlana Izosimova
Email: Svetlana.Izosimova@sgs.com
Sample Delivery Method: Courier to San Jose, CA distribution center or FedEx overnight shipment to Florida

Matrix	Analytical Group	Preparation/Analytical Method	Sample Volume	Containers	Preservation	Holding Time[1]	SGS Laboratory
Water	VOCs	EPA 5030/8260-SIM	120 mL	Three 40-mL Teflon-lined® VOA vials	HCl to pH < 2 Sample temp > 0°C ≤ 6°C	14 days	Florida
	Dissolved Metals	EPA 3010A/6010D	500 mL	One 500-mL HDPE bottle	HNO_3 to pH < 2 after field filtering Sample temp > 0°C ≤ 6°C	6 months	
	Chloride	EPA 9056A	100 mL	One 500-mL HDPE bottle	Sample temp > 0°C ≤ 6°C	28 days	

Notes:
°C: degrees Celsius
HCl: hydrochloric acid
HDPE: high-density polyethylene
HNO_3: nitric acid
mL: milliliter
VOA: volatile organic analysis
VOCs: volatile organic compounds

5.1.2 Worksheet #19 & 30b: Landfill Gas Sampling

Laboratory: Eurofins
180 Blue Ravine Road, Suite B
Folsom, CA 95630-4719
Telephone: 916-605-3408
Point of Contact: Monica Tran
Email: monica.tran@reports.et.eurofinsus.com
Sample Delivery Method: Expedited mail service

Analytical Group	Matrix	Analytical Method	Accreditation Expiration[1]	Containers (number, size, and type)	Preservation	Analytical Holding Time	Data Package Turnaround
Fixed Gases	Soil Gas	ASTM D1945	Oregon ELAP: 10-17-24; Certification No: CA30005-020 DoD ELAP: 04-27-26; Certificate Number: ADE-1451	6L-stainless steel SUMMA™ Canister	None	30 days	21 days
VOCs	Soil Gas	TO-15		6L-stainless steel SUMMA™ Canister	None	30 days	21 days

Notes:
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
NELAP = National Environmental Laboratory Accreditation Program
[1] The Oregon ELAP certification satisfies NELAP requirements.

5.1.3 Worksheet #19 & 30c: Sulfur Sampling

Laboratory: Atmospheric Analysis and Consulting
2225 Sperry Avenue
Ventura, CA 93003
Telephone: 909-396-2000
Point of Contact: Crystal Moreno
Email: qadept@aaclab.com
Sample Delivery Method: Expedited mail service

Analytical Group	Matrix	Analytical Method	Accreditation Expiration	Containers (number, size, and type)	Preservation	Analytical Holding Time	Data Package Turnaround
Sulfur Gases	Soil Gas	SCAQMD Method 307-91	South Coast Air Quality Management District exp. 11/30/26	Tedlar™ Bag[1]	None	24 hours	21 days

Notes:
[1] Tedlar™ bags used only during the annual source test for this method only, TA package TAT is 15 business days.

5.1.4 Worksheet #19 & 30d: Soil Gas Sampling

Laboratory: Eurofins
180 Blue Ravine Road, Suite B
Folsom, CA 95630-4719
Telephone: 916-605-3408

Point of Contact: Monica Tran
Email: monica.tran@reports.et.eurofinsus.com
Sample Delivery Method: Expedited mail service

The analytical and preparation method/SOP and associated sample volume, container specifications, preservation requirements, and maximum holding time are listed.

Analysis	Matrix	Analytical Method	Container	Preservation	Holding Time (from sample date)
VOCs	Soil Gas[3]	EPA TO-15 (5&20)[1]	1-liter SUMMA® canister	None	30 days
VOCs	Soil Gas[4]	EPA TO-15 (PPTV)[2]	1-liter SUMMA® canister	None	30 days

Notes:

[1] TO-15 (5&20): This method involves full scan gas chromatograph/mass spectrometer (GC/MS) analysis of whole air samples collected in evacuated stainless-steel canisters. Samples are analyzed for VOCs using EPA Method TO-14A/TO-15 protocols. An aliquot of up to 50 milliliters of air is withdrawn from the canister utilizing a volumetric syringe or mass flow controller. This volume is loaded onto a hydrophobic multi-bed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated to sweep adsorbed VOCs onto a secondary trap for further concentration and/or onto a GC/MS for separation and detection. The 5&20 analytical configuration has base LOQs of approximately 34 µg/m^3 for PCE and 26.9 µg/m^3 for TCE. The "5&20" associated with the analytical method designation refers to the laboratory instrumentation reporting limits of either 5 ppbv or 20 ppbv, depending on the compound. The methodology is described in more detail in Eurofins SOP #91 in Appendix A.

[2] TO-15 (PPTV): This method involves full scan GC/MS analysis of whole air samples collected in evacuated stainless steel canisters. Samples are analyzed for VOCs using EPA Method TO-14A/TO-15 protocols. An aliquot of up to 400 milliliters of air is withdrawn from the canister utilizing a volumetric syringe, volumetric loop, or mass flow controller. This volume is loaded onto a hydrophobic multi-bed sorbent trap to remove water and carbon dioxide and to concentrate the vapor sample. The focused sample is then flash-heated to sweep adsorbed VOCs onto a GC/MS for separation and detection. Compounds are detected using an MS operating in full scan mode. The Low-Level analytical configuration has base LOQs of approximately 0.68 µg/m^3 for PCE and 0.54 µg/m^3 for TCE. The methodology is described in more detail in Eurofins SOP #83 in Appendix A.

[3] Collected from soil gas probes and SVE wells.

[4] Collected from the SVTU influent and effluent.

5.2 Worksheet #20: Field Quality Control Summary

Matrix	Analytical Group (Method)	Frequency – Field Duplicate Samples	Frequency – Trip Blanks	Frequency – Field Blanks	Frequency – Equipment Blanks	Frequency – MS/MSD
Water	VOCs (8260-SIM)[1]	Two per preparatory batch as feasible or a minimum of 10% of project samples	1 set per cooler /day	1 per sampling day	1 per sampling event (Westbay sampling only[2])	One per preparatory batch of 20 samples
	Metals (6010D)[1]	Two per preparatory batch as feasible or a minimum of 10% of project samples	NA	NA	NA	One per preparatory batch of 20 samples
	Cl (9056A)[1]	Two per preparatory batch as feasible or a minimum of 10% of project samples	NA	NA	NA	One per preparatory batch of 20 samples
Landfill Gas	Fixed Gases (ASTM D1945)	1 field duplicate to be collected	NA	NA	NA	NA
	VOCs (TO-15)	Three per preparatory batch as feasible or a minimum of 10% of project samples	NA	NA	NA	NA
	Sulfur (SCAQMD Method 307-91)	1 field duplicate to be collected	NA	NA	NA	NA
Soil Gas	Fixed Gases (ASTM D1945)	NA	NA	NA	NA	NA
	VOCs (TO-15 and TO-15 PPTV)	10% of the number of project samples with a minimum of 1 per sampling event.	NA	NA	NA	NA

Matrix	Analytical Group (Method)	Frequency – Field Duplicate Samples	Frequency – Trip Blanks	Frequency – Field Blanks	Frequency – Equipment Blanks	Frequency – MS/MSD
	Sulfur Gases (SCAQMD 307-91)	NA	NA	NA	NA	NA

Notes:

Cl = chloride

MS/MSD = matrix spike/matrix spike duplicate

NA= not applicable

VOCs = volatile organic compounds

[1] Proficiency samples may be analyzed if requested by the Ahtna Project Manager.

[2] Sampling at Westbay wells requires reuse and decontamination of sampling equipment. Sampling with PDBs, HydraSleeves, and from sampling ports is performed with non-reusable sampling equipment, and no decontamination of field equipment is required. Westbay sample locations are identified as "Westbay Port" in the "Sampling Method" column of Worksheet #18.

5.3 Worksheet #21: Field SOPs/Methods

SOPs associated with project sampling and fieldwork are listed below and the SOPs are included in Appendix A. The SOP Reference Numbers are used throughout the QAPP to refer to specific SOPs. Site-specific procedures are also further described in this worksheet.

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of SOP	Equipment/ Sample Type	Modified for Project Work? Yes/No	Comments
FSOP-001	Fieldwork Documentation	Ahtna	NA	No	
FSOP-002	Sample Management	Ahtna	NA	No	
FSOP-201.00	Soil Classification	Ahtna	NA	No	
FSOP-301.00	Hollow Stem Auger	Ahtna	NA	No	
FSOP-302.00	Sonic Drilling	Ahtna	NA	No	
FSOP-303.00	Direct Push Drilling	Ahtna	NA	No	
FSOP-304.00	Mud Rotary Drilling	Ahtna	NA	No	
FSOP-305.00	Air Rotary Drilling	Ahtna	NA	No	
FSOP-408	Soil Vapor Sampling	Ahtna	NA	No	
FSOP-601.1	Well Installation	Ahtna	NA	No	
FSOP-602.02	Well Development	Ahtna	NA	No	
FSOP-603.01	Well Decommissioning	Ahtna	NA	No	
FSOP-606.00	Groundwater Well Rehabilitation	Ahtna	NA	No	
FSOP-607	Nested Soil Gas Probe Installation	Ahtna	NA	No	
FSOP-802	Investigation-Derived Waste Management	Ahtna	NA	No	
FSOP-A1	Supply Well Sampling Protocol	Ahtna	Sampling Ports	Yes	Groundwater project-specific procedures
FSOP-A2	OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements	Ahtna	Sampling Ports	Yes	Groundwater project-specific procedures
FSOP-A3	Low Flow Groundwater Quality Parameter Collection	Ahtna	Water Quality Meter	No	Groundwater project-specific procedures

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of SOP	Equipment/ Sample Type	Modified for Project Work? Yes/No	Comments
FSOP-A4	Downhole Meter Groundwater Quality Parameter Collection	Ahtna	YSI ProDSS Multi-Meter	Yes	Groundwater project-specific procedures
FSOP-A5	Source Test Protocol, Former Fort Ord, Monterey, CA. Thermal Treatment Unit (TTU). April 1, 2025	Ahtna	Mobile laboratory	Yes	Landfill Gas project-specific procedures
FSOP-A6	SVE Treatment System Sampling	Ahtna	SVTU	No	Soil Gas project-specific procedures
FSOP-A7	Treatment System Flow Meter Use	Ahtna	SVTU	No	Soil Gas project-specific procedures
FSOP-E1	Field Sampling Procedure Using Canisters with Quick-Connect (QC) Fittings: Grab Sample Collection	Eurofins	QC Fittings	No	Soil Gas project-specific procedures
FSOP-E2	Guide to Air Sampling Canister and Bags (Eurofins, 2014)	Eurofins	SUMMA™ Canister or Tedlar™ Bag	No	Soil Gas project-specific procedures
FSOP-E3	Helium Shroud Spec Sheet (Eurofins, 2014)	Eurofins	Helium Shroud	No	Soil Gas project-specific procedures
FSOP-GA1	Oil-Less Diaphragm Vacuum Pump & Compressors Operation & Maintenance Manual	Gast Manufacturing	Vacuum Pump	No	Soil Gas project-specific procedures
FSOP-GE1	HydraSleeve Field Manual	GeoInsight	HydraSleeve	No	Groundwater project-specific procedures
FSOP-K1	Key Instruments 2500 Series Flowmeters; installation and operation manual	Key Instruments	Flow Meter	No	Soil Gas project-specific procedures
FSOP-L1	GEM™ 5000 Gas Analyzer and Extraction Monitor, Operation Manual (LANDTEC, 2018)	LANDTEC	Portable landfill gas analyzer	No	Landfill Gas Specific Procedures

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of SOP	Equipment/ Sample Type	Modified for Project Work? Yes/No	Comments
FSOP-S1	Westbay MOSDAX Sampler Probe – Model 2531 Operations Manual	Schlumberger	Westbay Multi-port Wells	No	Groundwater project-specific procedures
FSOP-T1	Trimble Catalyst DA2	Trimble	GPS	No	
FSOP-USGS1	PDB Sampling Protocol	U.S. Geological Survey (USGS)	PDBs	Yes	Groundwater Project-specific procedures are appended to USGS User's Guide
FSOP-Y1	YSI ProDSS Instruction Manual	Ahtna	YSI ProDSS Multi-Meter	No	Groundwater project-specific procedures

Details not provided in the above SOPs are discussed in the following sections. Text in this section should be considered project specific and therefore supersedes procedures outlined in the SOPs.

5.3.1 Remedial Systems O&M

Remedial systems O&M, including sampling and field procedures, will be conducted in accordance with the applicable O&M manual or plan:

- *Final Operations and Maintenance Manual Volume II, Sites 2 and 12 Groundwater Remedy, Former Fort Ord, California* (AES, 2009)
- *Final Operations and Maintenance Manual, Volume II, Sites 2 and 12 Groundwater Remedy (Section 2.5.3 Replacement Pages)* (AEI, 2015a)
- *Final Operations and Maintenance Manual Volume III, Sites 2 and 12 Soil Vapor Extraction and Treatment System, Former Fort Ord, California* (AEI, 2015c)
- *Operations and Maintenance Plan Revision 4, Operable Unit 2 Landfills, Former Fort Ord, California* (Ahtna, 2023c)
- *Operations and Maintenance Manual Revision 5, Operable Unit 2 Groundwater Treatment System* (Ahtna, 2025b)

5.3.2 Groundwater Monitoring

The majority of the groundwater samples are collected using PDBs at groundwater monitoring wells and extraction wells where the extraction pump was removed. The vertical placement of a PDB within the well screen is designed to capture the highest COC concentration zone of the aquifer based on historical data from the saturated screen interval. If the well has two or more high (or similar) COC concentration zones, then hanging multiple PDBs or hanging PDBs at different sampling stations each quarter is necessary.

PDBs are placed at a designated depth using PDB sampler hardware consisting of a dedicated rope and stainless steel weight secured to the top of the well casing or well cap. The PDB hardware rope is fitted with PDB hanging stations, usually at five-foot intervals in the well screen zone. Depth to water measurements taken prior to sample collection ensure proper placement and complete groundwater submersion of the PDB, which is necessary for representative data collection. Once sampling is completed, a new PDB for the next quarterly GWMP event (if the well is sampled quarterly) is hung at the appropriate station. PDBs are typically left in place for three months (but must remain in place for at least two weeks) before sampling. Additionally, HydraSleeve™ sampling is conducted annually for dissolved metals (antimony, copper, and lead)[38] at select OU2 groundwater monitoring wells and for chloride[39] at select Sites 2/12 groundwater monitoring wells and extraction wells during the Third Quarter annual GWMP event each year.

Aqueous sample collection at GWTP monitoring points and active groundwater extraction wells use the designated sampling spigot. If applicable, offline groundwater extraction wells with operational pumps

[38] Metals are not identified as COCs for groundwater in the OU2 Record of Decision and therefore do not have ACLs (Army, 1994). However, dissolved metals are monitored to validate that groundwater near the Fort Ord Landfills is not impacted by soil and spent small arms ammunition disposed of in the Fort Ord Landfills during remediation of small arms firing ranges at Fort Ord.

[39] Chloride is not identified as a COC for groundwater in the RI Sites ROD and therefore does not have an ACL. However, chloride is monitored to validate that groundwater near the GWTS at Sites 2/12 is not impacted by seawater intrusion during remediation.

are turned online for several minutes prior to sampling to remove stagnant water from the pumping and sampling pipelines. Sampling standard operating procedures are in this QAPP.

SGS performs analyses for the GWMP samples. SGS is accredited through the Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP). SGS DoD ELAP accreditation information is provided in this QAPP. Groundwater samples are analyzed for a project-specific list of COCs (Worksheet #15a) by EPA Method 8260-SIM. Also, during the annual GWMP event (third quarter GWMP events), dissolved metals analysis is performed with EPA Method 6010D at select OU2 wells and chloride analysis is performed at select Sites 2/12 wells with EPA Method 9056A.

5.3.3 Soil Gas Monitoring

Soil gas samples will be collected from soil gas probes at 10-foot intervals from approximately 10 feet bgs to 70 feet bgs, and from SVE wells screened from approximately 45 feet bgs to 65 feet bgs. Twenty-four (24) soil gas probe locations and ten (10) SVE well locations at Site 12 are shown on Figure 13. Samples will be collected either quarterly or annually (Table 1) and sampling will continue until it can be demonstrated that RAOs have been achieved, as described in RI Sites ESD No. 1 (Army, 2016). If the SVETS is in operation, soil gas samples will also be collected from the SVTU located in a fenced compound adjacent to the Sites 2/12 GWTP. A process flow diagram for the SVTU with potential sampling locations is shown in Figure 14.

Soil gas sampling is conducted using SUMMA canisters evacuated to subatmospheric pressure. A SUMMA canister is attached to the soil gas probe via a sample manifold used for soil gas probe purging and sampling. The sampling apparatus is covered with a plastic shroud, which is filled with approximately 30% helium (by volume) to field test for leaks in the sampling train.

Eurofins in Folsom, California, performs analyses for the Sites 2/12 SGMP samples. Eurofins is accredited through the DoD ELAP. The Eurofins DoD ELAP accreditation information is provided in this QAPP. Soil gas samples are analyzed for a project-specific list of Sites 2/12 COCs (Worksheet #15i and Worksheet #15j) by EPA Method TO-15.

5.3.4 Landfill Gas Monitoring

LFG sampling is conducted using SUMMA canisters evacuated to subatmospheric pressure. A SUMMA canister is attached to the LFG probe via a sample port. Eurofins in Folsom, California, performs analyses for the LFG samples. Eurofins is accredited through the DoD ELAP. The Eurofins DoD ELAP accreditation information is provided in this QAPP. LFG samples are analyzed for a project-specific list of VOCs (Worksheet #15f and Worksheet #15g) by EPA Method TO-15.

A certified mobile laboratory provided and staffed by Best Environmental will be on site to measure the parameters for TTU source testing and operational influent LFG testing (with the exception of VOCs, fixed gases, and reduced sulfur compounds, which will be analyzed at a certified fixed laboratory). Best Environmental is certified by the State of California Air Resources Board to conduct compliance testing pursuant to California Code of Regulations, Title 17, Section 91207. The LFG flow rate and flare temperature will be measured using a calibrated flow meter and thermocouple on site.

5.3.5 Groundwater Well Installation and Decommissioning

Installation activities will be conducted in accordance with *California Well Standards, Water Wells, Monitoring Wells, Cathodic Protection Wells, Bulletin 74-90 (Supplement to Bulletin 74-81)* (DWR, 1991), FSOP-601.1 (Appendix A), and ASTM D5092 – Standard Practice for Design and Installation of Groundwater Monitoring Wells (ASTM, 2024) though well installation requirements found in Monterey County Code Chapter 15.08 (Monterey County Code, 2026) will take precedence and well installation will be consistent with previous practices at the former Fort Ord.

Decommissioning activities will be conducted in accordance with FSOP-603.01 (Appendix A), ASTM D5299 – Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities (ASTM, 2018) and applicable Federal, State, and local regulations, though well decommissioning requirements found in Monterey County Code Chapter 15.08 (Monterey County Code, 2024) will take precedence and well decommissioning will be consistent with previous practices at the former Fort Ord. If obstructions do not allow pressure grouting per County guidelines, the well shall be overdrilled. Other SOPs relevant to well installation and decommissioning activities are listed above.

5.3.5.1 Pre-Field Activities

Notification and Access: Property owners will be notified of fieldwork activities at least three days before the start of work. Site users will be coordinated with for site access, limited access to the project site during construction, and scheduling changes.

Permitting: Permits for installation and decommissioning will be obtained from the Monterey County Department of Health; however, no permit fees are required to be paid because the former Fort Ord is a CERCLA site.

Utility Clearance: A utility clearance will be performed at the proposed project location before ground-disturbing activities commence to avoid encountering underground utilities and other potential obstructions. Clearance activities include review of available utility maps, notification of utility agencies and/or utility protection organizations, as appropriate, and performing onsite surveys by a California licensed Professional Geophysicist using the appropriate geophysical equipment including, but not necessarily limited to, ground penetrating radar, electromagnetic metal detection, and radio frequency pipe location. Locations of utilities will be marked on the ground surface with indications of the assumed type of utility. Prior to initiating intrusive activities, utility location information will be reviewed, including field markings and available drawings, to ensure the excavation is a minimum of 3 feet away from a marked utility. Additionally, the boring location will be hand augured (or similar method) to a depth of 5 feet bgs. Non-mechanical excavation methods may be required based on the documented presence of direct-buried subsurface utilities without trace wires.

Habitat Clearance: Prior to fieldwork activities, the Onsite Biologist will survey proposed project locations, access routes, and staging areas for locations in the FONR or the Fort Ord Dunes State Park for sensitive species such as Monterey gilia, Monterey spineflower, piperia, and Buckwheat. Identified plants will be GPS-located and mapped. The baseline survey will be conducted during the peak blooming period for the sensitive species. The maps will be used to field-identify and mark areas that personnel may not enter, and areas that are permissible to access, stage equipment, and turn vehicles around. The Onsite Biologist will be familiar with Fort Ord Habitat Management Plan (HMP; USACE, 1997) plant and

wildlife species and the requirements of the Programmatic Biological Opinion (USFWS, 2017). In accordance with the Programmatic Biological Opinion, the Onsite Biologist may conduct California tiger salamander (CTS) relocation if so authorized by the USFWS. If not so authorized, the Onsite Biologist will coordinate CTS relocation with the Fort Ord BRAC Office Biologist.

Traffic Control: The project location is in areas ranging from low to high public and/or property user traffic. Traffic control around the project site with proper safety delineators and protocol will be adhered to as described in the APP (Ahtna, 2024).

Support Facilities: Support facilities include lockable containers, chemical toilets, portable containment tanks and bins with lids. Lockable support facilities will be secured when project personnel are not on site. It is anticipated most of the support facilities will be located in the vicinity of the Ahtna field offices adjacent to the OU2 GWTP.

5.3.5.2 Field Activities

Borehole Drilling and Logging: Wells will be installed by a California-licensed contractor using a truck- or track- mounted mud rotary, rotosonic (rotary-vibratory), or hollow-stem auger drill rig. The work area footprint for these drill rigs, including support vehicles and drilling equipment, is expected to be approximately 25 feet by 50 feet or 1,250 square feet.

The borehole diameter will be sized to ensure proper borehole sidewall clearance for well construction. The boring will be completed under the supervision of the Project Geologist/Engineer who will be responsible for oversight of borehole logging, well installation, and development activities. General procedures for borehole drilling and logging include:

- The well location will be verified and determined to be safe for construction operations from underground utilities and aboveground hazards.
- Drilling equipment will be staged to avoid disturbing the normal flow of traffic using safety delineators as needed.
- The pavement, if any, will be cut around the borehole location with a cutting tool.
- A hand auger will be used to advance the borehole from 0 to 5 feet bgs to ensure there are no underground utilities at the borehole location.
- Drilling will commence and removed soil will be classified in accordance with the Unified Soil Classification System.
- Soil may be screened with a photoionization detector for the potential presence of VOCs if the conceptual site model warrants it.
- Field borehole logs will be used to determine proper borehole depth and well screen placement.
- Soil cuttings or cores will be containerized for transport and disposal per Section 5.3.8. Other liquid and solid IDW will be managed according to Section 5.3.8.
- The volume of water added downhole to assist with drilling will be tracked for well development purposes.
- Drilling methods that may be used include:
    - Mud Rotary: A common well installation method that uses a rotating drill bit to advance a borehole while circulating a drilling fluid (“mud”)—typically a mixture of water and bentonite clay—down the drill stem and back up the annular space. The drilling fluid serves multiple functions: it cools and lubricates the bit, stabilizes the borehole walls by forming a

filter cake, and transports cuttings to the surface where they are removed in a settling pit or tank. This technique is particularly effective in unconsolidated formations such as sands and silts, where borehole collapse is a concern, and it allows for relatively fast advancement and deeper drilling compared to direct push methods, though it can introduce formation disturbance and potential cross-contamination if not properly managed.

- Hollow-Stem Auger: The borehole is advanced by continuous flight augers with hollow stems that are driven by top head rotary machines. The soil cuttings are removed from the borehole via helical flights and placed in a bin adjacent to the borehole. The borehole will be logged from soil cuttings as they come off the augers. The augers keep the borehole open during drilling and allow for installation of the well casing through the stem while removing the augers once total depth is reached.
- Rotosonic: This drilling method typically produces approximately 80 percent less IDW than traditional drilling methods and provides undisturbed continuous soil core. The drill head of the sonic rig generates a high-frequency resonant energy, which is combined with rotational and vibrational movement of the drill core barrel that the operator can control to match the force needed to optimally penetrate the soil formation. The core barrel is advanced first and the over casing is advanced around the core barrel to protect the integrity of the open borehole when the core barrel and sample are removed. After the core sample is removed, the core barrel is advanced deeper into the borehole and the process is repeated until the desired depth is achieved. Core samples will be staged adjacent to the borehole for logging and then placed in a bin for transport and disposal.

Well Construction Materials: Use clean, new materials (e.g., Schedule 80 polyvinyl chloride (PVC) casing, stainless steel screen (for extraction wells) or PVC screen (for monitoring wells), filter pack, bentonite seal, grout). Well construction materials will be new, clean, and in good condition. If the protective plastic shipping sleeve is damaged, the screen and casing will be decontaminated immediately prior to installation in the boring.

- Casing material shall be flush-jointed, threaded, Schedule 80 PVC manufactured per ASTM F480. The casing will be clean and new and joints between casing and screen will be compatible. The casing diameter for monitoring wells is typically 3 inches. The casing diameter for A-Aquifer and unconfined Upper 180-Foot Aquifer extraction wells is typically 6 inches and the casing diameter for confined Upper 180-Foot Aquifer extraction wells is typically 10 inches.
- The well screen for extraction wells will typically consist new, Type 316 stainless steel. The well screen will be wire wrapped, with the wire welded to an internal structure. The wire will be V-shaped in the cross section so the slots between the wires widen inward to minimize clogging. A bottom cap will be installed at the bottom of each well. The screen diameter for A-Aquifer and unconfined Upper 180-Foot Aquifer extraction wells is typically 6 inches and the screen diameter for confined Upper 180-Foot Aquifer extraction wells is typically 10 inches.
- The well screen for monitoring wells will typically consist of new 3-inch diameter slotted Schedule 80 PVC. The monitoring well screen lengths will be comprised of 10-foot sections. The screen slot size will be 0.020-inch. A 3-inch diameter PVC bottom cap will be installed at the bottom of each monitoring well. A lockable expansion cap will be placed at the top of the PVC well casing for secure access to the well.
- The well will be constructed with centering guides comprised of stainless steel. Mounting will be provided such that centering guides can be securely attached to the well riser. Centralizers will

be positioned to ensure the well screen in the center of the borehole. One centralizer will be placed above the screen and bentonite seal, with the remaining centralizers spaced approximately every 40 feet upward for the remainder of the casing.

- The filter pack will be placed around the well screen and will extend 5 feet above the top of the well screen. The filter pack will consist of SiLibeads® (or equivalent glass beads) or clean, washed, rounded to subrounded siliceous sand material that is free from calcareous grains or material. The uniformity coefficient of the filter pack material will not exceed 2.5. The well will have 3 feet of fine sand placed directly above the filter pack. The fine sand will be well sorted and have a predominant grain size of between 0.42 millimeter and 0.074 millimeter. Filter pack and fine sand will be hard, durable, and have an average specific gravity of not less than 2.50. The sand will be visibly free of clay, dust, micaceous, and organic matter.
- A 5-foot bentonite seal will be placed directly above the fine sand filter pack using a tremie pipe. A bentonite-cement grout seal will be used in the construction of the well and placed directly above the bentonite seal. The well will be grouted to within 36 inches of ground surface. The bentonite-cement grout will be mixed in the ratio of 5 pounds bentonite gel, one 94-pound bag of Type I Portland cement, and 7 gallons of clean, potable water. The grout will have a weight of approximately 15.3 pounds per gallon. Cement will meet requirements of ASTM C150. Neither additives nor borehole cuttings shall be mixed with the grout.

Assembly of Well: Install screen, casing, filter pack, seal, and grout in sequence. Ensure proper alignment and centralization.

- The final position of the well screen will be determined in the field by the Field Geologist.
- Filter pack will be placed around the well within the saturated zone. The filter pack will extend from a minimum of 1 foot beneath the bottom of the well to 5 feet above the top of the well screen. Three feet of fine sand will be placed above the filter pack. A 5-foot bentonite seal will be placed above the fine sand. The annular space from the top of bentonite seal to 36 inches bgs will consist of bentonite-cement grout.
- Care will be taken to ensure the pipe does not contact the ground. Joints and other accessory parts will be securely fastened prior to installation in the borehole. The screen and casing will be placed in the hole in such a manner as to avoid jarring impacts and to ensure the assembly is not damaged. Each well screen and casing will be emplaced while the temporary casing (depending on the drilling method used) is still in place in the boring.
- The well will be plumb, true, and centered in the hole by the use of centralizers. No centralizers will be placed on the screen sections; one will be placed above the screen and bentonite seal, with the remaining centralizers spaced approximately every 40 feet upward for the remainder of the casing. Excessive misalignment or binding will be corrected before placing the filter pack.
- To prevent compression of the well screen, the casing and screen will be suspended in the borehole until the filter pack is placed. The filter pack will be tremied into place, from the bottom of the borehole up, in such a manner as to ensure uniform placement around the screen. Temporary casing will be withdrawn from the boring as the filter pack is placed in a manner that will not cause the well to be displaced. During placement of the filter pack, frequent measurement of the top of the filter pack will be made to ensure the bottom of the drive casing is not higher than 2 feet below the top of the filter pack. Water added to the filter pack during the tremie operation will be from a known clean source. The volume of water added

will be monitored and recorded. Filter pack material will be protected from contamination prior to placement by either storing it in plastic-lined bags or in a location protected from the weather and contamination on plastic sheeting. Filter pack materials will be transported to the site in a manner that prevents contamination by other soils, oil and grease, and other chemicals.

- The well will have 3 feet of fine sand placed directly above the filter pack and a bentonite seal placed directly above the fine sand. The fine sand and bentonite seal are intended to keep the bentonite cement grout from infiltrating into the filter pack. Prior to placement of the seal, soundings will be conducted to verify the filter pack extends 5 feet above the top of well screen elevation. If it does not, sufficient filter pack material will be added to bring the pack to the specified level for the given well design. The bentonite seal will consist of ⅜-inch pellets or slurry, which will be added via a tremie pipe. The well will be grouted to 36 inches bgs with a bentonite-cement grout. The grout will be placed by tremie pipe submerged in grout after initial placement of grout. The tremie pipe may be raised as the grout is placed as long as the discharge end remains submerged in grout. Additional grout will be added from the surface to maintain the level of grout, as specified, as settlement occurs.

Surface Completion:

- Extraction Well:
  - Following well installation, the area surrounding the extraction well will be excavated to allow for the construction of the vault and sump. The bottom of the excavation will be covered by a geotextile fabric. An 8-inch layer of class II aggregate base will be placed over the fabric and compacted to 95% of maximum compaction.
  - The vault will be constructed of concrete composed of Type I or II Portland cement conforming to ASTM C150; coarse and fine aggregate conforming to ASTM C33; and clean, potable water free of deleterious amounts of oils, acids, alkalis, salts, and organic material. Rebar will be sized and placed within the vault walls and floor to provide H-10 load rating. A construction joint will be installed in the vault between the walls and floor to resist hydrostatic pressure. The top of the vault will be completed to just above the existing grade elevation and accessible through a traffic rated, lockable lid.
  - The well will have an underground concrete vault to allow for wellhead access and extraction pipe and electrical connections below grade. The interior dimensions of the vault will be approximately 8 feet long by 6 feet wide by 4 feet deep. The vault may be pre-cast or constructed on site. The vault walls and floor will be a minimum 8 inches thick. The vault will have access holes for the wellhead, extraction piping, and electrical conduits. The vault will also include a 36-inch diameter sump that is 18 inches deep and is grouted to the bottom.
  - A vault lid constructed of corrosion-resistant aluminum will be attached to the concrete vault. The vault lid will be spring-loaded and hinged with a recessed lock box. The hinged lid will have a range of motion from being locked closed to 90 degrees open or greater. Two lids are required to meet the 60 pounds of maximum force to open. The lid will be attached to the well vault by type 303 stainless steel mounting bolts and nuts. Lid frames, mounting hardware, washers, and other fittings will be composed of type 304 or type 316 stainless steel. Anchor bolts will be stainless steel type 304 and penetrate the concrete a minimum of 4 inches on the vertical axis and at least 3 inches on the horizontal axis. Vault lids will have a rainwater collection tray. When the lid is closed, falling rain will drain away from the vault. A concrete apron will be placed around the vault lid to support the lid and provide protection.

The apron will extend a minimum of 12 inches in each horizontal direction, with the surface sloped away from the lid.

- Monitoring Well:
  - Surface completion of each monitoring well will consist of either a flush vault or stovepipe.
  - The 8-inch diameter traffic-rated flush-mounted steel vault will be a minimum of 12 inches deep set in the concrete surface seal and be equipped with a bolt-down watertight cover. The top of the vault will be raised slightly above existing grade, and the surface of the cement seal will slope away from the vault to the existing grade to promote surface drainage away from the well. The vault will be installed such that there are no more than 6 inches and no less than 5 inches between the top of the monitoring well casing and the top of the vault cover. The cover of the vault will have the wording "monitoring well" on its outer surface.
  - A stovepipe, or stickup, completion would include the 3-inch diameter well casing extending approximately 3 feet above the ground. The PVC well casing will be surrounded by a steel casing with lockable lid and filled to just below the well casing with sand pack material. If the well is in a vehicle traffic area, the steel casing will be flanked on at least three sides with traffic-rated bollards. The bollards and stovepipe will be set in a concrete pad as described above. The bollards and stovepipe will be painted yellow to alert vehicles of their presence.

Well Development: Wells will be developed in accordance with ASTM D5521 to assure inflow is physically and chemically representative of that portion of the aquifer adjacent to the screened interval.

- Within one week after the well has been constructed, but no sooner than 48 hours after grouting is completed, the well will be developed using a bailer, vented surge block, and submersible pump. The total depth of the well and the depth to water measurements will be used to calculate the volume of water in the well casing. The well will be developed by alternately bailing and surging with a vented surge block. Care shall be taken so as not to dislodge the end plug or to disturb the well casing and screen. The well will be bailed prior to surging to remove debris.
- Following bailing, the well screen will be carefully surged for a minimum of 15 minutes. During well surging, the vented surge plug will be placed at different depths within the screened portion of the well to expedite well development. If this development technique does not produce satisfactory results within one hour, then pumping the well with a submersible pump may be conducted. Care will be taken when developing with a submersible pump so as not to over pump the well and plug the sand pack. Additives and dispersing agents will not be used during well development without express permission of the Project Geologist/Engineer.
- During development, the Field Geologist will monitor well development water for turbidity, pH, temperature, and specific conductance using a YSI ProDSS Multi-parameter Digital Water Quality Meter (FSOP-Y1). For each casing volume of water removed, measured water quality parameters (temperature, specific conductance, pH, and turbidity) will be recorded on the well development log. Water quality parameters will be measured in the following units:
  - Temperature degrees Celsius (°C)
  - Specific conductance micromhos per centimeter (µmhos/cm)
  - pH standard pH units = -log [H+]
  - Turbidity Nephelometric Turbidity Units

- A minimum of ten (10) well casing volumes of water plus the volume of water introduced into the borehole, if any, to facilitate drilling and well construction will be removed from the well, and water quality parameters will be monitored, with successful development indicated by three successive measurements of the parameters showing:
  - pH has changed less than 0.1 pH units
  - Temperature has changed 1°C or less and is approximately equal to ambient groundwater temperature[40]
  - Conductivity has changed less than 10%
  - Consistent turbidity readings measured five minutes apart, with no more than 10 percent change

- For extraction wells, specific capacity testing will be conducted during well development to evaluate the production capacity of the well. Specific capacity is a term used to express the productivity of a well, and is defined as Q/s, where Q is the discharge rate and s is the drawdown in the well. The observed drawdown in the well is a function of aquifer and well loss; therefore, Q/s is a term incorporating both aquifer and well performance. Water levels and flowrates will be measured during the process of pumping the well. If specific capacity testing indicates the well does not have sufficient capacity to meet project objectives, additional well development measures may be implemented.

Extraction Well – Groundwater Extraction Conveyance:

- Trench excavation will be conducted using appropriate equipment, following surveyed alignment and safety protocols such as sloped or shored walls and proper soil placement. Bedding will be verified or replaced as needed, and grade control will be maintained throughout construction. After pipeline installation and testing, the trench will be backfilled in stages with compacted material and marked with warning tape before final surface restoration.
- The conveyance pipeline will consist of double-contained HDPE piping installed in a trench, transitioning from PVC near the well vault. The pipeline will include necessary fittings, vents, drains, and electrical conduit, with layout and connections following manufacturer specifications. Pipe routing may be adjusted in the field to avoid obstacles.
- High points and low points will be installed as needed where a drain will be installed for maintenance and leak management. The low-point drain will be housed in a precast concrete vault designed to prevent stormwater intrusion and ensure secure access. Vault covers will be corrosion-resistant, lockable, and rated for incidental traffic loads.
- An isolation valve will be installed in the pipeline to allow control overflow to a specific extraction well. The valve will be housed in a precast concrete vault located in a non-traffic area, designed to prevent stormwater intrusion and ensure secure access. Vault covers will be corrosion-resistant, lockable, and rated for incidental traffic loads.
- Before backfilling, the pipeline will undergo pressure testing: the inner pipe will be tested with water, and the outer containment pipe with air. Welds and fittings will remain exposed during testing, which will follow manufacturer guidelines and field engineer recommendations. These procedures ensure the integrity of the system and compatibility with connected components.

[40] Groundwater temperatures from recent quarterly GWMP events will be referenced.

- A licensed surveyor will verify pipeline routes and vault elevations before backfilling. As-built drawings will be created to document actual alignments and construction details. Survey accuracy will be maintained within a tenth of a foot for both horizontal and vertical control.

Extraction Well – Groundwater Extraction Equipment: Install submersible pump, shroud, valves, and sample port. Connect to control panel.

- A submersible pump will be installed to pump groundwater to the GWTP. The specific pump size will be determined by specific capacity testing conducted during well development following extraction well installation. The pump will be installed in the extraction well at a depth near the bottom of the screened interval to maximize the groundwater recovery from the well. The pump will be suspended by stainless steel type 304 downhole pipe attached to the well cap, which rests on the top of the extraction well casing. A shroud constructed from PVC will be installed over the pump and motor to direct water flow over the motor to the impeller opening. Power cables with a water-proof termination fitting will be installed from the pump motor to the electrical panel in the well vault. Piping at the wellhead will be Schedule 80 PVC and will include a globe valve to control the flow from the well and a check valve and gate valve to isolate the well from other wells connected to the header piping. Because of the potential pressure induced by the well pump, the globe valve and components between the well cap and globe valve will be rated for a minimum of 250 pounds per square inch (psi). Components after the globe valve within the well vault will be rated to 160 psi. A sample port will also be installed at the wellhead for system monitoring. A digital output PVC float switch will be installed in the well vault to indicate a high water level in the vault as a result of a pipeline leak.
- Instrumentation within the well vault will include a flow-indicator totalizer, pressure switch with gauge, downhole pressure transducer, level switch (leak detection), and variable frequency drive (VFD). The flow indicator totalizer will be installed at the wellhead to monitor instantaneous flowrate and total gallons extracted from the well. The flowmeter will be a Rosemount magnetic style water meter with 1.5% accuracy and a 4- to 20-milliamp output.
- A digital pressure switch will also be installed to monitor the pump pressure and ensure safe operation of the extraction system. The switch will be adjustable and provide a digital output. The switch will have a pressure range of 0 to 200 psi. The pressure switch will be installed downstream of a pulsation dampener to reduce false high-pressure readings caused by pipeline pressure surges.
- A pressure transducer will be installed in the extraction well piezometric tube at a depth near the bottom of the extraction pump to measure the water level within the extraction well and control the operation of the pump to prevent the pump from running dry and cavitating. The pressure transducer will be welded titanium with a sealed gauge, 0 to 60 psi gauge span, ±0.25% accuracy, with a 4- to 20-milliamp output.
- A digital output stainless PVC float switch will be installed within the well vault to allow for detection of leaks within the well vault and extraction conveyance pipeline that would drain into the vault sump.

Extraction Well – Electrical Installation: Install power and control conduit, VFD, disconnect switch, and instrumentation (flowmeter, pressure transducer, float switch). The electrical wire and conduit will be sized based on the final extraction well pump size in accordance with industry standards and the pump manufacturer's requirements. Pull boxes will be spaced no more than 200 feet apart along the length of

the new conduit. Power will be terminated in the extraction well vault in a National Electric Manufacturers Association 4X panel with a lockable disconnect switch. The switch will be connected to a motor-run VFD that will be connected to the downhole extraction pump through the motor power cable. The disconnect and VFD will be sized based on the final extraction pump size in accordance with industry standards. The power in the extraction well vault will be grounded in accordance with National Electric Code requirements.

5.3.5.3 Post-Field Activities

Groundwater Elevation Monitoring: A minimum of 48 hours after well construction and development activities are completed, the groundwater elevation will be measured at the new well using a hand-held measuring device and recorded. Data from the groundwater elevation monitoring will be provided for incorporation into the groundwater model.

Surveying: Following well installation, the well will be surveyed by a professional California-licensed land surveyor for northing and easting coordinates and elevation with respect to MSL in compliance with established protocol. Surveying will be conducted using North American 1983 Datum, California State Plane Zone 4 horizontal and North American Vertical Datum of 1988. The top of each well casing will be surveyed within 0.1-foot horizontal and 0.01-foot vertical accuracy.

Extraction Well Operations: Perform system startup, mechanical/electrical checks, and hydrogeologic testing (step-drawdown and constant-rate).

- A mechanical and electrical completion check will be performed to verify the correct installation of the equipment. Installation of all components need not be completed for this inspection to commence. Mechanically moving devices will be individually inspected prior to and immediately following installation. This initial inspection includes a visual check of the moving parts to confirm whether the parts are free to operate as specified after installation.
- During the final mechanical check, a visual inspection of the entire system against the construction drawings will be made to confirm that equipment and pipelines are in their proper locations and are appropriately connected, bolts and fittings have been tightened, and supports have been secured to support the intended weight. The mechanical completion checklist for the initial shakedown/startup will be prepared after all mechanical items have been installed.
- During the electrical check, electrical equipment and wiring will be visually checked against construction drawings to ensure proper installation and connections. Wiring will be tested with a megohmmeter to ensure the wiring is intact and properly insulated. Instrumentation will be calibrated in accordance with the manufacturers' recommendations and tested to verify proper operation. After the installation of the power system, an operating test will be performed to assure proper rotation of the extraction pump. Following the installation of the control system, the GWTP operator will perform tests to ensure proper operating conditions. Alarms and automatic shutdowns will be tested by forcing a failed condition. The SCADA system will integrate the signals from the instruments installed within new extraction well and associated extraction conveyance pipeline to the programmable logic controller.
- Hydrogeologic testing to determine specific capacity and transmissivity will be conducted to evaluate recovery and COC plume capture by the new extraction well operating alone and in conjunction with the GWTS. Testing will be conducted after construction of the extraction well and the associated conveyance pipeline are complete. Therefore, the pump used for testing will

be the one specified and installed in the extraction well based on the results of pump testing during well development, and groundwater extracted from the extraction well during testing will be discharged into the pipeline to the GWTP.

- Baseline water level trends will be monitored for at least one week before testing to account for regional fluctuations. A step-drawdown test will determine the optimal pumping rate, followed by a constant-rate test lasting at least 24 hours, with flow and water levels continuously monitored using calibrated instruments and recorded via SCADA. Data from both tests will be analyzed and reported to support groundwater modeling and system design.

Operations and Maintenance: the new extraction well will be incorporated into and operated as part of the GWTS. The GWTS is currently operated in accordance with the latest O&M Manual (Ahtna, 2025b), which provides the specific requirements for startup of the GWTS after major modifications and general guidance for system operations, maintenance, and monitoring. The GWTS O&M Manual will be revised following system construction to incorporate necessary changes related to the new equipment, including revisions to system control logic, changes to periodic checklists, and changes to as-built drawings. Future system optimization will consider operation of the new extraction well for capture of the COC plume.

Groundwater Monitoring: Baseline sampling will be conducted after the development of new wells and during the next scheduled quarterly sampling event associated with the GWMP following well development. Accordingly, QC samples will be collected and samples will be analyzed by EPA Method 8260-SIM for volatile organic analysis following sampling and laboratory analytical protocols identified in this QAPP. For extraction wells, baseline sampling will be conducted in two phases: 1) passive diffusion bags (PDBs) for profiling the water column prior to pump installation; and 2) sample collection from the sample port in the well vault with the pump operating. Phase 1 baseline sampling includes installation of a weighted rope with identified stations at approximately five-foot intervals in the screened well zone. PDBs will be placed at each saturated station for at least two weeks prior to sampling. Phase 2 of the baseline sampling will occur following the placement of the submersible pump. For monitoring wells, baseline sampling includes installation of hardware including a weighted rope with identified stations at approximately five-foot intervals in the screened well zone. PDBs will be placed at each saturated station for at least two weeks prior to sampling. Subsequent sampling for performance monitoring and long-term monitoring will be conducted as part of the Fort Ord basewide quarterly GWMP and subject to QAPP decision rules to determine sampling frequency.

Follow-Up Habitat Monitoring: The Onsite Biologist will conduct three years of annual follow-up habitat monitoring in the areas of the FONR or Fort Ord Dunes State Park disturbed during well installation or decommissioning field activities. Habitat monitoring will be conducted in accordance with the HMP (USACE, 1997) and the Programmatic Biological Opinion (USFWS, 2017). Follow-up surveys will be conducted during the peak blooming period for the species being monitored. Each year for the three-year follow-up habitat monitoring period an evaluation report will be prepared and provided to the Fort Ord BRAC Office Biologist detailing updated special-status plant species populations and document impacts during the well installation.

Deliverables and Reporting: Field daily reports will be presented weekly in Contractor Quality Control Reports (CQCRs) during field activities. EDDs will be provided by the laboratory performing analyses in accordance with this QAPP. Preliminary and validated sample analytical results will be presented at

project meetings and in the appropriate quarterly and annual reports. A Completion Report will be prepared following completion of field activities. The Completion Report will document work associated with the construction or decommissioning of wells and will present geologic logs, well completion diagrams, well development records, and sample analytical results as applicable.

5.3.6 Soil Gas Probe Installation and Decommissioning

Installation activities will be conducted in accordance with FSOP-607 (Appendix A), though soil gas probe installation will be consistent with previous practices at the former Fort Ord.

Decommissioning activities will be conducted in accordance with FSOP-603.01 (Appendix A), though decommissioning requirements found in Monterey County Code Chapter 15.08 (Monterey County Code, 2026) will take precedence and soil gas probe decommissioning will be consistent with previous practices at the former Fort Ord. Generally, decommissioning of soil gas probes will require overdrilling, if warranted by site-specific conditions, soil gas probes may be cut at 5 feet bgs and capped with concrete with the approval of the Monterey County Health Department, Environmental Health Bureau. Other SOPs relevant to soil gas probe installation and decommissioning activities are listed above.

5.3.6.1 Pre-Field Activities

Notification and Access: Property owners will be notified of fieldwork activities at least three days before the start of work. Site users will be coordinated with for site access, limited access to the project site during construction, and scheduling changes.

Permitting: Permits for installation and decommissioning will be obtained from the Monterey County Department of Health; however, no permit fees are required to be paid because the former Fort Ord is a CERCLA site.

Utility Clearance: A utility clearance will be performed at the proposed project location before ground-disturbing activities commence to avoid encountering underground utilities and other potential obstructions. Clearance activities include review of available utility maps, notification of utility agencies and/or utility protection organizations, as appropriate, and performing onsite surveys by a California licensed Professional Geophysicist using the appropriate geophysical equipment including, but not necessarily limited to, ground penetrating radar, electromagnetic metal detection, and radio frequency pipe location. Locations of utilities will be marked on the ground surface with indications of the assumed type of utility. Prior to initiating intrusive activities, utility location information will be reviewed, including field markings and available drawings, to ensure the excavation is a minimum of 3 feet away from a marked utility. Additionally, the boring location will be hand augured (or similar method) to a depth of 5 feet bgs. Non-mechanical excavation methods may be required based on the documented presence of direct-buried subsurface utilities without trace wires.

Traffic Control: The project location is in areas ranging from medium to high public and/or property user traffic. Traffic control around the project site with proper safety delineators and protocol will be adhered to as described in the APP (Ahtna, 2024).

Support Facilities: Support facilities include lockable containers, chemical toilets, portable containment tanks and bins with lids. Lockable support facilities will be secured when project personnel are not on site. It is anticipated most of the support facilities will be located in the vicinity of the Sites 2/12 GWTP.

5.3.6.2 Field Activities

Borehole Drilling and Logging: Soil gas probes will be installed by a California-licensed contractor using a truck-mounted rotosonic (rotary-vibratory) or hollow-stem auger drill rig. The work area footprint for these drill rigs, including support vehicles and drilling equipment, is expected to be approximately 25 feet by 50 feet or 1,250 square feet.

The borehole diameter will be sized to ensure proper borehole sidewall clearance for soil gas probe construction. The boring will be completed under the supervision of the Project Geologist/Engineer who will be responsible for oversight of borehole logging and probe installation. General procedures for borehole drilling and logging include:

- The soil gas probe location will be verified and determined to be safe for construction operations from underground utilities and aboveground hazards.
- Drilling equipment will be staged to avoid disturbing the normal flow of traffic using safety delineators as needed.
- The pavement, if any, will be cut around the borehole location with a cutting tool.
- A hand auger will be used to advance the borehole from 0 to 5 feet bgs to ensure there are no underground utilities at the borehole location.
- Drilling will commence and removed soil will be classified in accordance with the Unified Soil Classification System.
- Soil may be screened with a photoionization detector for the potential presence of VOCs if the conceptual site model warrants it.
- Field borehole logs will be used to determine proper borehole depth and soil gas probe screen placement.
- Soil cuttings or cores will be containerized for transport and disposal per Section 5.3.8. Other liquid and solid IDW will be managed according to Section 5.3.8.
- The borehole will be advanced by continuous flight augers with hollow stems or drill core barrel that are driven by top head rotary machines. The soil cuttings are removed from the borehole via helical flights or core barrels and placed in a bin adjacent to the borehole. The borehole will be logged from soil cuttings as they come off the augers or cores extruded from the core barrel. The augers or core barrel will keep the borehole open during drilling and allow for installation of the soil gas probes through the stem or barrel while removing the augers or drive casing once total depth is reached.
- Drilling methods that may be used include:
    - Hollow-Stem Auger: The borehole is advanced by continuous flight augers with hollow stems that are driven by top head rotary machines. The soil cuttings are removed from the borehole via helical flights and placed in a bin adjacent to the borehole. The borehole will be logged from soil cuttings as they come off the augers. The augers keep the borehole open during drilling and allow for installation of the well casing through the stem while removing the augers once total depth is reached.
    - Rotosonic: This drilling method typically produces approximately 80 percent less IDW than traditional drilling methods and provides undisturbed continuous soil core. The drill head of the sonic rig generates a high-frequency resonant energy, which is combined with rotational and vibrational movement of the drill core barrel that the operator can control to match the

force needed to optimally penetrate the soil formation. The core barrel is advanced first and the over casing is advanced around the core barrel to protect the integrity of the open borehole when the core barrel and sample are removed. After the core sample is removed, the core barrel is advanced deeper into the borehole and the process is repeated until the desired depth is achieved. Core samples will be staged adjacent to the borehole for logging and then placed in a bin for transport and disposal.

Soil Gas Probe Construction Materials: Soil gas probe cluster construction materials will be in accordance with FSOP-607 (Appendix A). Construction materials will be new, clean, and in good condition.

Assembly of Soil Gas Probes: Seven nested permanent soil gas probes will be constructed in each of the proposed soil borings at approximately 10-foot intervals below ground surface. Probe depths may change based upon soil conditions and actual depth to groundwater. Soil gas probe cluster construction details will be recorded in the field using the forms in Appendix B.

Surface Completion:

- Surface completion of each soil gas probe cluster will consist of either a flush vault or stovepipe.
- The 8-inch diameter traffic-rated flush-mounted steel vault will be a minimum of 12 inches deep set in the concrete surface seal and be equipped with a bolt-down watertight cover. The top of the vault will be raised slightly above existing grade, and the surface of the cement seal will slope away from the vault to the existing grade to promote surface drainage away from the well. The vault will be installed such that there are no more than 6 inches and no less than 5 inches between the top of the soil gas probes and the top of the vault cover. The cover of the vault will have the wording “monitoring well” on its outer surface.
- A stovepipe, or stickup, completion would include the soil gas probes extending approximately 3 feet above the ground. The PVC well casing will be surrounded by a steel casing with lockable lid and filled to just below the well casing with sand pack material. If the well is in a vehicle traffic area, the steel casing will be flanked on at least three sides with traffic-rated bollards. The bollards and stovepipe will be set in a concrete pad as described above. The bollards and stovepipe will be painted yellow to alert vehicles of their presence.

5.3.6.3 Post-Field Activities

Surveying: Following soil gas probe installation, the location will be surveyed by a professional California-licensed land surveyor for northing and easting coordinates in compliance with established protocol. Surveying will be conducted using North American 1983 Datum, California State Plane Zone 4 horizontal and North American Vertical Datum of 1988. The top of the soil gas probe cluster will be surveyed within 0.1-foot horizontal and 0.01-foot vertical accuracy.

Soil Gas Monitoring: Baseline sampling will be conducted during the next scheduled quarterly sampling event associated with the SGMP. Accordingly, QC samples will be collected and samples will be analyzed by EPA Method TO-15 for volatile organic analysis following sampling and laboratory analytical protocols identified in this QAPP. Subsequent sampling for long-term monitoring will be conducted as part of the Sites 2/12 quarterly SGMP and subject to QAPP decision rules to determine sampling frequency.

Deliverables and Reporting: Field daily reports will be presented weekly in CQCRs during field activities. EDDs will be provided by the laboratory performing analyses in accordance with this QAPP. Preliminary

and validated sample analytical results will be presented at project meetings and in the appropriate quarterly and annual reports. A Completion Report will be prepared following completion of field activities. The Completion Report will document work associated with the construction or decommissioning of soil gas probes and will present geologic logs, well completion diagrams, well development records, and sample analytical results as applicable.

5.3.7 Equipment Decontamination

Equipment decontamination will be conducted in accordance with FSOP-801.01 (Appendix A). Equipment brought onsite will be decontaminated in accordance with the SOP and requirements set forth in the Habitat Checklist. Drilling, sampling, and support equipment brought to the site will be in operable condition and free of leaks in the hydraulic, lubrication, fuel, and other fluid systems. Drilling and sampling equipment and tools will be cleaned and decontaminated prior to rig mobilization to the well location and will be maintained in a clean condition throughout drilling and sampling activities.

Downhole drilling and development equipment will be: (1) cleaned of caked drill cuttings, soil, or other material using a brush; (2) steam-cleaned using a hot water high-pressure washer; and (3) rinsed with potable water prior to its use downhole. Decontaminated equipment will be kept off the ground by storing on clean metal racks (not wooden pallets) and/or wrapped in plastic.

Decontamination facilities will consist of portable secondary containment for personnel and an equipment decontamination pad. Decontamination water will be collected in portable tanks for disposal (see Section 5.3.8). It is anticipated most of the decontamination facilities will be located in the vicinity of the Ahtna field offices adjacent to the OU2 GWTP.

5.3.8 Investigation-Derived Waste Management

IDW generated during this well installation activity will be managed per the applicable provision in FSOP-802.00 (Appendix A).

Liquid IDW will be contained in labeled drums or tanks and will be treated at the Sites 2/12 or OU2 GWTP. The OU2 and Sites 2/12 groundwater remedies consist of groundwater pump and treatment systems designed to remediate water containing COCs by pumping it through liquid-phase GAC.

Soil IDW will be contained in drums or bins onsite. One representative composite sample of borehole cuttings (soil IDW) will be collected from drilling locations and analyzed for applicable site COCs by USEPA Method 8260D, as listed in Worksheet #15a and Worksheet #15i. Soil IDW will be disposed of at the OU2 Landfills, consistent with the RI Sites ROD (Army, 1997a) in conjunction with OU2 ESD No. 3 (Army, 1997b) and OU2 ESD No. 4 (Army, 2006), which designates CAMU regulations as ARARs for the OU2 Landfills (Title 22 California Code of Regulations, Section 66264.552). Accumulated sediment from well development activities will also be disposed of at the Fort Ord Landfills.

Solid non-hazardous waste, such as disposable personal protective equipment, non-reusable sampling equipment, and other miscellaneous waste, will be disposed of in a waste receptacle located at the OU2 GWTP at 11000 Engineering Equipment Road, Marina, California.

5.3.9 Environmental Protection Plan

Environmental protection is defined as maintaining the environment in its natural state, to the extent possible, during and after fieldwork activities and returning the disturbed site to conditions similar to

those present prior to these activities. Environmental protection will consist of protecting air, water, land, and biological resources.

5.3.9.1 Air Resources Protection

Fieldwork activities will be conducted to minimize the release of airborne particulates within and outside of the boundaries of the site. Dust and particulates will be controlled in accordance with the APP (Ahtna, 2024) to minimize contaminate dispersion and to protect human health and the environment. The use of water to control dust will be minimized to avoid impact to natural resources. Visual air monitoring will be conducted to verify the effectiveness of the program.

5.3.9.2 Land Resources Protection

Fieldwork within the FONR will be coordinated with the USACE Technical Lead, Onsite Biologist, Fort Ord BRAC Office Biologist, and the University of California, which manages the area, to minimize impact to natural resources and ongoing research projects. Fieldwork within the Fort Ord Dunes State Park will be coordinated with the USACE Technical Lead, Onsite Biologist, Fort Ord BRAC Office Biologist, and the California Department of Parks and Recreation, which manages the area, to minimize impact to natural resources. Coordination will include:

- Scheduling fieldwork to start after June 1, or after the beginning of the dry season (i.e., outside the primary growing season for rare plants) as determined by the Onsite Biologist and approved by the University of California for the FONR, California Department of Parks and Recreation for Fort Ord Dunes State Park, and the BRAC Office Biologist, to avoid the flowering periods of special-status species.
- Scheduling fieldwork at Fort Ord Dunes State Park to start after early September or be completed before mid-June as determined by the Onsite Biologist and approved by the California Department of Parks and Recreation, and the BRAC Office Biologist, to avoid the flight season of Smith's blue butterfly.
- Maintaining site security.
- Defining acceptable and unacceptable work areas, access routes, and turnaround and staging locations in the Habitat Checklist.
- Ensuring implementation of the conservation measures identified in the HMP (USACE, 1997) and Programmatic Biological Opinion (USFWS, 2017).

Prior to intrusive activities within the FONR and Fort Ord Dunes State Park, the Onsite Biologist will review existing habitat surveys to determine the quantity and specific location of threatened or endangered plants and animals within the planned work areas. This habitat survey data and information provided by the University of California and the California Department of Parks and Recreation will be used to minimize impact to the habitat and special-status species within FONR and Fort Ord Dunes State Park. Where practicable, adjustments will be made to construction plans (e.g., adjustments to monitoring well locations) and coordinated with the University of California and California Department of Parks and Recreation to minimize the impact on natural resources.

The field activities may include installation of new wells, conduit, pipeline, and soil borings. The locations where construction activities will occur will be identified in the Habitat Checklist prior to commencing fieldwork. Field personnel will receive training to familiarize them with the site restrictions necessary to minimize impacts to the habitat and special-status species on FONR and Fort Ord Dunes

State Park lands. During each of these activities, staging areas and specific access routes will be established to minimize excess impact to the ground surface, such as rutting and erosion. Mats will be used where necessary to protect vegetation and prevent damage to the ground surface, including activities such as the operation of vehicles off of existing roads and creation of new access routes.

The Onsite Biologist will monitor work as necessary to ensure conservation measures are implemented. Baseline and 3-year follow-up monitoring will be conducted to determine if special-status species have been adversely impacted and if corrective measures are recommended. Because the corrective actions may take place in the FONR or the Fort Ord Dunes State Park, the Onsite Biologist will coordinate with the University of California, the California Department of Parks and Recreation, the USACE Technical Lead, and the BRAC Office Biologist prior to implementation.

Following field activities, disturbed land in the work areas will be restored as closely as possible to its original condition by limited grading after coordination with the USACE Technical Lead and the BRAC Office Biologist.

5.3.9.3 Water Resources Protection

The potential for impact to surface water resources is assumed to be minimal because there is no surface water drainage or storm drains that lead to surface water within the project sites. Equipment maintenance and fueling will be conducted offsite and away from open storm drain inlets.

5.3.9.4 Material Handling

Both hazardous and non-hazardous wastes may be generated during fieldwork activities. These wastes will be managed as described in Section 5.3.8. Chemicals brought onsite will be managed per the Hazard Communication Program in the APP (Ahtna, 2024).

5.3.9.5 HMP Species

Project activities undertaken must protect and maintain the special-status species found within FONR. Efforts are taken to avoid or minimize impacts to HMP species, with emphasis on three federally listed plant species: Monterey spineflower, Monterey gilia, and Yadon's piperia. Special-status species listed in the HMP and Programmatic Biological Opinion (USFWS, 2017) that occur or may occur within the FONR or Fort Ord Dunes State Park include:

- Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*) – federally endangered, state threatened
- Monterey spineflower (*Chorizanthe pungens* var. *pungens*) – federally threatened
- Seaside bird's beak (*Cordylanthus rigidus* ssp. *littoralis*) – state endangered
- Sandmat manzanita (*Arctostaphylos pumila*)
- Monterey manzanita (*Arctostaphylos montereyensis*)
- Monterey ceanothus (*Ceanothus rigidus*)
- Eastwood's goldenbush (*Ericameria fasciculata*)
- Yadon's piperia (*Piperia yadonii*) – federally endangered
- Coast wallflower (*Erysimum ammophilum*)
- California black legless lizard (*Anniella pulchra nigra*; BLL) – state species of concern
- California tiger salamander (*Ambystoma californiense*; CTS) – federally threatened, state threatened

- Monterey ornate shrew (*Sorex ornatus salarius*) – state species of concern
- Smith's blue butterfly *(Euphilotes enoptes smithi)* – federally endangered
- Coast buckwheat (*Eriogonum latifolium*)
- Seacliff buckwheat (*Euriogonum parvifolium*)

Monterey gilia, Monterey spineflower, Seaside bird's beak, and coast wallflower are annual herb species that may occur within maritime chaparral, coastal scrub, grasslands, dune scrub, or disturbed areas. Sandmat manzanita, Monterey manzanita, Monterey ceanothus, and Eastwood's goldenbush are perennial shrub species that typically occur in maritime chaparral, but individuals can also be found mixed with oak woodland or coastal scrub habitats. Yadon's piperia is a perennial herb that is typically found in maritime chaparral and Monterey pine habitats.

The BLL is a rare variety of the California legless lizard (*Anniella pulchra*) that inhabits areas with sandy soils on the former Fort Ord. The Monterey ornate shrew is a rare variety of the ornate shrew (*Sorex ornatus)* found in riparian forest and oak woodland habitats. The CTS is typically found in vernal or seasonal ponds on the former Fort Ord. The CTS may also be found aestivating in small mammal burrows or under logs in upland areas within 2.2 kilometers of vernal ponds. The Smith's blue butterfly co-occurs during all life stages with Coast and Seacliff buckwheat plants that grow in coastal dune, cliff side chaparral, coastal scrub, and coastal grassland communities.

As identified in the Programmatic Biological Opinion (USFWS, 2017), success criteria for contaminated groundwater remediation are as follows:

After the final monitoring period for each of the federally listed species or designated Monterey spineflower critical habitat, species reestablishment will be considered successful when:

1. *densities and acreage of HMP annual species are within a normal range compared with information from reference sites, and;*
2. *the number of wells where HMP annual species are detected in follow-up surveys will be the same or greater than the number of wells where these species were found in baseline surveys.*

If the success criteria are not met, based on the evaluation of the monitoring data, corrective measures will be developed in coordination with the U.S. Fish and Wildlife Service, as specified in the Programmatic Biological Opinion (USFWS, 2017).

5.3.9.6 HMP Species Protection

The Onsite Biologist will identify areas containing populations of Monterey gilia, Monterey spineflower, Seaside bird's beak, Yadon's Piperia, Coast buckwheat, and Seacliff buckwheat during baseline surveys. Access routes will be delineated with rope or flagging tape to ensure personnel and equipment stay within designated work areas and prohibit access to protected areas. The Onsite Biologist will ensure conservation measures are implemented during well installation activities in the FONR and Fort Ord Dunes State Park and will be available to resolve unanticipated resource issues as they arise.

Ahtna will communicate to personnel working at the site the resources of concern and habitat protection requirements prior to the start of field activities. Staging areas, access routes, and turnaround areas will be clearly delineated and shown to field personnel. Field personnel will be instructed to lock any access gate behind them after each entry to and exit from the FONR and Fort Ord

Dunes State Park. If a BLL or CTS is discovered during the proposed activities, the Onsite Biologist will be immediately notified. The Onsite Biologist will coordinate with the BRAC Office Biologist to confirm appropriate conservation steps, including relocation, if necessary.

The Onsite Biologist will fill out the field observation form with the necessary information and then relocate the individual, if necessary, to suitable nearby habitat. If the Onsite and/or BRAC Office Biologist are not available onsite during observation of CTS or BLL, onsite personnel may carefully relocate BLL away from fieldwork if harm is imminent and fill out the biological observation form. Work must stop if CTS is observed until an approved Biologist has removed the CTS from the project site.

When driving vehicles and heavy equipment through the inner roads of the FONR area, personnel must walk in front of vehicles to ensure there are no coast horned lizards (*Phyrnosoma blainvilli*) in the road before the vehicle passes.[41] If coast horned lizards are observed, they must be relocated away from the vehicle's path. Observations of coast horned lizards may be reported to the University of California and the BRAC Office Biologist for tracking purposes.

Some limited vegetation clearance may be necessary to access work areas. If necessary, vegetation clearance will be coordinated with the University of California for the FONR, the California Department of Parks and Recreation for Fort Ord Dunes State Park, the BRAC Office Biologist, and USACE Technical Lead, and conducted following standard best management practices to protect the existing oak trees and special-status species. Tree branches may be trimmed as necessary to provide access, but no trees will be removed. Vegetation removed from work areas will be consolidated with other construction debris and taken to an appropriate disposal facility.

[41] Coast horned lizard is not an HMP species but is a state species of special concern.

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

5.4.1 Worksheet #22a: GWMP

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Trimble Catalyst DA2	Depending upon desired accuracy (sub-centimeter, 20 cm, etc.).	NA; unless there are unexpected readings	Proper links to applications on handheld devices	Before use for physical damage	Before/after use	Effective link to iPhone/iPad via Bluetooth, effective satellites link	Send to factory for repair	Field Supervisor	FSOP-T1
Electric Water Level Sounder	Calibrated against steel tape	Maintain in proper working order, store in a secure location, decon after each use	Check battery and sensitivity daily prior to use	Inspect tape for damage prior to use	Quarterly prior to use	Calibrates with steel tape to within 0.05 ft/100 feet depth to water	Send into factory for repair	Field Supervisor	FSOP-USGS1 and FSOP-A2
YSI ProDSS multi meter	Simultaneous Auto Calibration of DO, pH, conductivity, and turbidity with standard pH 4 solution	Maintain in proper working order, store in a secure location, decon after each use	Check battery prior to use	Inspect tape for damage prior to use	Quarterly prior to use	pH: 4.0 Conductivity: 4.49 DO: 8.92 mg/L Turbidity: 0 NTU	Send into factory for repair	Field Supervisor	FSOP-Y1

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
YSI ProDSS multi-meter with downhole cable	Calibrated with solutions	Decon after each use, store according to manufacturer directions	Check battery prior to use	Inspect for damage prior to use	Quarterly prior to use	According to manufacturer instructions	Check manual or send to factory for repair	Field Supervisor	FSOP-Y1
Digital Thermometer	Factory calibrated, ice-point method per HACCP-based SOP	Store in a secure location, avoid excessive heat	Check battery prior to use	Inspect for damage prior to use	Quarterly	Factory calibration, temperature reading = $0^{o}C \pm 1^{o}C$	Replace with new unit	Field Supervisor	FSOP-USGS1 and FSOP-A2

5.4.2 Worksheet #22b: OU2 Landfills TTU Source Testing

Field instrument specifications for source testing are as follows:[1]

NO_X/NO Chemiluminescent Analyzer – Ecophysics Model 70E	
Zero drift	Negligible after 30-minute warm-up
Linearity	±1% of full scale
Accuracy	±1% of full scale
Output	0-10 V
Range	0-50, 100 ppmv
O_2 Analyzer, Fuel Type – Teledyne Model 326A	
Accuracy	±1% of scale at constant temperature or ±1% of scale at ±5% of reading, whichever is greater, over the operating temperature range
Output	0-1 V
Range	0-10, 25%
CO Infrared Analyzer – Horiba Model VIA 510	
Zero drift	±1%
Span drift	±1%
Linearity	±1%
Output	0-1 V
Range	0-100 ppmv
THC Flame Ionization Detector Analyzer – TECO Model 51	
Zero drift	±1%
Span drift	±1%
Linearity	±1%
Output	0-10 V
Range	0-50 ppmv

Notes:

[1] See FSOP-A5, Source Test Protocol for mobile laboratory equipment calibration, maintenance, testing, and inspection procedures.

5.4.3 Worksheet #22c: Sites 2/12 Soil Gas Monitoring and SVETS Operation

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person
SUMMA Canister (1 L)	Pre-certified by lab; verify vacuum gauge before use	Keep valve clean, protect from impact	Verify start/end vacuum (≥5 inHg at end)	Check canister ID, label, and chain-of-custody	Each sampling event	Initial vacuum ~28–30 inHg; end vacuum ≥5 inHg	Replace canister if vacuum lost or damaged	Field technician / Lab
Soil Gas Probe	NA (probe itself not calibrated)	Clean tubing, replace if kinked/contaminated	Helium leak test via shroud	Inspect seals, bentonite hydration, tubing integrity	Each installation	Helium ≤0.1% of shroud concentration in probe exhaust	Reseat probe, reseal annulus, re-test	Field technician
Helium Shroud Assembly	NA (helium concentration verified, not calibrated)	Check fittings, replace O-rings, leak check	Fill with helium (10–20%); monitor stability	Inspect shroud for cracks, secure seal to ground	Each sampling event	Stable helium concentration; no leaks detected	Repair/replace shroud, repeat test	Field technician
Flow Regulator (SUMMA)	Calibrate with low-flow mass flow meter (e.g., Alicat)	Store clean/dry; protect gauges	Verify flow rate matches target (e.g., 200 mL/min)	Inspect gauges, fittings, and threads	Before each sampling	Flow rate within ±10% of target	Adjust regulator or replace if out of spec	Field technician / Lab
Helium Detector	Calibrate with standard helium gas	Replace batteries, sensor maintenance	Measure helium concentration in probe exhaust	Inspect sensor response and tubing connections	Daily during use	Detector response stable, within manufacturer specs	Recalibrate or replace sensor	Field technician / Equipment custodian

5.4.4 Worksheet #22d: OU2 LFG Monitoring

Field Equipment[1]	Activity	SOP/ Method Reference	Responsible Person	Frequency	Acceptance Criteria	Corrective Action
Gas Analyzer	Calibration	Operations Manual	Field Team Lead (FTL)	Daily during use	Manufacturer's Specifications	Adjust instrument
Infrared O_2 Analyzer	Calibration	FSOP-A5[1]/EPA Method 3A		Daily during use prior to and after completion of analytical batch	2% of span	
	Bias Check				5% of span	
	Response time check				< 2 minutes	
Flame ionization detector	Calibration	FSOP-A5/EPA Method 25A		Daily, prior to and after completion of analytical batch	5% of span	
	Drift Test				3% of span	
Nondispersive infrared sensor CO analyzer	Calibration	FSOP-A5/EPA Method 10		Daily, prior to and after completion of analytical batch	2% of span	
	Calibration error check				3% of span	
	Bias Check				5% of span	
	Response time check				< 2 minutes	
Chemiluminescent Analyzer	Calibration	FSOP-A5/EPA Method 7E			2% of span	
	Bias Check				5% of span	
	Response time check				< 2 minutes	

Notes:
[1] FSOP-A5 is for mobile laboratory analysis used during the source test.

5.4.5 Worksheet #22e: Soil Gas

Field equipment will be calibrated, maintained, tested, and inspected per the SOPs in Appendix A or manufacturer instructions. The following field equipment may be used during soil gas sampling and SVETS sampling:

Site Setup

- Personal protective equipment including high visibility vest, sun/wind protection (if necessary),
- steel-toe boots, and nitrile gloves
- Tools to open soil gas probe vault if it is flush mount (¾-inch or $^{15}/_{16}$-inch wrench)
- Traffic cones for delineation of exclusion zone

Soil Gas Probe Purging

- Vacuum pump
- Vacuum gauge
- Tubing (silicone and nylon)

Soil Gas Probe Integrity Test (Helium Test)

- Helium compressed gas cylinder (can be provided by laboratory)
- Helium cylinder regulator and tubing with connection to shroud (can be provided by laboratory)
- In-line helium detector (can be provided by laboratory)
- Shroud helium detector (can be provided by laboratory)
- Shroud assembly (provided by laboratory)
- Plastic sheeting to cover shroud
- Weights to hold shroud down

Sampling

- Sample containers: 1-liter SUMMA® canisters (provided by laboratory)
- Flow regulator: 100–200 milliliters per minute (part of shroud sampling manifold assembly)
- Sample manifold (T-manifold for duplicate samples) (provided by laboratory)
- Vacuum gauge
- Tools (9⁄16-inch wrench to remove canister caps and attach gauges, tubing, and/or flow regulators, tubing cutter)
- Tubing
    - ¼-inch Low Density Polyethylene, approximately 1 foot per probe
    - ⅜-inch silicone, approximately 3 inches per probe
- Small zip ties
- Ferrules and ¼-inch compression caps (extras in case laboratory-provided ones do not work)

6.0 Analytical Requirements

6.1 Worksheet #23: Analytical SOPs

Laboratory SOP Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
6	Analysis of Volatile Organic Compounds in SUMMA™ Polished Canisters by Modified EPA Methods TO-14A/TO-15[2], 05/24/24, Revision 52	Definitive	VOCs	Mass Spectro-meter	Eurofins	No
50	Sample Receiving/Login Procedures, 4/30/26, Revision 34	NA	NA	NA	Eurofins	No
54	Analysis of Natural Gases by Modified ASTM D1945, 07/23/25, Revision 31	Definitive	Fixed Gases	Gas Chromato-graph	Eurofins	No
63	Sample Tracking, Transmittal and Custody Procedures, 07/23/25, Revision 27	NA	NA	NA	Eurofins	No
91	EPA Method TO-14A/TO-15 Volatile Organic Compounds (5&20 ppbv)[2]	Definitive	Soi Gas VOCs	GC/MS	Eurofins	No
83	EPA Method TO-14A/TO-15 Volatile Organic Compounds (Low-Level), March 5, 2026, Revision 32[2]	Definitive	SVTU Influent/ Effluent VOCs	GC/MS	Eurofins	No
SCAQMD 307.91	Standard Operating Procedure, Determination of Sulfur Compounds in a Gaseous Matrix by Gas Chromatography and Chemiluminescence, 10/09/25, Revision 7[2]	Definitive	Sulfur Gases	Sulfur Chemi-luminescence Detector	Atmospheric Analysis and Consulting	No
LAB.107	Sample Receiving, Shipping and Disposal, 3/18/2024, Revision 12	NA	NA	NA	Atmospheric Analysis and Consulting	No

Laboratory SOP Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
LAB.103	Sample Login Using Labtrack, 3/18/2024, Revision 3	NA	NA	NA	Atmospheric Analysis and Consulting	No
MS010.14	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260-SIM), 10/17/2025	Definitive	Water	GC/MS	SGS	No
MET108.11	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D), 4/22/2026	Definitive	Water	GC/MS	SGS	No
GN237-06	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A), 9/6/2025	Definitive	Water	ICP-OES/MS	SGS	No
SAM101.23	Sample Receipt and Storage, 9/1/2024	N/A	N/A	None	SGS	No
SAM108.14	Sample and Laboratory Waste Disposal, 11/18/2025	N/A	N/A	None	SGS	No

Notes:

[1] Laboratory SOPs are named directly from each individual contracted laboratory

[2] SOP is available upon request

6.2 Worksheet #24: Analytical Instrument Calibration – Groundwater

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
Gas Chromatography/Mass Spectrometry (GC/MS)						
GC/MS- VOCs by EPA Method 8260-SIM	Check of instrument tuning using 4-bromofluorobenzene (BFB)	Prior to ICAL and every 12 hours	Refer to method for specific ion criteria	Re-tune instrument, Re-analyze affected samples.	GC/MS Analyst	MS010.12
	Multipoint calibration (minimum of five points), lowest point at or below LOQ	Initially and as required	Minimum RF per method. Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15% Option 2: linear least squares regression r^2 ≥ 0.99. Option 3: non-linear regression – COD r^2 > 0.99 (six points shall be used for second order, seven for third order)	Correct problem, then repeat ICAL.	GC/MS Analyst	MS010.12
	Second Source – ICV Standard	Once after each ICAL	Analytes within ±20% of true value	Correct problem and verify second source standard. Re-run second source verification. If that fails, correct the problem and repeat ICAL.	GC/MS Analyst	MS010.12
	Instrument blanks and method blanks	After initial calibration and daily, prior to	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the	Re-analyze blank, Clean system, Re-analyze affected samples	GC/MS Analyst	MS010.12

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
		sample analysis (instrument blank) and with each batch of samples (method blank)	regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ			
	Continuing calibration verification (CCV) standard	Daily before sample analysis and every 12 hours of analysis time, and at the end of the analytical run	RF criteria per method. All reported analytes and surrogates within ±20% of true value All reported analytes and surrogates within ±50% for end of analytical batch CCV	Correct problem, then re-run the CCV. If that fails, repeat ICAL. Re-analyze samples run since last successful CCV.	GC/MS Analyst	MS010.12
Gas Chromatograph/Mass Spectrometer (GC/MS)						
GC/MS – VOCs by EPA Method TO-15	Tuning Criteria	Prior to ICAL and prior to each 24-hour period of sample analysis	Specific ion abundance criteria of BFB from method.	Retune instrument and verify.	Laboratory Analyst/Section Manager	6
	Minimum 5-Point ICAL	Prior to sample analysis	Calculated RSD for the relative response factor of each target analyte in the	Correct the problem, then repeat ICAL.	Laboratory Analyst/Section Manager	6

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
			calibration must be less than 30%			
	ICV	After each initial calibration curve, and daily prior to sample analysis	All reported analytes within ±30% of true value	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Laboratory Analyst/Section Manager	6
	CCV	Daily before sample analysis; after every 24 hours of analysis time; and at the end of the analytical batch run	Concentration the same as the mid-point calibration standard (or lower). All reported analytes within ±30% of true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since the last successful CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.	Laboratory Analyst/Section Manager	6
Inductively Coupled Plasma (ICP)						
Thermo 6500 (ICP) Metals by EPA Method 6010D	ICAL: Single or multipoint calibration. Minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis	If more than one calibration standard is used, $r^2 \geq 0.995$	Correct problem, then repeat ICAL.	ICP Analyst	MET108.11

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
	Second Source (ICV) Standard	Once after each ICAL, prior to sample analysis	Value of second standard source for target analytes within ±10% of true value	Correct the problem and verify second source standard. Re-run ICV. If that fails, correct problem and repeat ICAL.	ICP Analyst	MET108.11
	CCV	After analysis of every 10 samples and at the end of the analytical sequence	Within ±10% of true value	Where an assignable cause isolated to only the CCV is identified, one CCV may be reanalyzed immediately (i.e., within one hour and no samples analyzed). If the immediate CCV is acceptable, proceed with analysis. Sample reanalysis is not required. Otherwise, correct problem and analyze passing CCV or recalibrate. All affected samples since last passing CCV shall be reanalyzed. If the samples cannot be reanalyzed, apply qualifier to affected analyte results and explain in the case narrative.	ICP Analyst	MET108.11
	Low-level calibration check standard (LOQ low point standard from calibration)	Daily, following one point ICAL	Within ±20% of true value	Investigate and perform necessary equipment maintenance; recalibrate and reanalyze all affected samples.	ICP Analyst	MET108.11
	ICS (interference check sample)	After ICAL and prior to	ICS-A: Absolute value of concentration for all non-spiked project	Terminate analysis. Locate and correct problem. Re-analyze ICS and samples.	ICP Analyst	MET108.11

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
		sample analysis	analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes) ICS-AB: Within ± 20% of true value. ICS-AB is not required if the instrument is able to read negative responses.			
	Calibration blanks	Immediately after the ICV and Immediately after every CCV	The absolute values of all analytes must be < ½ LOQ or < ⅒ the amount measured in any sample	Where an assignable cause is isolated to only the CCB is identified, one CCB may be reanalyzed immediately (i.e., within one hour and no samples analyzed). If the immediate CCB is acceptable, proceed with analysis. Sample reanalysis is not required. Otherwise, correct problem and analyze passing CCB or recalibrate. All affected samples since last passing CCB shall be reanalyzed. If the samples cannot be reanalyzed, apply qualifier to affected analyte results and explain in the case narrative.	ICP Analyst	MET108.11

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
Ion Chromatography (IC)						
Metrohm 930 (IC) - Chloride by EPA Method 9056A	Initial Calibration (minimum three standards and one calibration blank)	ICAL prior to sample analysis	$r^2 > 0.995$	Correct problem, then repeat ICAL.	IC Analyst	GN237-06
	ICV	After each ICAL and prior to sample analysis	Analytes within ±10% of true values and retention times within appropriate windows	Correct problem and verify second source standard. Re-run ICV. If that fails, correct the problem and repeat ICAL.	IC Analyst	GN237-06
	Retention time window position establishment	Once per multipoint calibration	Retention time width is set using the midpoint standard of the ICAL for each analyte when ICAL is performed. On days when ICAL is not performed, the initial CCV is used	If the retention time shifts by more than 10%, a new ICAL is performed.	IC Analyst	GN237-06
	CCV	After ICAL, after every ten samples, and at end of run	Analytes within established retention time windows and within ±10% of true value	Correct problem, then re-run the CCV. If that fails, repeat ICAL. Re-analyze samples run since last successful CCV.	Wet Chemistry Analyst	GN237-06
Gas Chromatograph (GC)						
GC – Fixed Gases by ASTM D1945, Sulfurs	Initial Calibration (ICAL)	Prior to sample analysis and annually	< 15% Relative Standard Deviation (RSD)	Correct problem, then repeat Initial Calibration.	Laboratory Analyst/Section Manager	54

Instrument	Calibration Procedure	Calibration Frequency	Acceptance Criteria	Corrective Action	Responsible Person(s)	SOP Reference[1]
by SCAQMD Method 307-91	Initial Calibration Verification and Laboratory Control Sample (ICV and LCS)	After each initial calibration and once per analytical batch	85–115% Recovery (%R)	Check the system and reanalyze the standard. Re-prepare the standard if necessary. If the primary standard is found to be in error, re-prepare the primary and calibrate the instrument.	Laboratory Analyst/Section Manager	54
	Continuing Calibration Verification (CCV)	Daily prior to sample analysis and after every 20 reportable samples	Percent Difference (% D) < 15%	Check the system and reanalyze the standard. Recalibrate the instrument if the criteria cannot be met.	Laboratory Analyst/Section Manager	54
	ICAL	Prior to sample analysis	A minimum of 3 points, $r^2 \geq 0.99$, max range ≤ 5% for three consecutive trials, %R: 95-105% of theoretical value	Rerun curve; prepare new standards and rerun curve.	Laboratory Analyst/Section Manager	A.5504.07,
	CCV	After the curve; before analyzing any samples; and at the end of each sequence	Max range ≤ 5% for three consecutive trials, %R: 95-105% of theoretical value	Rerun check; prepare new standard and rerun; flag data.	Laboratory Analyst/Section Manager	A.5504.07,

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS VOC	Change Trap	Analyze ICV, CCV, or sensitivity check	Daily	When responses start to drop	ICV, CCV, or sensitivity check passes criteria	Re-bake trap, replace trap, re-analyze ICV, CCV, or sensitivity check, recalibrate	Analyst or Department Manager	MS010.12
	Backflush Purge and Trap Lines	Analyze ICV, CCV, or sensitivity check	Daily	ICV, CCV, or sensitivity check will not pass, high level sample analyzed	ICV, CCV, or sensitivity check passes criteria, Blank clean	Backflush lines again, replace lines, recalibrate	Analyst or Department Manager	MS010.12
	Change septa and liner, clean injection port, clip column	Analyze ICV, CCV, or sensitivity check	Daily	After high level sample analyzed	ICV, CCV, or sensitivity check passes criteria	Re-inspect injection port, cut additional column, re-analyze ICV, CCV, or sensitivity check, recalibrate instrument	Analyst or Department Manager	MS010.12
ICP Metals	Clean torch assembly and spray chamber when discolored or when observe data quality degradation. Clean nebulizer, check argon, replace peristaltic pump tubing as	Analyze ICAL, ICV, CCV	Torch, nebulizer chamber, pump, pump tubing	Prior to ICAL and as necessary	Acceptable ICAL and CCV	Correct the problem and repeat ICAL or CCV ; Maintenance activities are documented in Instrument Maintenance logbooks	Analyst or Department Manager	MET108.1 1

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
	needed. Other maintenance specified in lab equipment maintenance SOP.							
IC Chloride	Pump maintenance, guard column cleaning	Analyze ICAL, ICV, CCV	Clean or replace tubing, check connections	Frequency determined by instrument remaining in calibration and free of interference	Passing Calibration	Reconnect tubes, check pump rate. Rerun calibration and samples; Maintenance activities are documented in Instrument Maintenance logbooks	Analyst or Department Manager	GN237-07
GC/MS	Check for leaks, replace gas line filters, replace column, clean injection port/liner	VOC	Monitor instrument performance via tune and CCV	As needed	Calibration and QC criteria met	Replace connections, clean source, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port, replace electron multiplier.	Laboratory Analyst/ Section Manager	6
GC-FID	Clean injection port and replace liner, clip/replace column	Gases	Monitor instrument performance via Continuing Calibration	Daily	Calibration and QC criteria met	Change column instrument maintenance.	Laboratory Analyst/ Section Manager	54
Sulfur Chemiluminescence Detector	Inspect the system, clean sample introduction line	Sulfur Gases	Monitor instrument performance	Daily	Calibration and QC criteria met	Evaluate system.	Laboratory Analyst/ Section Manager	A.5504.07

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
			via Continuing Calibration					

6.4 Worksheet #26 & 27: Sample Handling, Custody, and Disposal

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample Labeling	Ahtna/ Blaine Tech Field Technicians	FSOP-A2
Chain of custody form completion	Ahtna/ Blaine Tech Field Technicians	FSOP-A2
Packaging	Ahtna/ Blaine Tech Field Technicians	FSOP-A2
Shipping coordination	Ahtna/ Blaine Tech Field Technicians	FSOP-A2
Sample receipt, inspection, & log-in	SGS Sample Management Supervisor	SAM101.23
	Eurofins Sample Management Supervisor	50
	Atmospheric Analysis and Consulting Sample Management Supervisor	LAB.103
Sample custody and storage	SGS Sample Management Supervisor	SAM101.23
	Eurofins Sample Management Supervisor	63
	Atmospheric Analysis and Consulting Sample Management Supervisor	LAB.107
Sample disposal	SGS Sample Management Supervisor	SAM108.12
Sample labeling	Ahtna/Field Technician	FSOP-GE1, FSOP-A3, FSOP-A5

6.5 Worksheet #28: Analytical Quality Control and Corrective Action

Below is a summary of the quality control and corrective action methods for each analytical method used for this project. Analytical QC requirements for this project are implemented in accordance with EPA-approved analytical methods, laboratory accreditation requirements, and the DoD QSM Version 6.0 (DoD, 2023). Quality control results are evaluated to assess potential impacts on data quality and project decision-making, rather than serving as automatic criteria for data rejection.

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
VOCs (TO-15)					
Method Blank	1 per extraction batch	Target analytes not detected > ½ LOQ	Reanalyze samples; qualify as needed.	Laboratory Analyst/Section Manager	Representativeness
LCS (Lab QC)	1 per batch	See Worksheet #12	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Accuracy/Bias
Laboratory Duplicate	1 per batch	Analyte-specific RPD acceptance criteria	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Precision
Surrogate	1 per blank, sample, and standard	Surrogate-specific %R acceptance criteria	Evaluate system and samples; reanalyze.	Laboratory Analyst/Section Manager	Accuracy/Bias
Internal Standard Performance	Every sample	Peak area ±40 % of the peak area in the corresponding CCV; retention time within ±20 seconds of the corresponding CCV	Reanalyze or qualify results as necessary.	Laboratory Analyst/Section Manager	Accuracy/Bias
RRT Position	Once per initial calibration and at the beginning of	RRT within ±0.06 RRT units for each analyte and surrogate	Correct problem; recalibrate instrument; reanalyze results as necessary.	Laboratory Analyst/Section Manager	Analyte Identification

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
	the analytical shift				
Mass Spectrometer Results	All positive results must be confirmed	Spectral match to reference spectrum	Analyst must evaluate results to confirm identification if spectral match does not meet criteria; Section Manager must review analyst's determination.	Laboratory Analyst/Section Manager	Analyte Identification
Sulfur Gases (SCAQMD 307-91)					
Method Blank	1 per extraction batch	Target analytes not detected > ½ LOQ	Reanalyze samples; qualify as needed.	Laboratory Analyst/Section Manager	Representativeness
LCS (Lab QC)	1 per batch	Laboratory-specific %R acceptance criteria	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Accuracy/Bias
Laboratory Duplicate	1 per batch	Analyte-specific RPD acceptance criteria	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Precision
Fixed Gases (ASTM D1945)					
Method Blank	1 per extraction batch1	Target analytes not detected ≥ LOQ and > ⅒ the amount measured in any sample or ⅒ the regulatory limit (whichever is greater)	Reanalyze samples; qualify as needed.	Laboratory Analyst/Section Manager	Representativeness
LCS (Lab QC)	1 per batch1	Laboratory-specific %R acceptance criteria	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Accuracy/Bias

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
Laboratory Duplicate	1 per batch1	Laboratory-specific RPD acceptance criteria	Evaluate system; reanalyze.	Laboratory Analyst/Section Manager	Precision
Relative Retention Time (RRT) Position	Confirmed at method setup and after major maintenance	RT windows established by calculating the standard deviation of the mean absolute retention time over a 72-hour period. 3 x standard deviation must be <0.08 min for analysis to proceed	Correct problem; recalibrate instrument; reanalyze results as necessary.	Laboratory Analyst/Section Manager	Analyte Identification
VOCs (8260-SIM)					
Method Blank	1 per analytical batch	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Re-analyze method blank. If it fails, clean the system and re-analyze blank and affected samples.	GC/MS Analyst	Accuracy/ Bias Contamination
Laboratory Control Sample (LCS)/LCSD	1 set per analytical batch. Spike target compounds. Vinyl chloride to be spiked at DL of 0.1 µg/L.	Analyte Recovery RPD 1,1-DCA: 77-125% ≤ 20% 1,1-DCE: 71-131% ≤ 20% 1,2-DCA: 73-128% ≤ 20% 1,2-DCE (total): 79-121% ≤ 20% 1,2-DCPA: 78-122% ≤ 20% 1,3-DCPE (total): 77-123% ≤ 20% Benzene: 79-120% ≤ 20% CT: 72-136% ≤ 20% Chloroform: 79-124% ≤ 20% cis-1,2-DCE: 78-123% ≤ 20% MC: 74-124%: ≤ 20% PCE: 74-129% ≤ 20%	Re-prep and re-analyze LCS/LCSD and associated batch samples	GC/MS Analyst	Bias/Accuracy/Precision

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
		TCE: 79-123% ≤ 20% Vinyl chloride: 58-137% ≤ 20%			
MS/MSD	1 per analytical batch spike target compounds.	Same as LS/LCSD acceptance limits for 8260-SIM.	If MS results are outside LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.	GC/MS Analyst	Bias/Precision
Surrogates	VC to be spiked at DL of 0.1 µg/L.	Same as LS/LCSD acceptance limits for 8260-SIM.	If the concentration in parent sample is > 4x the spiked amount, include in case narrative. No corrective action required.	GC/MS Analyst	Precision
Internal Standards	Field samples and laboratory QC	1,2-Dichloroethane-d4	Re-prep and re-analyze affected samples unless matrix interference is present.	GC/MS Analyst	Bias/Precision
Metals (6010D)					
Method Blank	1 per analytical batch	Absolute values of analytes detected < ½ LOQ or < 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.	ICP Analyst, Department Manager	Accuracy/Bias Contamination
LCS	1 per analytical batch. Spike	Analyte Recovery (per DoD QSM 6.0 limits) Antimony 88-113%	Evaluate and reanalyze if possible. If LCS recoveries are high but	ICP Analyst, Department Manager	Bias/Accuracy/Position

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
	target compounds	Copper 86-114% Lead 86-113%	the sample results are < LOQ, narrate. Otherwise, re-digest and reanalyze. QSM 6.0 allows reporting non-detects associated with high bias LCS without reanalysis and with data qualifier.		
Laboratory Duplicate Sample	1 per analytical batch	< 20% per	Narrate outliers in case narrative. No CA	ICP Analyst. Department Manager	Precision
MS/MSD	1 per analytical batch	Analyte Recovery RPD Antimony 88-113% ≤20% Copper 86-114% ≤20% Lead 86-113% ≤20%	Perform additional QC test (dilution test and/or post-digestion spike [PDS]) unless concentrations in parent sample are > 4x the spiked amount (no corrective action required). Perform PDS	ICP Analyst, Department Manager	Bias/Precision
Dilution Test	1 per prep batch	5-fold dilution must agree within ±10% of the original measurement	Perform post-digestion spike	ICP Analyst, Department Manager	Bias/Precision
Post-Digestion Spike (PDS)	Perform if MS/MSD fails, 1 per analytical batch	Recovery within 80-120%	Flag same matrix samples results as estimated in case narrative.	ICP Analyst, Department Manager	Bias/Precision
Wet Chemistry (Chloride via 9056A)					

QC Sample	Frequency	Acceptance Limits	Corrective Action (CA)	Person Responsible	Data Quality Indicator
Method Blank	1 per analytical batch	No analytes detected > ½ the LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.	Analyst, Department Manager	Accuracy/ Bias Contamination
LCS	1 per analytical batch (up to 20 samples)	Within DoD QSM 6-series Appendix C limits (87-111)	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. QSM 6.0 allows reporting non-detects associated with high bias LCS without reanalysis and with data qualifier.	Analyst, Department Manager	Bias/Accuracy/Position
MS/MSD	1 set per analytical batch.	%R within LCS limits RPD ±15%	Determine and correct the problem, reanalyze samples and MS/MSD, or document why data are acceptable	Analyst, Department Manager	Bias/Precision

Notes:

See Worksheet #15 for LOQs and project action limits
<: less than
≤: less than or equal to
>: greater than
≥: greater than or equal to
%: percent
°C: degrees Celsius
CCAL: continuing calibration
1,1-DCA: 1,1-dichloroethane
1,1-DCE: 1,1-dichloroethene
1,2-DCA: 1,2-dichloroethane
1,2-DCE (total): total 1,2-dichloroethene
1,2-DCPA: 1,2-dichloropropane
1,3-DCPE (total): 1,3-dichloropropene
cis-1,2-DCE: cis-1,2-dichloroethene
CT: carbon tetrachloride
ICAL: initial calibration
LCS: laboratory control sample
LCSD: laboratory control sample duplicate
LOQ: limit of quantitation
MC: methylene chloride
MS: matrix spike

MSD: matrix spike duplicate
PCE: tetrachloroethene
QC: quality control
RPD: relative percent difference
SIM: selected ion monitoring
TCE: trichloroethene
trans-1,2-DCE: trans-1,2-dichloroethene
VOC: volatile organic compound
VC: vinyl chloride

When analytical quality control acceptance criteria are not met, the results are evaluated to determine the cause of the nonconformance and the potential impact on data quality. In accordance with the DoD QSM Version 6.0 (DoD, 2023), data usability is determined relative to project-specific data quality objectives and decision needs rather than strict pass/fail application of individual QC criteria. Corrective actions may include reanalysis where feasible, qualification of results, documentation of data limitations, or no further action if the data are determined to be usable for their intended purpose.

7.0 Data Management and Data Review

7.1 Worksheet #29: Project Documentation and Records

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location/archive**
Field notes/logbook	Field Team Lead	Project Manager	Project File[1]
Chain of custody forms	Field Team Lead	Project Manager	Project File
Laboratory raw data package	Analytical Lab	Project Chemist	Project File
PDF copy of analytical data	Analytical Lab	Project Chemist	Fort Ord Administrative Record
Audit/assessment checklists/reports	Field Team Lead/Project Chemist	Project Manager	Project File
Corrective action reports	Field Team Lead/Project Chemist	Project Manager	Project File
Laboratory sample custody log	Analytical Lab	Project Chemist	Project File
Laboratory equipment calibration logs	Analytical Lab	Project Chemist	Project File
Sample preparation logs	Analytical Lab	Project Chemist	Project File
Run logs	Analytical Lab	Project Chemist	Project File
Sample disposal records	Analytical Lab	Project Chemist	Project File
Electronic Validated data/Manual Validated data/Data Validation Reports	Fort Ord Data Integration System (FODIS) chemistry database	Project Chemist	Fort Ord Data Integration System (FODIS) chemistry database
Annual Report	Fort Ord Administrative Record	USACE Project Manager	Project File
Fort Ord Data Integration System (FODIS) chemistry database	Fort Ord Data Integration System (FODIS) chemistry database	Fort Ord Data Integration System (FODIS) chemistry database	Fort Ord Data Integration System (FODIS) chemistry database
Quarterly/Annual Reports	Project Manager	USACE Project Manager	Fort Ord Administrative Record

Notes:

[1] The Project File is maintained on a secure server accessible at the Ahtna Monterey Project Office.

7.2 Worksheet #31, 32 & 33: Assessments and Corrective Action

Planned project assessments will be completed for the work conducted using the Three Phase Quality Control Process, which consists of the following:

- Preparatory Phase: Activities and assessments during the preparatory phase are conducted prior to the start of a definable feature of work and are performed to ensure technical requirements and work prerequisites are completed prior to the start of the feature of work. Discrepancies will be resolved and corrective actions implemented and verified prior to the start of work.
- Initial Phase: Activities and assessments during the initial phase are performed during the first day of the definable feature of work and are conducted to verify compliance with the specifications and requirements described in this QAPP and approved project plans and procedures. Discrepancies will be resolved and corrective actions implemented and verified prior to work proceeding.
- Follow-Up and Reporting Phase: Activities and assessments performed during the follow-up and reporting phase are conducted to verify continued compliance with project requirements and to verify project reports meet client and regulatory requirements.
- An overview of the Three Phase Quality Control Process and related forms used to document the process are provided in Appendix D. The activities and assessments conducted during each phase of the Three-Phase Quality Control Process are described below.

7.2.1 Assessments and Corrective Action

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
Phase I - Preparatory Phase						
Planning Document review	Internal Memo	Document Author	Prior to the start of field activities	Response to comments documentation and USACE approval of document as applicable	Eric Schmidt, Project Manager, Ahtna	One week
Planning document (QAPP) sign-off by field staff, subcontractors, and laboratory	Memo	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Obtain sign-off that document has been read and understood by field and laboratory personnel	Eric Schmidt, Project Manager, Ahtna	One week

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
Preliminary work activities performed	Memo	Mark Fisler, Field Supervisor, Ahtna	Prior to the start of field activities	Provide clearance forms, permit forms, site access communications	Eric Schmidt, Project Manager, Ahtna	Prior to the start of field activities
Review of lab and field staff readiness	Memo	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Provide kick-off meeting notes from field and laboratory meetings	Eric Schmidt, Project Manager, Ahtna	One week
Review of field equipment	Memo	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Provide checklist documenting field equipment is available and in good working order	Eric Schmidt, Project Manager, Ahtna	Prior to the start of field activities
Phase II – Initial Phase						
Work performed according to project plans	Memo	Mark Fisler, Field Supervisor, Ahtna Scott Davis, Site Safety and Health Officer, Ahtna Eric Schmidt, Project Manager, Ahtna Steven Bennett, QC Manager, Ahtna	Within 24 hours of observation	Communications with USACE	Kirsten Hiortdahl, Technical Lead, USACE Joseph Gomez, Project Manager, USACE	One week
Field and laboratory audit	Field and Lab audit report	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Eric Schmidt, Project Manager/Chemist, Ahtna	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Eric Schmidt, Project Manager, Ahtna Steven Bennett, QC Manager, Ahtna	One week

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
Review of Contractor Quality Control Reports (CQCRs)	Memo	Mark Fisler, Field Supervisor, Ahtna	Within 48 hours of review	Revision of CQCRs as needed	Eric Schmidt, Project Manager, Ahtna Kirsten Hiortdahl, Technical Lead, USACE Joseph Gomez, Project Manager, USACE	One week
Review of project plans to reflect current site or lab activities	Memo	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Eric Schmidt, Project Manager, Ahtna	Within 10 days of observations	Update project plans to reflect current conditions (may be addendum to existing document) or documentation of changes to field or laboratory protocol to be in accordance with project plans	Eric Schmidt, Project Manager, Ahtna Kirsten Hiortdahl, Technical Lead, USACE Joseph Gomez, Project Manager, USACE	Prior to next scheduled sampling event
Field and laboratory audit	Field and Lab audit report	Mark Fisler, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Eric Schmidt, Project Manager/Chemist, Ahtna	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Eric Schmidt, Project Manager, Ahtna Steven Bennett, QC Manager, Ahtna	One week
Phase III – Follow-up and Reporting Phase						
Data reports prepared in accordance with project plans	Internal comments from staff	Document Author	Prior to issuance of report	Provide response to comments and revise report as needed	Commenting Staff, Eric Schmidt, Project Manager, Ahtna	Prior to issuance of report

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
Report meets client and regulatory agency requirements	External comments from client and regulatory agencies	Document Author Eric Schmidt, Project Manager, Ahtna	Within 30 days of receipt of report	Provide response to comments and revise report as needed	Commenting Client and or Agencies, Eric Schmidt, Project Manager, Ahtna, Kirsten Hiortdahl, Technical Lead, USACE, Joseph Gomez, Project Manager, USACE	30 days
Other definable features of work completed	Memo	Eric Schmidt, Project Manager, Ahtna	Before the end of the contract period	Complete definable features of work	Eric Schmidt, Ahtna, Kirsten Hiortdahl, Technical Lead, USACE, Joseph Gomez, Project Manager, USACE	Before end of contract period
Review of QAPP, SOPs, and Accident Prevention Plan with Field Staff	Commentary and issuance of an addendum	Field Team Leader, Ahtna	Following completion of field work	Completed acknowledgement signature pages	Eric Schmidt, Project Manager/Chemist, Ahtna	48 hours following assessment
Work performed in accordance with site-specific QAPPs	Memo	Field Team Leader, Ahtna	Following completion of field work	Daily progress reports	Eric Schmidt, Project Manager/Chemist, Ahtna	24 hours following conclusion of business day
Logbook and Field Form Review	Memo	Field Team Leader, Ahtna	Following completion of field work	N/A; corrections will be made directly to reviewed documents	Eric Schmidt, Project Manager/Chemist, Ahtna	24 hours following assessment
Laboratory Assessment for	Correspondence with laboratory contact	Eric Schmidt, Project Chemist, Ahtna	Upon completion	Receipt of copies of certifications. Email traffic concerning lab	Eric Schmidt, Project Manager/Chemist, Ahtna	48 hours following assessment

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
Appropriate Certifications, Capacity, and QAPP Review with Staff			and reception of EDC	capacity prior to sampling startup. QAPP sign-off sheet received from laboratory		
Tailgate Safety Meeting	Fieldwork form	Site Safety and Health Officer, Ahtna	Every day prior to field work	Verbal debriefing and daily sign-off log. If a safety incident occurs, a Supervisor Injury Employee Report is completed	Eric Schmidt, Project Manager/Chemist, Ahtna	Weekly; safety incidents will be reported to the Project Manager and Corporate Health and Safety Officer immediately
Daily QC Reports	Fieldwork form	Field Team Leader, Ahtna	Every day post field activities	Three-Phase Inspection Forms (Appendix D)	Eric Schmidt, Project Manager/Chemist, Ahtna	24 hours following conclusion of business day
Field Sampling and Chain of Custody Form Review Against QAPP Requirements	Fieldwork form	Eric Schmidt, Project Chemist, Ahtna	Every sample container sent from field	Corrections will be made directly to reviewed documents; communication may be in the form of email	Eric Schmidt, Project Manager/Chemist, Ahtna	24 hours following assessment
Data Validation	Memo	Data Validation Chemist, Laboratory Data Consultants	Time as determined with laboratory contractor	Communication may be in the form of email traffic, Amendment of the analytical report or corrective actions due to deficiencies	Eric Schmidt, Project Manager/Chemist, Ahtna	24 hours following assessment

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, and Organization)	Timeframe for Response
				identified in the validation process		
Laboratory Report Deliverables and Analytical Results Against QAPP Requirements	Memo	Eric Schmidt, Project Chemist, Ahtna	In accordance with listed QAPP requirements	Memorandum or email to Project Manager and Project Chemist	Eric Schmidt, Project Manager/Chemist, Ahtna	72 hours following assessment

7.2.2 QA Management

Type of Report	Frequency (daily, weekly, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (name, title and organization)	Report Recipient(s) (name, title and organization)
Daily CQCR Field Report	Daily	At the end of each day of fieldwork. Original field reports will be kept onsite in the project file.	Mark Fisler, Field Supervisor, Ahtna	Eric Schmidt, Project Manager, Ahtna Steven Bennett, QC Manager, Ahtna Joseph Gomez, Project Manager, USACE Kirsten Hiortdahl, Technical Lead, USACE Greg Weisenfeld, Field Oversight Inspector, Chenega
Field Work Variance Report	As needed	Prior to implementation of proposed change or immediately following a variance implemented in the field. A copy of the Field Work Variance will also be included in the final report.	Mark Fisler, Field Supervisor, Ahtna	Joseph Gomez, Project Manager, USACE Eric Schmidt, Project Manager/Project Chemist, Ahtna Kirsten Hiortdahl, Technical Lead, USACE

Type of Report	**Frequency (daily, weekly, etc.)**	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation (name, title and organization)**	**Report Recipient(s) (name, title and organization)**
Non-Routine Occurrences Report	As needed	Within 48 hours of a Non-Routine Occurrence in the field or laboratory. A copy of this report will also be included in the final report.	Mark Fisler, Field Supervisor, Ahtna	Joseph Gomez, Project Manager, USACE Eric Schmidt, Project Manager/Project Chemist, Ahtna Kirsten Hiortdahl, Technical Lead, USACE

7.3 Worksheet #34: Data Verification and Validation Inputs

This worksheet lists the inputs that will be used during data verification and validation. Inputs include planning documents, field records, and laboratory records. Data verification is a check that all specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs, and the QAPP.

Item	Description	Verification (completeness)	Validation (conformance to specifications)
1	Approved QAPP	X	
2	Contract	X	
4	Field SOPs	X	
5	Laboratory SOPs	X	
Field Records			
6	Field Logbooks	X	X
7	Equipment Calibration Records	X	X
8	Chain of Custody Forms	X	X
9	Sampling Diagrams/Surveys	X	X
10	Relevant Correspondence	X	X
11	Change Orders/Deviations	X	X
12	Field Audit Reports	X	X
13	Field Corrective Action Reports	X	X
Analytical Data Package			
14	Cover Sheet (laboratory identifying information)	X	X
15	Case Narrative	X	X
16	Sample Chronology (e.g., dates and times of receipt, preparation, and analysis)	X	X
17	LOD/LOQ Establishment and Verification	X	X
18	Standards Traceability	X	X
19	Instrument Calibration Records	X	X
20	Definition of Laboratory Qualifiers	X	X
21	Results Reporting Forms	X	X
22	QC Sample Results	X	X
23	CA Reports	X	X
24	Raw Data	X	X
25	Chromatograms	X	X
26	Electronic Data Deliverable	X	X

7.4 Worksheet #35: Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Methods	QAPP, SOP	Records support implementation of the SOP-sampling and analysis.	Project Chemist, Ahtna
Performance Requirements	QAPP, SOP	Verify laboratory method SOPs are sufficient to satisfy DQOs.	Project Chemist, Ahtna
Sampling Locations, Number of Samples	QAPP, SOP	Verify that sample locations and quantities will be sufficient to satisfy DQOs.	Project Chemist, Ahtna
Three phase inspection forms and Other Field Documentation	QAPP, SOP	Review daily sampling activity reports including pertinent field sampling data.	Project Chemist, Ahtna
Chain of Custody	QAPP, SOP	Examine traceability of data from sample collection to generation of project reported data.	Project Chemist, Ahtna
Deviations	QAPP, SOP	Determine impacts of deviations from methods.	Project Chemist, Ahtna
Sensitivity	QAPP, SOP	Verify that LODs and LOQs are achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the LOD.	Project Chemist, Ahtna
Precision	QAPP, SOP	Review data against performance criteria and determine impact of any result out of criteria.	Project Chemist, Ahtna
Accuracy	QAPP, SOP	Review data against performance criteria and determine impact of any result out of criteria.	Project Chemist, Ahtna
QC samples	QAPP, SOP	Ensure that a sufficient number of QC samples are analyzed, as outlined in the QAPP, to meet DQOs.	Project Chemist, Ahtna
Field Change Requests	QAPP, SOP	Review any change request or corrective action documentation. Determine impact to project objectives.	Project/Program Chemist, Ahtna
Electronic Data Deliverables (EDDs)	QAPP	Verify that acceptable EDDs have been qualified. The Laboratory Data Consultants Automated Data Review (LDC ADR) EDD format files will be uploaded into the FODIS chemistry database, EDD files will be submitted to USACE. EDD File Specifications are provided in Appendix E.	Project Chemist, Ahtna

The data verification procedures described in this worksheet are applied to the data and documentation inputs identified in Worksheet #34.

7.5 Worksheet #36: Data Validation Procedures

Analytical Group/Method:	Volatile Organics – TO-15 (TO-15 5&20)	Volatile Organics – TO-15 (Low-Level)	VOCs – EPA Method 8260-SIM	Metals - EPA Method 6010D	Chloride – EPA Method 9056A
Data deliverable requirements:	LDC ADR	LDC ADR	LDC ADR	LDC ADR	LDC ADR
Analytical specifications:	Worksheet #28	Worksheet #28	Worksheet #28	Worksheet #28	Worksheet #28
Measurement performance criteria:	Worksheet #12	Worksheet #12	Worksheet #12	Worksheet #12	Worksheet #12
Percent of data packages to be validated:	100% Stage 2B	100% Stage 2B	100% Stage 2B	100% Stage 2B	100% Stage 2B
Percent of raw data reviewed:	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]
Percent of results to be recalculated:	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]	10% Stage 4[1]
Validation procedure:	DoD Data Validation Guidelines	DoD Data Validation Guidelines	DoD Data Validation Guidelines	DoD Data Validation Guidelines	DoD Data Validation Guidelines
Validation qualifiers:	See table below	See table below	See table below	See table below	See table below
Electronic validation program:	LDC ADR	LDC ADR	LDC ADR	LDC ADR	LDC ADR

Notes:

[1] The following requirements are applicable for the Stage 4 portion of the validation. A minimum of reported quality control calculations should be verified at a frequency of 10% per analytical method, per SDG. If the SDG is analyzed on multiple instruments, then each instrument should be included in the calculations. A minimum of 10% of the laboratory standards (instrument QC), field QC samples, field samples, and batch QC samples, should undergo re-quantification and recalculation, per analytical suite, per SDG. Project-specific target analyte detects should also undergo re-quantification (minimum 10%) per analytical suite, per SDG. When choosing samples for re-quantification, precedence should be given to priority contaminants, diluted samples, manual integrations, and any samples requiring re-analysis.

DoD Data Validation Guidelines = Department of Defense General Data Validation Guidelines Environmental Data Quality Workgroup, Revision 1 (DoD, 2019), Data Validation Guidelines Module 1: Data Validation Procedure for Organic Analysis by GC/MS (DoD, 2020a), for Metals by ICP-OES (DoD, 2020b), and Data Validation Guidelines Module 1, 2, and 4 Revised Blank Qualification Table (DoD, 2021a)

LDC ADR = Laboratory Data Consultants Automated Data Review format

Summary of Data Qualifiers

Qualifier	Definition
U	The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample.
J	The reported result was an estimated value with an unknown bias.
J+	The result was an estimated quantity, but the result may be biased high.
J-	The result was an estimated quantity, but the result may be biased low.
N	The analysis indicates the presence of an analyte for which there was presumptive evidence to make a "tentative identification."
NJ	The analyte has been “tentatively identified” or “presumptively identified” as present, and the associated numerical value was the estimated concentration in the sample.
UJ	The analyte was not detected and was reported as less than the LOD or as defined by the customer. However, the associated numerical value is approximate.
X	The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The presence or absence of the analyte cannot be substantiated by the data provided. Acceptance or rejection of the data should be decided by the project team (which should include a Project Chemist), but exclusion of the data is recommended.

7.6 Worksheet #37: Data Usability Assessment

The procedures, methods, and activities that will be used to determine whether data are of the right type, quality, and quantity to support project decisions are described below. Also described is how data quality issues will be addressed and how limitations on the use of the data will be handled.

The suitability of the environmental data collected for its intended use will be assessed by the Ahtna Project Chemist in consultation with the Project Manager. Data usability will comprise an evaluation of the quantity, type, and overall quality of the generated data against the project DQOs as presented in Worksheet #11. Consistent with the Department of Defense General Data Validation Guidelines (DoD, 2019), the conventional "R" (reject) qualifier is not used during data validation. Data affected by serious deficiencies are qualified "X" as described in Worksheet #36, and the project team determines during the data usability assessment whether the qualified data are usable for the intended project purpose or should be rejected. The usability of data associated with QC results outside of the established acceptance criteria is dependent on the degree of the exceedance, whether the potential bias is high or low, and whether the uncertainty implied by the exceedance is significant relative to project decisions and DQOs. Data usability will be assessed in accordance with the guidance provided in QSM Version 6.0 (DoD, 2023) and additional applicable USACE and EPA guidance, as well as the professional experience of the decision-maker during data validation. The following items will be assessed and conclusions drawn based on their results.

Data usability is assessed in accordance with the DoD QSM Version 6.0 (DoD, 2023) and is based on the ability of the data to support project-specific decision-making objectives. Data usability determinations are not based solely on strict compliance with individual quality control acceptance criteria, but on the collective evaluation of data quality relative to the project's data quality objectives.

7.6.1 Step 1 – Review the project's objectives and sampling design

The goal for O&M activities at Fort Ord is to implement remedies as necessary to protect human health and the environment while maximizing the number of site closures or advance sites as close to site closure as practicable during the Period of Performance in a cost-effective manner. The site-specific QAPPs will indicate the project objectives and sampling design. To that end, the usability assessment will incorporate the activities listed below.

7.6.1.1 Field Certification

Field personnel will generate field forms, maps, and notes describing the daily procedures. The three-phase inspection forms (Appendix D), generated during sampling, will discuss successes and/or deviations from the QAPP. The Task Lead will review field documentation as it is generated for consistency and errors. Anomalies identified will be discussed with the project team to determine if changes to the sampling design are needed. Any changes will be documented in a QAPP amendment.

7.6.1.2 Data Quality Indicators: Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity (PARCCS)

The PARCCS parameters will be used to help identify deficiencies in the sample data that would affect the achievement of the project DQOs. Laboratory limits and QC samples will be used as part of the PARCCS assessment to detect anomalies in the dataset. In addition, the laboratory will create trend charts to track variability in laboratory processes and establish in-house precision and accuracy criteria.

Laboratory limits used in the sensitivity review consist of the LOD and LOQ. Laboratory QC samples consist of method blanks, LCSs, surrogates, and laboratory duplicates. All samples will be spiked with surrogate compounds where recommended or required by the method.

7.6.1.2.1 Precision

Precision is defined as the degree of mutual agreement between individual measurements of the same property under similar conditions and provides a measurement of the reproducibility of an analytical result. Precision will be evaluated through the analysis of field duplicate samples, LCS/LCSDs, and MS/MSDs (if applicable). Field duplicate samples will be collected at a frequency of one per 10 field samples of a given matrix. The duplicate sample will not be reanalyzed when the RPD criteria are not met. Discussion of QC failures will be documented in the laboratory case narrative. The Project Chemist will work with the laboratory to determine the cause of the failure and to determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.

The variance between the samples, in terms of RPD, is calculated according to the following equation:

$$RPD = \frac{|A - B|}{(A + B)/2} \; x \; 100\%$$

where:

A = First duplicate concentration

B = Second duplicate concentration

For this project, the goal for precision of field duplicates is listed in Worksheet #12. If both of the duplicate sample results are less than the LOD, the RPD will not be calculated.

7.6.1.2.2 Accuracy

Accuracy is the degree of agreement between an analytical measurement and a reference accepted as a true value. The accuracy of a measurement system can be affected by errors introduced by field contamination, sample preservation, sample handling, sample preparation, or analytical techniques. A program of sample spiking will be conducted to evaluate laboratory accuracy. Accuracy will be evaluated by the percent recovery of the spiked compounds in the LCS/LCSDs, MS/MSDs, surrogates, and proficiency samples (if requested by the Ahtna Project Manager). LCS/LCSDs, MS/MSDs, and surrogates will be spiked prior to extraction. LCS/LCSD and MS/MSD samples will be spiked with the method target compounds indicated in this QAPP, and surrogates will be added to every sample and spike. Proficiency samples will be taken through the entire sample preparation and analysis process. LCS/LCSD, MS/MSD, or blank spike samples will be analyzed at a frequency of 5%, or one per sample delivery group/analytical batch (sample sets can be up to 20 field samples). Proficiency samples will be analyzed once per sampling event if required. The results of the spiked and proficiency samples are used to calculate the percent recovery for evaluating accuracy, using the following equation:

$$Percent\ Recovery = \frac{S - C}{T} x\ 100$$

where:

S = Measured spike sample concentration

C = Sample concentration

T = True or actual concentration of the spike or proficiency

Worksheet #12 presents accuracy goals for this investigation based on the percent recovery of LCSs and surrogate spikes. The data reviewer will use the accuracy results to help determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.

The presence of high levels of target compounds in the sample chosen for spiking may necessitate a dilution of the sample or may otherwise result in errors in spiked compound recovery. Discussion of laboratory QC failures will be documented in the laboratory case narrative. The Project Chemist will work with the laboratory to determine the cause of the failure and to determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.

7.6.1.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that the data are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters, through proper collection and handling of samples to avoid interference and minimize cross-contamination, and through consistent application of the appropriate established field and laboratory procedures.

To aid in evaluating the representativeness of the sample results, laboratory blank samples will be evaluated for the presence of contaminants. Laboratory procedures will be reviewed to verify that SOPs were followed, and method requirements were met during the analysis of project samples. Laboratory sample storage practices, holding times, sub-sampling procedures, and method blanks will be assessed for potential impacts on the representativeness of the data. Data determined to be non-representative will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

Representativeness (as it relates to field procedures) refers to the collection of samples that allow accurate conclusions to be made regarding the composition of the sample media at the entire site. Representativeness will be assessed qualitatively by evaluating whether the procedures described in this QAPP were followed.

7.6.1.2.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with the procedures outlined in this QAPP and when none of the QC criteria used to determine the usability of the data is critically exceeded to the point of rejection.

When data validation is completed, the percent completeness value will be calculated by dividing the number of usable sample results by the total number of sample results planned for this investigation.[42] The evaluation of completeness will help determine whether any critical deficiencies identified during the validation process resulted in non-attainment of project objectives.

[42] The number of usable results is the difference between the number of possible/planned results and the number of rejected/unreported results.

Completeness will be evaluated by reviewing the tasks that contribute to the sampling event, such as sample handling and storage procedures, chain of custody procedures, analytical procedures, and data validation procedures. The procedures and determined impact on the sample results will be used to identify any problems along the data path that will render the decision-making process useless and the data set incomplete. The completeness goal for this project that still allows for attainment of the project objectives is 90%.

$$\frac{Number\ of\ possible\ analyte\ results^{43} - Number\ of\ rejected\ and\ unreported\ results}{Possible\ number\ of\ analyte\ results}\ x\ 100$$

The project team may determine that an individual sampling point or area is more critical than others for decision-making. Sampling locations identified as such will have a completeness goal of 95% as determined by the validation process.

7.6.1.2.5 Comparability

Comparability expresses the confidence with which one dataset can be compared with another. Comparability of data will be achieved by following standard field and laboratory procedures outlined in SOPs and published methods. In addition, standard units of measurement will be used in reporting analytical and field data. Analytical and field methods selected for this investigation are consistent with the methods used during previous investigations of this type. Oversight by experienced team members will ensure that the procedures are conducted in a manner appropriate to attaining the project objectives. Deviations from field or laboratory methods will be documented on a change request form. The project team will review the change request to determine if the change will impact the comparability of the data.

7.6.1.2.6 Sensitivity

The LOD and LOQ will be evaluated by the project team prior to sample analysis to determine if the laboratory is able to attain the sensitivity required for the project. If project decision limits are too sensitive, it will be determined prior to sample analysis whether a sensitivity variance will be issued to the laboratory based on the method chosen and the technology available.

The LOD is the minimum quantity of an analyte that can be reliably detected for a specific analytical method at a 99% confidence level that the value is not a false negative. The LOQ represents the smallest quantity of an analyte that can be quantified accurately and reproducibly in a given sample matrix (e.g., three to five times the LOD). The LOD and/or the LOQ shall be sensitive enough to meet the project decision limits. The LOD and LOQ will be evaluated after sample analysis to determine if there were any matrix effects, operator errors, or analytical process errors that interfered with the ability to compare the results to the project decision limits. The LOD will be used to determine if detectable amounts of analytes are present. If no detectable amounts are reported, and all data are acceptable (as determined by the verification and validation process), then the data are usable. The LOD will be used to determine if any detectable amounts of contaminants of concern are present. If detectable amounts are reported and the verification and validation are acceptable, then the data are usable. Detections falling between the LOD and LOQ will be qualified as estimated. If anomalies in sensitivity are present, the rationale for use or non-use of the affected samples will be discussed in the data validation reports. Worksheet #15

[43] Possible analyte results can also be defined as planned analyte results.

presents the laboratory LODs and LOQs for the selected analytical method(s) used to support the project decision limits.

7.6.2 Step 2 - Review the data verification and data validation outputs

The outputs from the verification and validation process will be used to determine data usability. Data validation reports and three phase inspection forms will be reviewed. Data will be summarized as necessary using graphs, maps, and/or tables. The entire project team is responsible for assessing whether the data meet the project objectives. Personnel at all levels will generate data and documentation that will be reviewed to identify trends, relationships, and/or anomalies in the dataset.

7.6.3 Step 3 - Implement the statistical method

For each analytical method, the laboratory will use the LCS data to track and analyze trends in the laboratory. From these trends, they can recognize deficiencies in the method and create in-house acceptance criteria. For this project, the limits are based on laboratory control limits. The precision and accuracy of the entire dataset will be used to determine if any systemic problems have occurred during the sampling event that will result in deficiencies in the dataset. The occurrence of systemic problems and the resulting consequences will be discussed in the data validation report. The data reviewer will make every effort to identify any critical elements or trends that would result in non-usability of data as early as possible.

7.6.4 Step 4 - Document data usability and draw conclusions

Data determined to meet project decision-making needs may be considered usable even when associated with data qualifiers or documented limitations, provided that such limitations are clearly understood and are not expected to affect the intended use of the data, consistent with DoD QSM Version 6.0 (DoD, 2023).

Again, the entire project team is responsible for assessing whether the data meet the project objectives. The site-sampling layout, including sampling locations, frequency of sampling, and timing of sampling activities, will be reviewed by the project team. Data usability will be assessed in accordance with the guidance provided in QSM Version 6.0 (DoD, 2023) and additional applicable USACE and EPA guidance as well as the professional experience of the decision-maker during data validation. The conclusions will be discussed in the final annual report. If the data indicate anomalies, the impacted data will be qualified as described in DoD Data Validation Guidelines (DoD, 2019), Data Validation Guidelines Module 1 (DoD, 2021b) and Data Validation Guidelines Module 1, 2, and 4 Revised Blank Qualification Table (DoD, 2021a). The impact will be documented along with the rationale for limited use of the data.

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TABLES

Table 1. Sites 2/12 Soil Gas Probe Identification, Sample Schedule, and Purge Specifications

Soil Gas Location ID	Soil Gas Probe ID	Screen Depth (ft bgs)	Updated Sample Schedule[1]	Previous Sample Schedule[2]	Purge Volume (mL)	Purge Rate[3] (mL/min)	Purge Time (min)
SG-12-01[5]	SG-12-01-10	10	P	R	21,810	200	109
	SG-12-01-20	20	P	R	21,973	400	55
	SG-12-01-30	30	P	R	22,136	400	55
	SG-12-01-40	40	P	R	21,112	400	53
	SG-12-01-50	50	P	R	23,054	400	58
	SG-12-01-58	58	P	R	22,592	400	56
	SG-12-01-65	65	Q	Q	23,892	400	60
SG-12-02	SG-12-02-10[4]	10	Q	Q	22,403	200	112
	SG-12-02-20	20	A	A	22,566	400	56
	SG-12-02-30	30	A	A	22,729	400	57
	SG-12-02-40	40	A	A	22,892	400	57
	SG-12-02-50	50	A	A	23,054	400	58
	SG-12-02-57	57	A	A	23,168	400	58
	SG-12-02-65	65	A	A	23,299	400	58
SG-12-03[5]	SG-12-03-10	10	P	R	22,403	200	112
	SG-12-03-20.5	20.5	P	R	22,574	400	56
	SG-12-03-30	30	P	R	22,729	400	57
	SG-12-03-39.5	39.5	P	R	19,918	400	57
	SG-12-03-50	50	P	R	22,461	400	58
	SG-12-03-58	58	P	R	23,185	400	58
	SG-12-03-65	65	P	R	23,299	400	58
SG-12-04	SG-12-04-10[4]	10	Q	Q	21,810	200	109
	SG-12-04-20	20	Q	Q	21,973	400	55
	SG-12-04-30	30	N	N	22,136	400	55
	SG-12-04-40	40	Q	Q	22,892	400	57
	SG-12-04-50	50	Q	Q	22,461	400	56
	SG-12-04-58	58	Q	Q	22,592	400	56
	SG-12-04-65	65	Q	Q	20,333	400	51
SG-12-05	SG-12-05-10	10	R	R	22,403	200	112
	SG-12-05-20	20	R	R	22,566	400	56
	SG-12-05-30	30	R	R	22,729	400	57
	SG-12-05-40	40	R	R	22,892	400	57
	SG-12-05-50	50	R	R	23,054	400	58
	SG-12-05-60	60	R	R	23,217	400	58
	SG-12-05-70	70	R	R	20,415	400	51

Table 1. Sites 2/12 Soil Gas Probe Identification, Sample Schedule, and Purge Specifications

Soil Gas Location ID	Soil Gas Probe ID	Screen Depth (ft bgs)	Updated Sample Schedule[1]	Previous Sample Schedule[2]	Purge Volume (mL)	Purge Rate[3] (mL/min)	Purge Time (min)
SG-12-06	SG-12-06-10[4]	10	Q	Q	22,403	200	112
	SG-12-06-20	20	R	R	22,566	400	56
	SG-12-06-30	30	R	R	22,729	400	57
	SG-12-06-40	40	R	R	22,892	400	57
	SG-12-06-50	50	R	R	23,054	400	58
	SG-12-06-60	60	R	R	23,217	400	58
	SG-12-06-70	70	Q	Q	20,415	400	51
SG-12-07	SG-12-07-10	10	N	N	21,810	200	109
	SG-12-07-20	20	R	R	36,799	400	92
	SG-12-07-30	30	R	R	22,136	400	55
	SG-12-07-40	40	R	R	22,298	400	56
	SG-12-07-50	50	R	R	23,054	400	58
	SG-12-07-57.5	57.5	R	R	20,211	400	51
	SG-12-07-65	65	I	I	20,333	400	51
SG-12-08	SG-12-08-10	10	R	R	22,403	200	112
	SG-12-08-20	20	R	R	22,566	400	56
	SG-12-08-30	30	R	R	22,729	400	57
	SG-12-08-40	40	R	R	22,892	400	57
	SG-12-08-50	50	R	R	23,054	400	58
	SG-12-08-60	60	R	R	23,217	400	58
	SG-12-08-70	70	R	R	20,415	400	51
SG-12-09	SG-12-09-10	10	R	R	22,403	200	112
	SG-12-09-20	20	R	R	22,566	400	56
	SG-12-09-30	30	R	R	22,729	400	57
	SG-12-09-40	40	R	R	22,298	400	56
	SG-12-09-50	50	R	R	20,089	400	50
	SG-12-09-59	59	R	R	20,236	400	51
SG-12-11	SG-12-11-10	10	R	R	21,810	200	109
	SG-12-11-20	20	R	R	22,566	400	56
	SG-12-11-30	30	R	R	22,729	400	57
	SG-12-11-40	40	R	R	22,892	400	57
	SG-12-11-50	50	R	R	23,054	400	58
	SG-12-11-60	60	R	R	23,217	400	58
	SG-12-11-70	70	R	R	20,415	400	51

Table 1. Sites 2/12 Soil Gas Probe Identification, Sample Schedule, and Purge Specifications

Soil Gas Location ID	Soil Gas Probe ID	Screen Depth (ft bgs)	Updated Sample Schedule[1]	Previous Sample Schedule[2]	Purge Volume (mL)	Purge Rate[3] (mL/min)	Purge Time (min)
SG-12-12	SG-12-12-10	10	R	R	21,810	200	109
	SG-12-12-20	20	R	R	22,566	400	56
	SG-12-12-30	30	R	R	22,729	400	57
	SG-12-12-40	40	R	R	22,298	400	56
	SG-12-12-50	50	N	N	22,461	400	56
	SG-12-12-60	60	R	R	22,624	400	57
	SG-12-12-70	70	R	R	20,415	400	51
SG-12-14	SG-12-14-10	10	R	R	21,810	200	109
	SG-12-14-20	20	R	R	21,973	400	55
	SG-12-14-30	30	R	R	22,136	400	55
	SG-12-14-40	40	R	R	22,892	400	57
	SG-12-14-50	50	R	R	23,054	400	58
	SG-12-14-60	60	R	R	22,624	400	57
	SG-12-14-70	70	R	R	20,415	400	51
SG-12-15	SG-12-15-10	10	R	R	25,368	200	127
	SG-12-15-20	20	R	R	25,531	400	64
	SG-12-15-30	30	R	R	25,694	400	64
	SG-12-15-40	40	R	R	25,857	400	65
	SG-12-15-50	50	R	R	22,461	400	56
	SG-12-15-60	60	R	R	26,183	400	65
	SG-12-15-70	70	R	R	23,973	400	60
SG-12-16	SG-12-16-10	10	R	R	25,368	200	127
	SG-12-16-20	20	R	R	21,973	400	55
	SG-12-16-30	30	R	R	22,136	400	55
	SG-12-16-40	40	R	R	23,485	400	59
	SG-12-16-50	50	R	R	22,461	400	56
	SG-12-16-60	60	R	R	23,217	400	58
	SG-12-16-70	70	R	R	20,415	400	51

Table 1. Sites 2/12 Soil Gas Probe Identification, Sample Schedule, and Purge Specifications

Soil Gas Location ID	Soil Gas Probe ID	Screen Depth (ft bgs)	Updated Sample Schedule[1]	Previous Sample Schedule[2]	Purge Volume (mL)	Purge Rate[3] (mL/min)	Purge Time (min)
SG-12-17	SG-12-17-10	10	R	R	22,403	200	112
	SG-12-17-20	20	R	R	25,531	400	64
	SG-12-17-30	30	R	R	22,729	400	57
	SG-12-17-40	40	R	R	25,857	400	65
	SG-12-17-50	50	R	R	26,020	400	65
	SG-12-17-60	60	I	I	23,217	400	58
	SG-12-17-75	75	N	N	20,496	400	51
SG-12-19	SG-12-19-10	10	R	R	21,810	200	109
	SG-12-19-20	20	R	R	21,973	400	55
	SG-12-19-30	30	R	R	22,136	400	55
	SG-12-19-40	40	R	R	23,485	400	59
	SG-12-19-50	50	R	R	23,648	400	59
	SG-12-19-60	60	R	R	22,624	400	57
	SG-12-19-70	70	R	R	20,415	400	51
SG-12-20	SG-12-20-10	10	A	A	22,996	200	115
	SG-12-20-20	20	A	A	21,973	400	55
	SG-12-20-30	30	R	R	22,136	400	55
	SG-12-20-40	40	R	R	23,485	400	59
	SG-12-20-50	50	R	R	23,648	400	59
	SG-12-20-60	60	R	R	23,810	400	60
	SG-12-20-70[6]	70	I	I	20,415	400	51
SG-12-22	SG-12-22-10	10	R	R	21,810	200	109
	SG-12-22-20	20	R	R	23,159	400	58
	SG-12-22-30	30	R	R	23,322	400	58
	SG-12-22-40	40	R	R	22,298	400	56
	SG-12-22-50	50	R	R	23,648	400	59
	SG-12-22-60	60	R	R	23,810	400	60
	SG-12-22-70	70	R	R	21,601	400	54

Table 1. Sites 2/12 Soil Gas Probe Identification, Sample Schedule, and Purge Specifications

Soil Gas Location ID	Soil Gas Probe ID	Screen Depth (ft bgs)	Updated Sample Schedule[1]	Previous Sample Schedule[2]	Purge Volume (mL)	Purge Rate[3] (mL/min)	Purge Time (min)
SG-12-23	SG-12-23-10	10	R	R	22,996	200	115
	SG-12-23-20	20	R	R	23,159	400	58
	SG-12-23-30	30	R	R	23,322	400	58
	SG-12-23-40	40	R	R	22,298	400	56
	SG-12-23-50	50	R	R	22,461	400	56
	SG-12-23-60	60	R	R	21,438	400	54
	SG-12-23-70	70	R	R	22,787	400	57
SG-12-24	SG-12-24-10	10	R	R	22,966	200	115
	SG-12-24-20	20	R	R	23,159	400	58
	SG-12-24-30	30	R	R	23,322	400	58
	SG-12-24-40	40	R	R	23,485	400	59
	SG-12-24-50	50	R	R	23,648	400	59
	SG-12-24-60	60	R	R	23,810	400	60
	SG-12-24-70	70	R	R	20,415	400	51

Notes:

[1] The soil gas probe sample schedule as of December 2024 and subject to change based on the analytic approach.

[2] The soil gas probe sample schedule presented in Revision 9 of the SG QAPP (Administrative Record: BW-2792Y)

[3] Purge rates were determined based on guidance in the Advisory, Active Soil Gas Investigations (DTSC, 2015): shallow (10-foot) soil gas probes purged at approximately 200 mL/min due proximity to the surface where ambient air intereference is more likely; deeper soil gas probes purged at 400 mL/min or less. Purge vacuums will not exceed maximum of 7.4 inches mercury (100 inches water).

[4] Soil gas probe located vertically and laterally adjacent to the front of a building with historic results above soil gas cleanup level and sampled quarterly for the duration of the SGMP.

[5] Probe sampling frequency has changed from Revision 9 of the QAPP.

[a]

Acronyms and Abbreviations:

A: Annual (third quarter event)

ft bgs: feet below ground surface

I: Investigation; After the soil gas rebound study completion, regulatory agencies requested to continue monitoring this soil gas probe.

ID: identification

min: minutes

mL: milliliters

N: Non-functional, cannot be sampled due to an obstruction or the screen interval submerged in groundwater

P: Plume perimeter control. All depths will be sampled annually (or more frequently if noted). After the first annual sampling event of all depths, a reduced number of depths at this probe may be proposed.

Q: Quarterly

R: Removed from sampling program

SGMP: soil gas monitoring program

Table 2: Basewide Summary of Existing Monitoring Wells and Samples Collected Annually

Site	Aquifer	Total Number[1] of Wells Per Aquifer	Number of Army-Owned Wells	Total Number of Sample Ports Currently Sampled	Number of Well/Ports Sampled Quarterly	Number of Wells/Ports Sampled Annually	Number of Wells Not Sampled (water level only)	Number of Samples Collected Annually[2]	Average Well Depth[3] (feet)
Sites 2 and 12	A	0	0	0	0	0	0	0	NA
	Upper 180	34	34	17	15	2	17	68	107
	Lower 180	0	0	0	0	0	0	0	179
	Subtotal	**34**	**34**	**17**	**15**	**2**	**17**	**68**	**NA**
Operable Unit 2	A	57	57	45	45	0	12	198	134
	Upper 180	42	42	29	27	2	13	121	222
	Lower 180	0	0	0	0	0	0	0	NA
	Subtotal	**99**	**99**	**74**	**72**	**2**	**25**	**319**	**NA**
Operable Unit Carbon Tetrachloride Plume	A	97	97	54	43	11	43	201	101
	Upper 180	31	31	13	8	5	18	41	271
	Lower 180[4]	35	31	21	20	1	11	89	433
	Subtotal	**163**	**159**	**88**	**71**	**17**	**72**	**331**	**NA**
Total Number of Samples Collected Annually									**718**

Notes:

[1] Number of wells in the groundwater monitoring program (not including wells not measured for depth to water and to be decommissioned at a later date).

[2] Includes duplicate samples collected during groundwater monitoring at a frequency of 10 percent (%) per quarterly event.

[3] Value provided is the average depth for the wells that are sampled at the site/aquifer specified. For multiport wells, one value was used - the deepest port sampled

[4] The total number of wells includes three wells owned by Marina Coast Water District: FO-29, FO-30, and FO-31.

Table 3. Sites 2/12 Summary of Soil Gas and SVETS Samples Collected

Sample Location Type	Total Number of Sample Locations by Type	Number of Army-Owned Sample Locations	Total Number of Locations Currently Sampled	Number of Locations Sampled Quarterly	Number of Locations Sampled Annually[1]	Number of Locations Not Sampled	Number of Samples Collected Annually[2,3]
Soil gas probe	139	139	34	10	21	105	68
Soil vapor extraction well	10	10	0	0	0	10	0
Soil vapor treatment unit	3	3	1	0	0	2	0
Total	**152**	**152**	**35**	**10**	**21**	**117**	**68**

Notes:

[1] Includes probes sampled once annually for plume delineation.

[2] Total Includes duplicate samples collected during soil gas sampling at a frequency of 10 percent (%) per quarterly event at soil gas probes.

[3] The soil gas probe and SVETS sample schedule as of December 2024 and subject to change based on the analytic approach in Worksheet #11.

Table 4. Sites 2/12 Soil Vapor Extraction Treatment System Identification and Sample Schedule

SVETS Group	SVETS Sample Point ID	Screen Depth (ft bgs)	Top of Screen Elevation (ft MSL)	Sample Schedule[1]
Southern Well Field[2]	VE-12-01	47.9-67.9	37.77	R
	VE-12-02	50-70	37.07	QO
	VE-12-03	50.6-70.6	35.01	R
	VE-12-04	30-50	55.64	R
	VE-12-05	30.3-50.3	55.62	R
Northern Well Field[3]	VE-12-06	45-65	29.69	QO
	VE-12-07	45-65	32.1	R
	VE-12-08	45-65	34.01	QO
	VE-12-09	45-65	27.95	QO
	VE-12-10	45-65	26.99	R
SVTU	SVTU-212-INF	N/A	N/A	QO
	SVTU-212-EFF	N/A	N/A	QO

Notes:

[1] The SVETS sample schedule as of December 2024; subject to change based on the analytic approach in Worksheet #11.

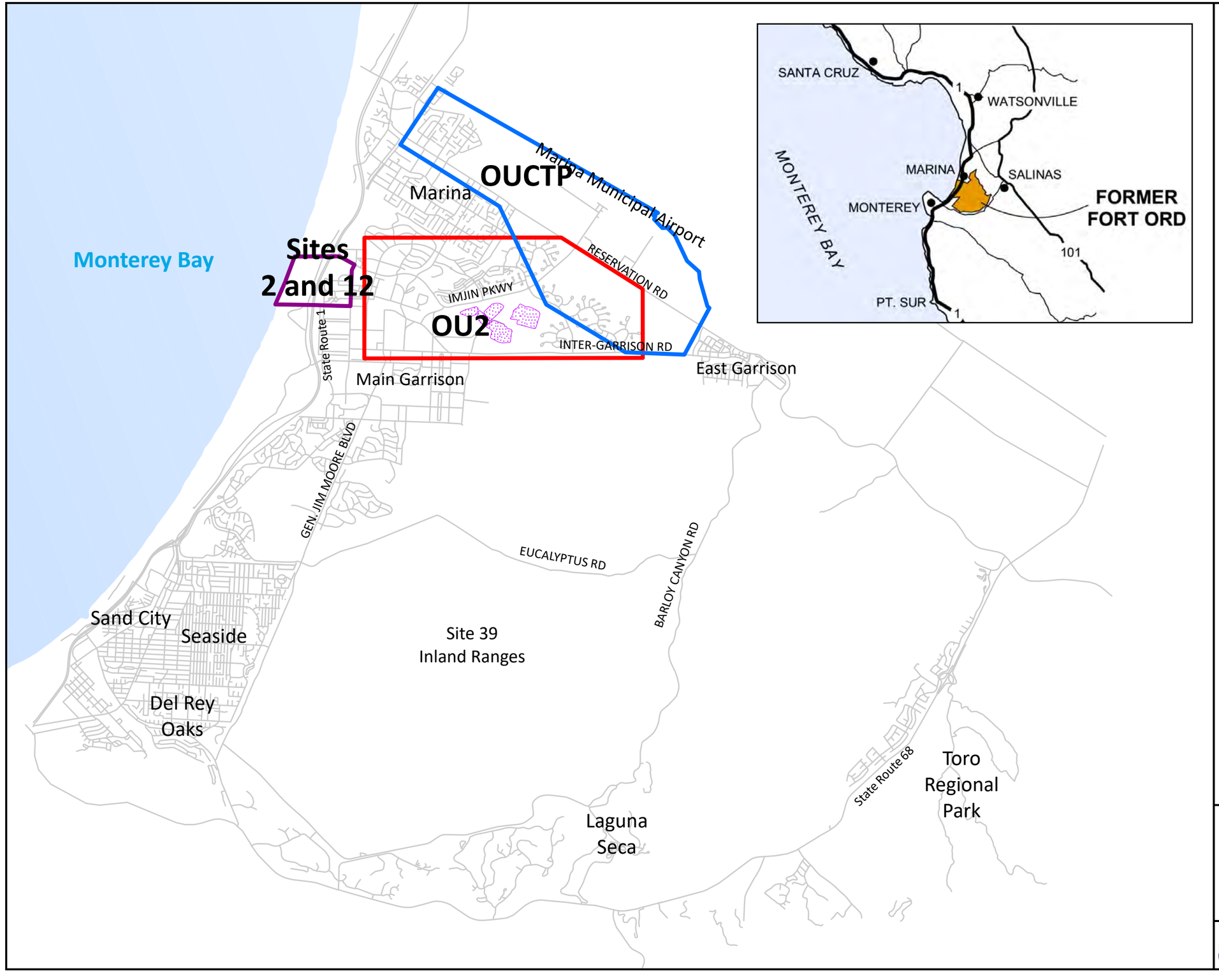
[2] These SVE wells are located near the historical trichloroethene soil gas plume footprint.

[3] These SVE wells are located in the tetrachloroethene groundwater plume footprint.

Acronyms and Abbreviations:

ft bgs: feet below ground surface
ID: identification
N/A: not applicable
QO: Quarterly if in operation
R: Removed from sampling program (unless online)
SVE: soil vapor extraction
SVETS: soil vapor extraction treatment system
SVTU: soil vapor treatment unit

FIGURES



EXPLANATION

- Roads
- Operable Unit 2 (OU2) Area Boundary
- Operable Unit 2 (OUCTP) Area Boundary
- Sites 212 Area Boundary
- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

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Miles

Former Fort Ord
Location Map
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **1**

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EXPLANATION

- Sites 2/12 Groundwater Treatment Plant
- Former Fort Ord Boundary

Well Type and Use

- Extraction Well - Operated
- Extraction Well - Not Operated
- Extraction Well - Not Operated - No Pump

Groundwater Pipeline

- Sites 2/12 Groundwater Collection Pipeline
- OU2 Treated Water Injection Pipeline
- Combined Treatment Water Discharge

Discharge Structures

- Infiltration Well
- Injection Well

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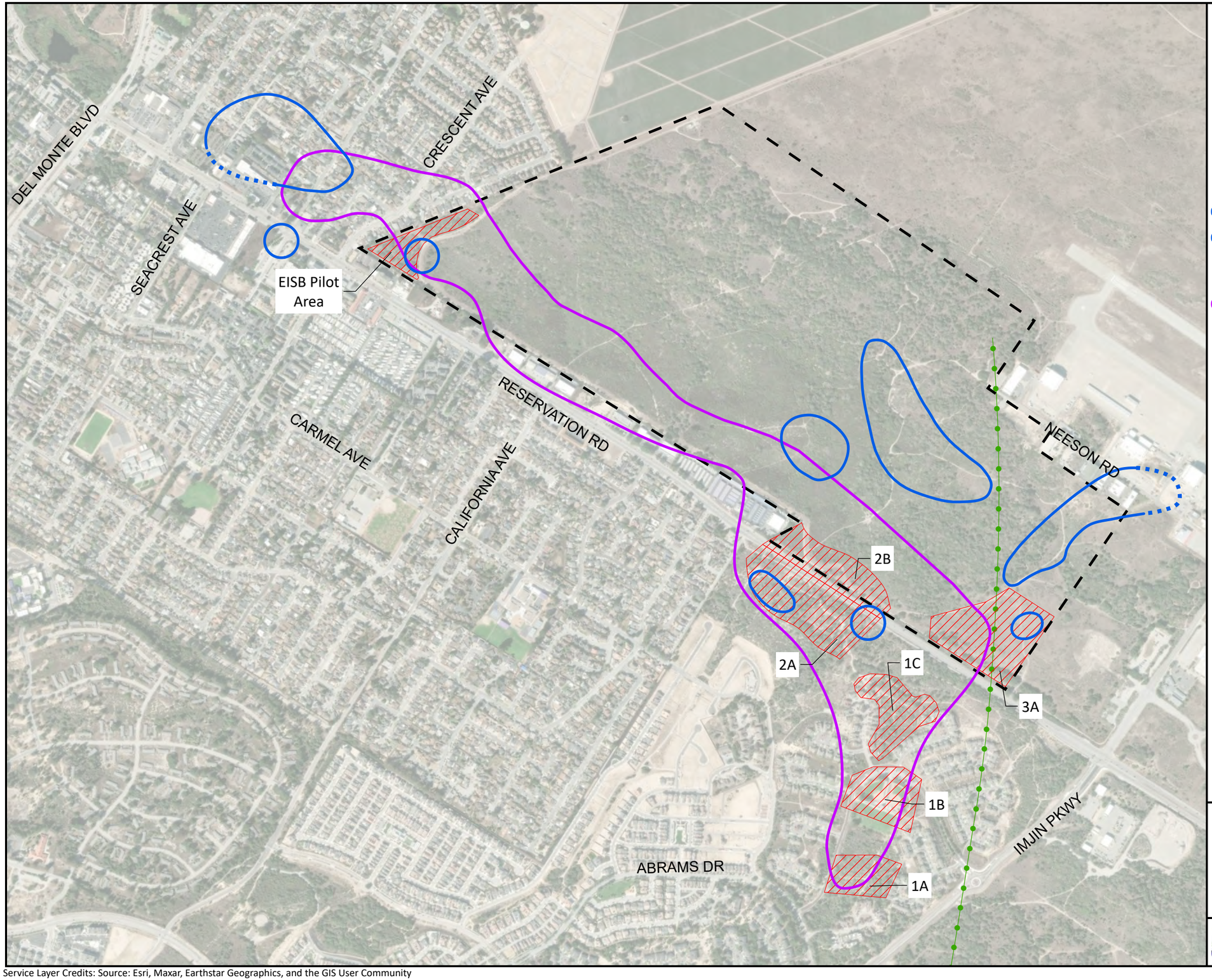
0 250 500
Feet

Sites 2 and 12
Groundwater Remedy Map
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **2**

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EXPLANATION

- Enhanced In-Situ Bioremediation (EISB) Deployment Areas
- Fort Ord Natural Reserve
- Former Fort Ord Boundary

4Q2025 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

- 0.5 — Carbon Tetrachloride (CT) Plume Extent
- 0.5 ··· Estimated CT Plume Extent

4Q2009 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

- 0.5 — CT Plume Extent

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0 1,000 2,000
Feet

OUCTP A-Aquifer
EISB Groundwater Remedy
Deployment Areas
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **3**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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EXPLANATION

Well Type and Sample Schedule

- Extraction well - Water-level only
- Extraction well - Annual VOCs
- Extraction well - Quarterly VOCs
- Monitoring well - Water-level only
- Monitoring well - Annual VOCs
- Monitoring well - Quarterly VOCs

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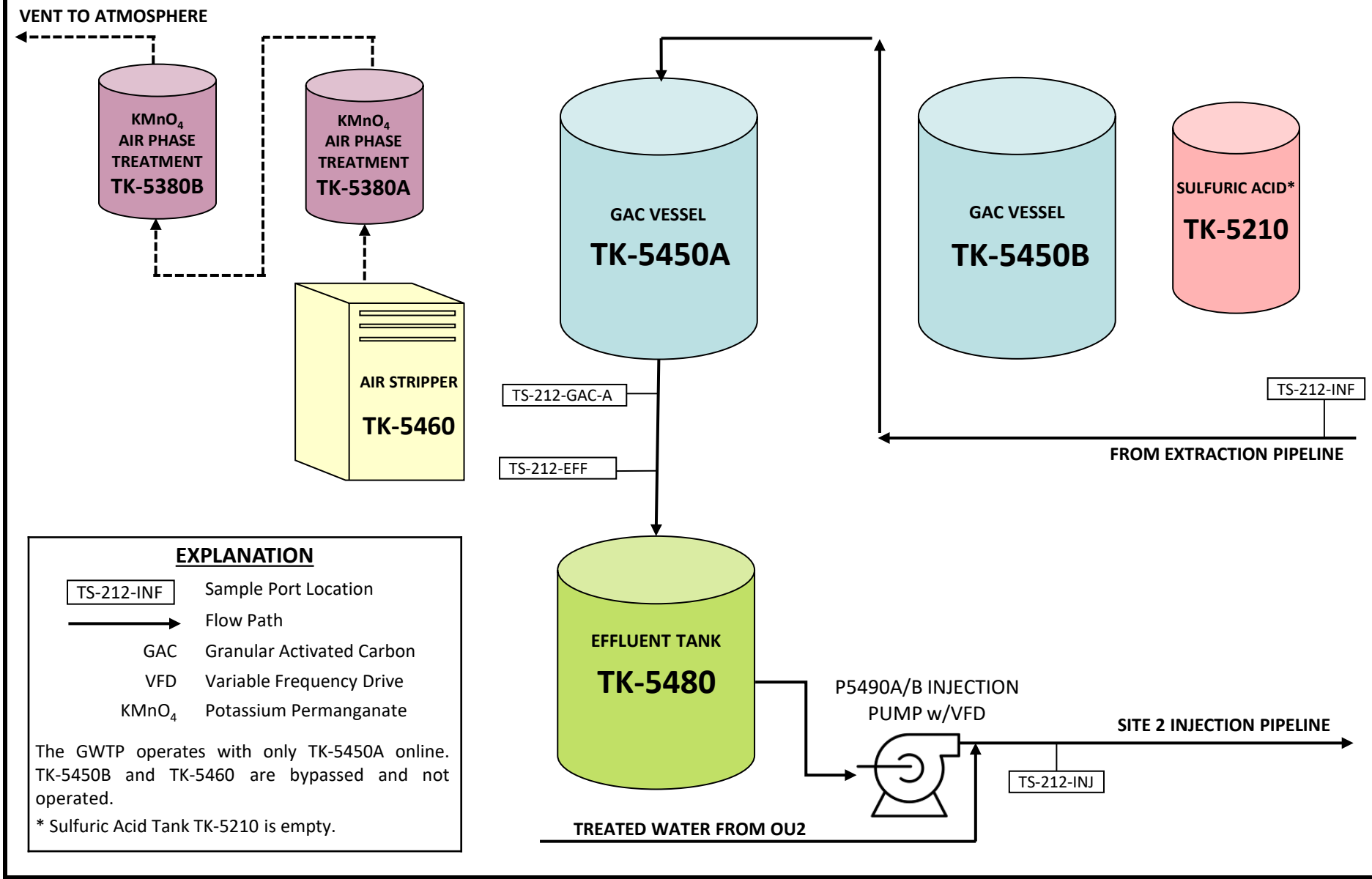
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Feet

Sites 2 and 12
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/23/2026 | Figure: **4**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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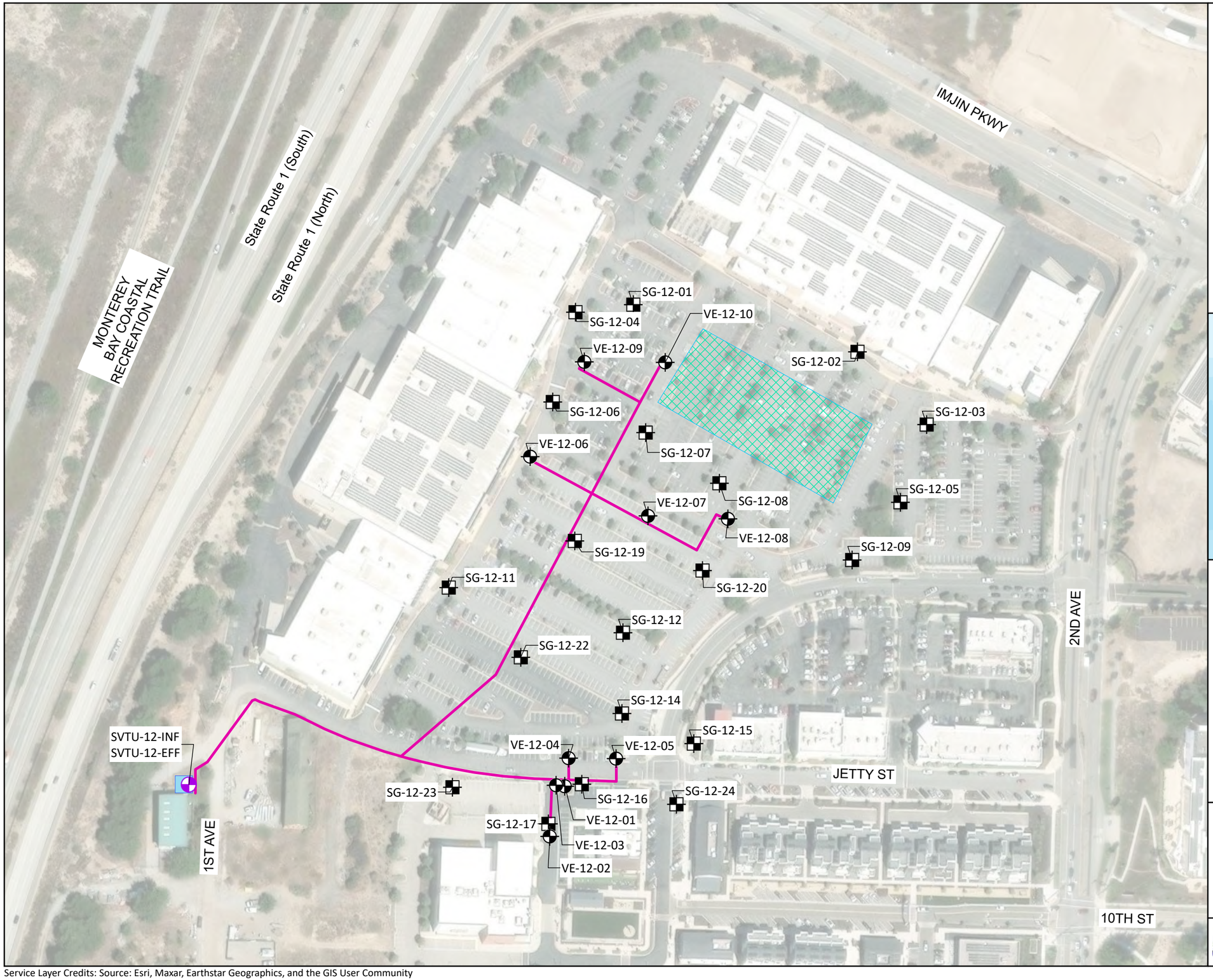


Ahtna

Sites 2 & 12 Groundwater Treatment Plant Schematic

Quality Assurance Project Plan, Groundwater, Soil Gas, and Landfill Gas Monitoring Former Fort Ord, California

Figure: 5

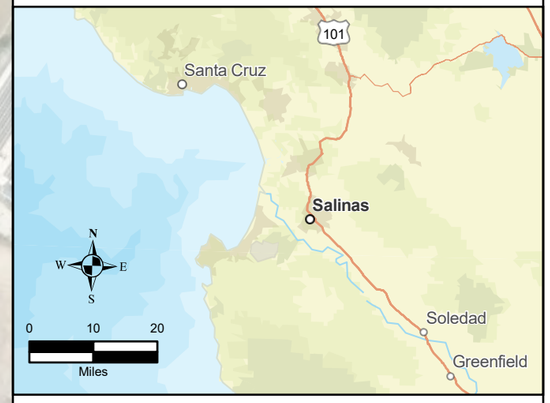


EXPLANATION

- Soil Vapor Extraction Pipeline
- Site 12 Stormwater Infiltration Basin
- Site 12 Boundary
- Soil Vapor Treatment Unit

Well Type

- Soil Gas Probe Cluster
- Soil Vapor Extraction Well
- Soil Vapor Treatment Unit



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Feet

Site 12 Soil Vapor Extraction and Treatment System and Soil Gas Monitoring Map

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

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AC-2330
AIR COOLER
HEAT EXCHANGER

DF-2104
DILUTION AIR FILTER
4 INCH

DS-2302
DISCHARGE SILENCER
8 INCH

DS-2321
DISCHARGE SILENCER
8 INCH

M/B-2320
BLOWER—POSITIVE DISPLACEMENT
W/SOUND ENCLOSURE
60 HP, 480V, 3Ø 1,100 CFM

M/P-2220
TRANSFER PUMP
2 HP, 120V, 1Ø
25 GPM @ 26 FT

M/P-2420
TRANSFER PUMP
⅛ HP, 120V, 1Ø
2 GPM @ 26 FT

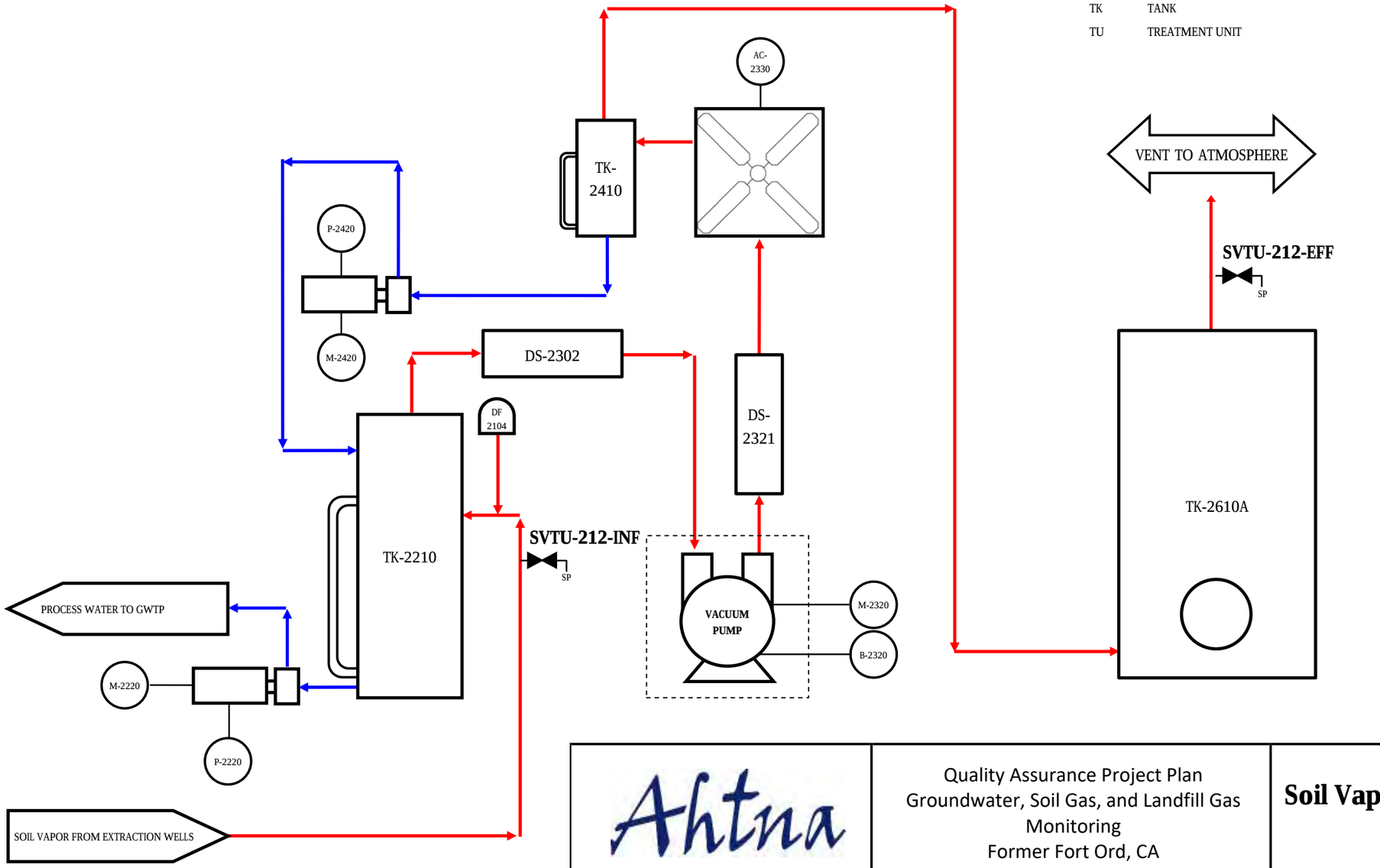
TK-2210 SEPERATOR—
LIQUID
100 GAL

TK-2410 SEPERATOR—
LIQUID
10 GAL

TK-2610A
VAPOR-PHASE CARBON VESSEL
3,000 LB GRANULAR ACTIVATED CARBON EACH

AC	AIR COOLER
B	BLOWER
DF	DILUTION AIR FILTER
DS	DISCHARGE SILENCER
EFF	EFFLUENT
GWTP	GROUNDWATER TREATMENT PLANT
INF	INFLUENT
M	MOTOR
MID	MID-POINT
P	PUMP
SP	SAMPLE PORT
TK	TANK
TU	TREATMENT UNIT

PROCESS AIR (SOIL VAPOR)
PROCESS WATER (CONDENSATE)
SAMPLE PORT

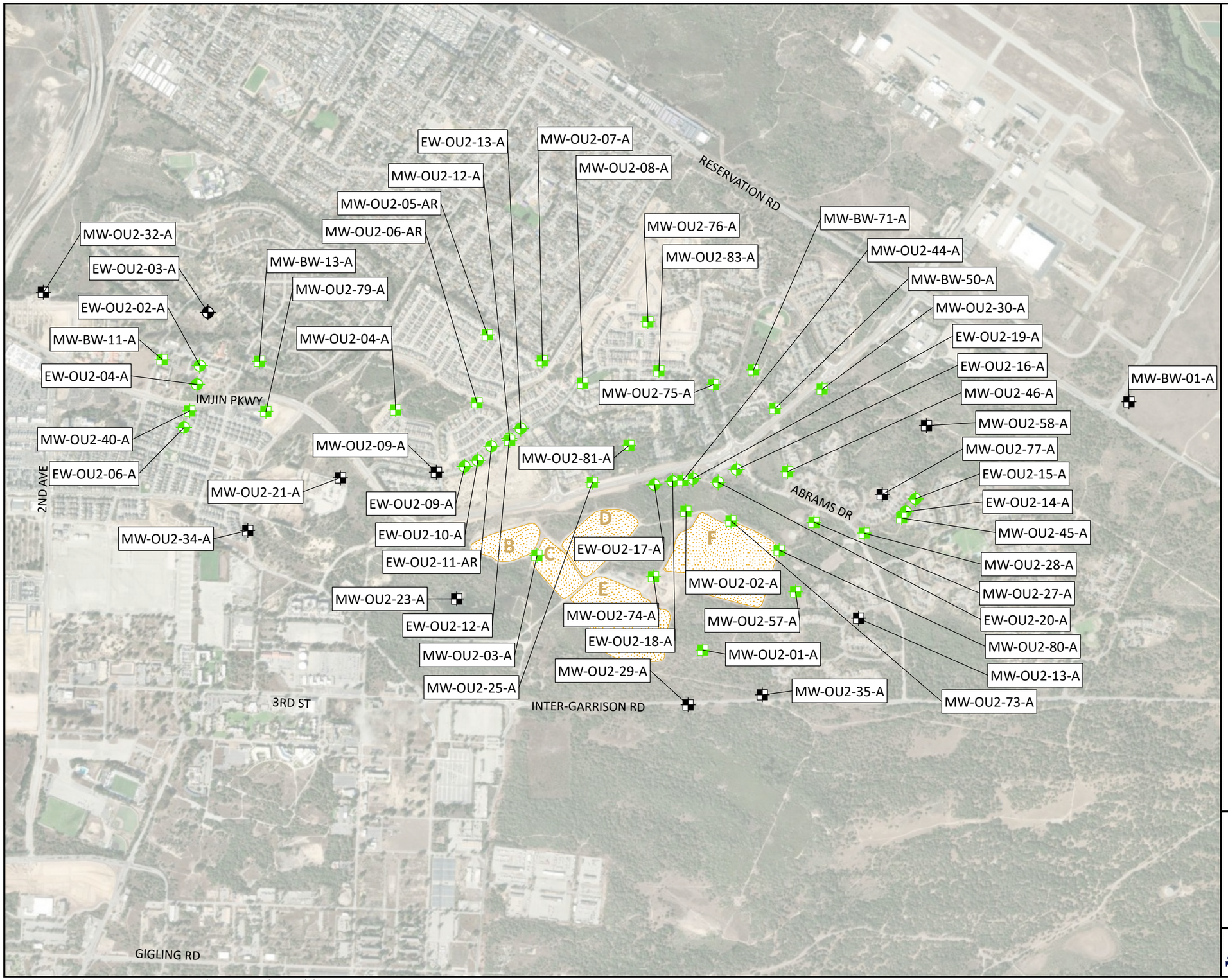


Ahtna

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, CA

Soil Vapor Treatment Unit Schematic

Figure
7



EXPLANATION

- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

Well Type and Sample Schedule

- Extraction Well - Quarterly VOCs
- Extraction Well - Water-level only
- Monitoring Well - Quarterly VOCs
- Monitoring Well - Water-level only

N
W E
S

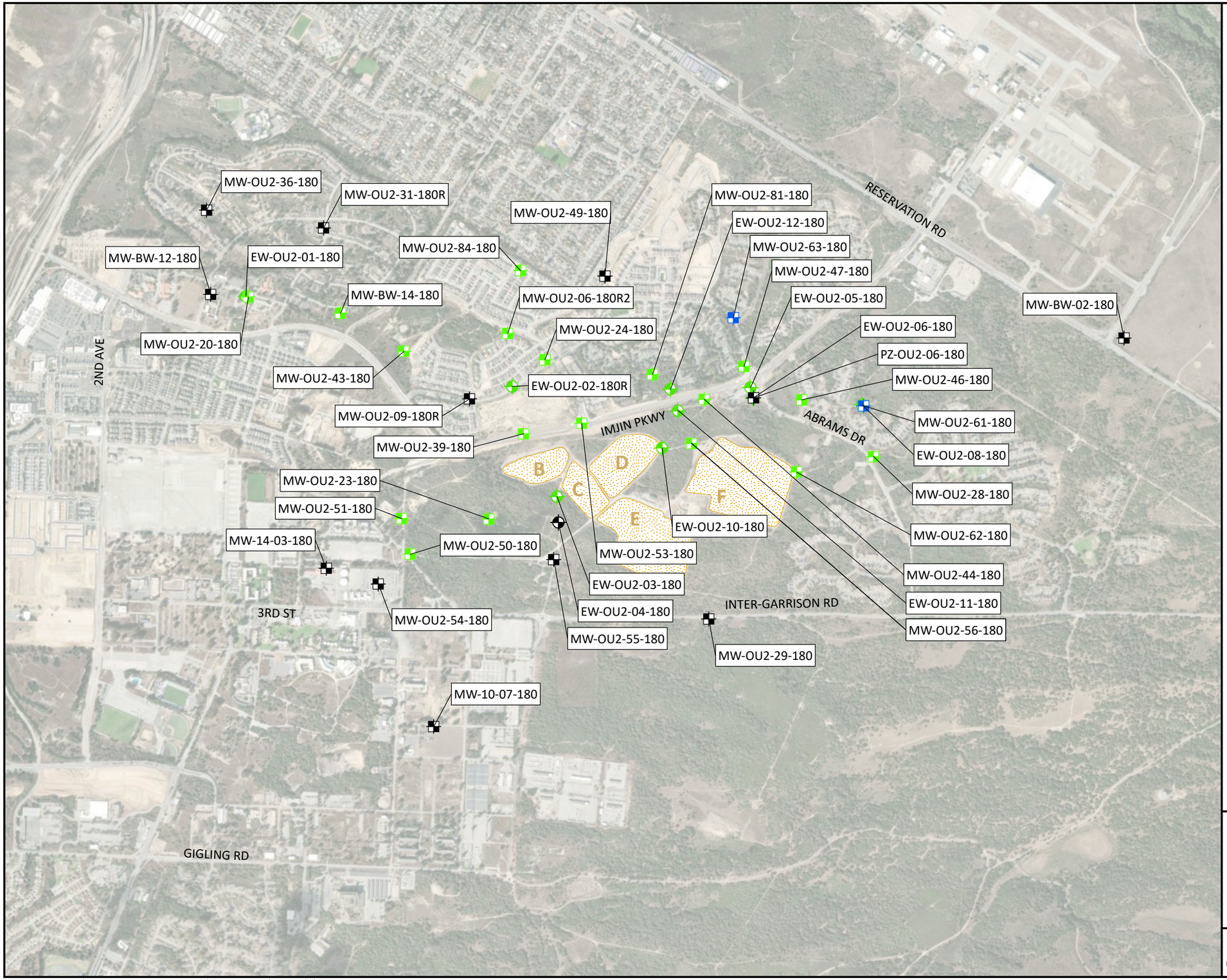
0 1,500 3,000
Feet

OU2 A-Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/23/2026 | Figure: **8**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Imagery Date: March 9, 2025

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EXPLANATION

Approximate extent of landfill areas (Areas B - F)

Sample Type and Sample Schedule

- Extraction well - Quarterly VOCs
- Extraction well - Water-level only
- Monitoring well - Quarterly VOCs
- Monitoring well - Annual VOCs
- Monitoring well - Water-level only

N
W E
S

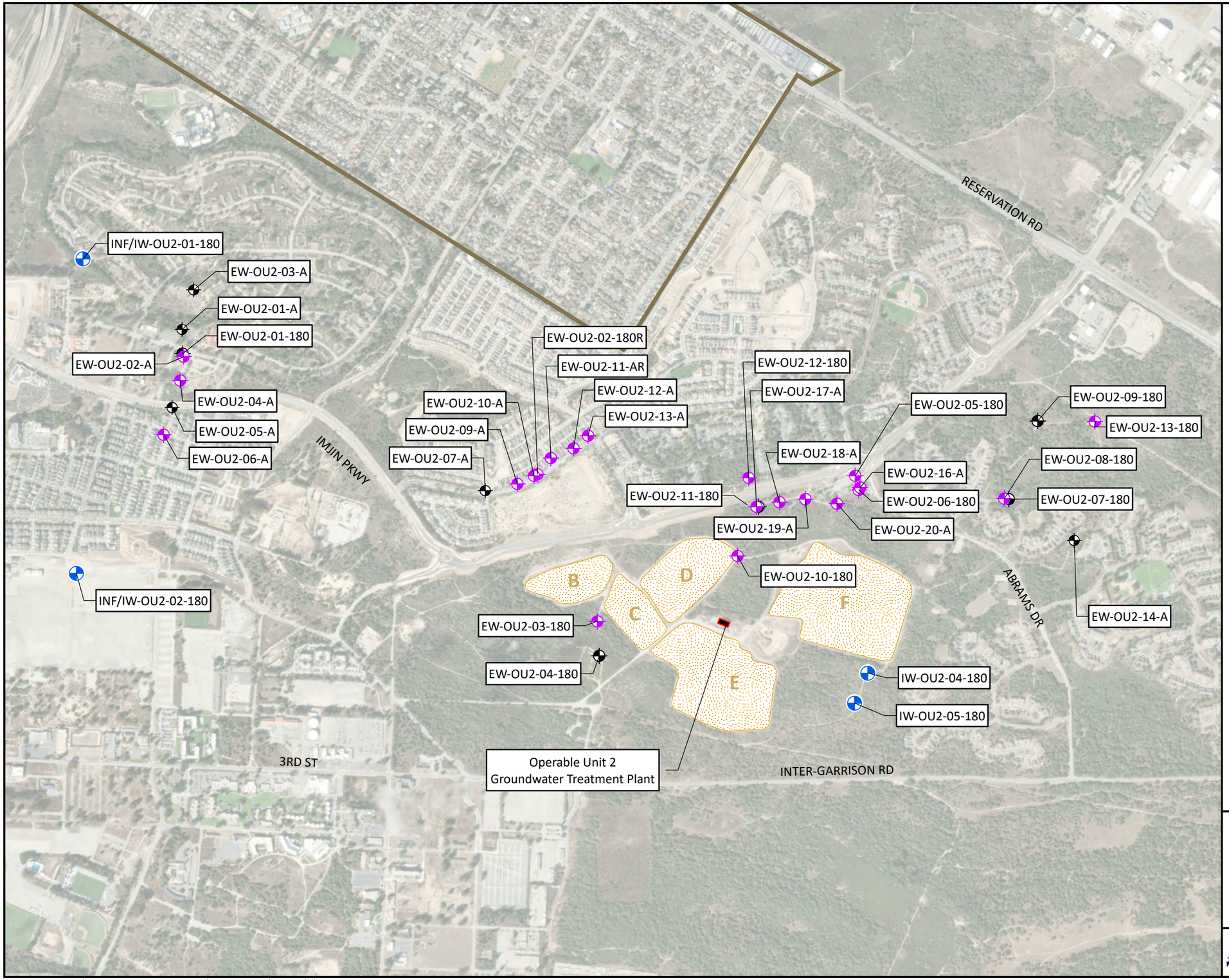
0 1,500 3,000
Feet

OU2 Upper 180-Foot Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/23/2026 | Figure: **9**

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EXPLANATION

- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

Well Type and Operational Status

- Operated
- Not Operated

Injection Well Status

- Injection well - Operated

N
W E
S

0 1,250 2,500
Feet

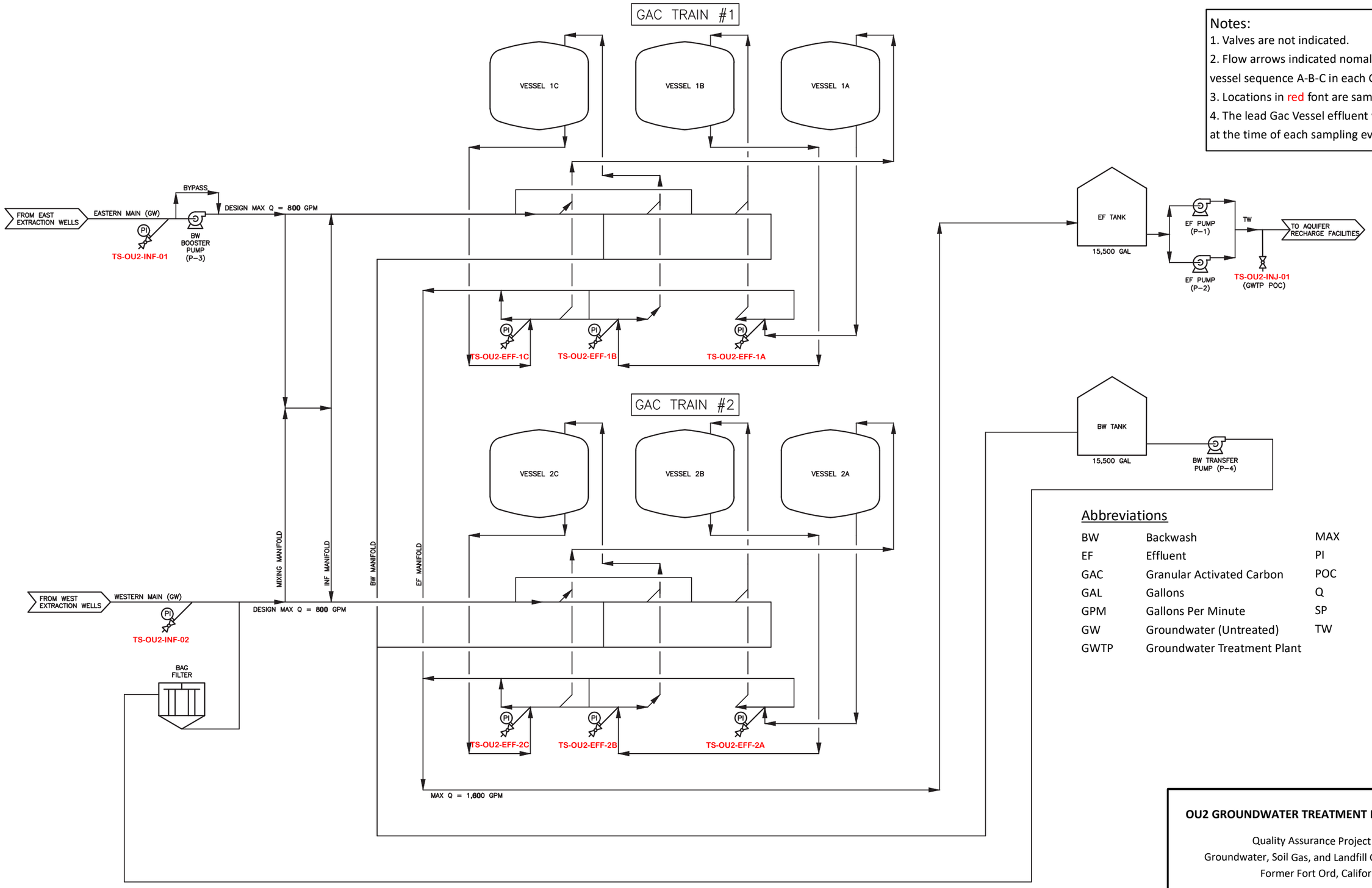
OU2 Groundwater Remedy and OUCTP Upper 180-Foot Aquifer Groundwater Remedy Map

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **10**

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Notes:

1. Valves are not indicated.
2. Flow arrows indicated nomal operation, with vessel sequence A-B-C in each GAC Train.
3. Locations in red font are sample locations.
4. The lead Gac Vessel effluent will be sampled at the time of each sampling event.

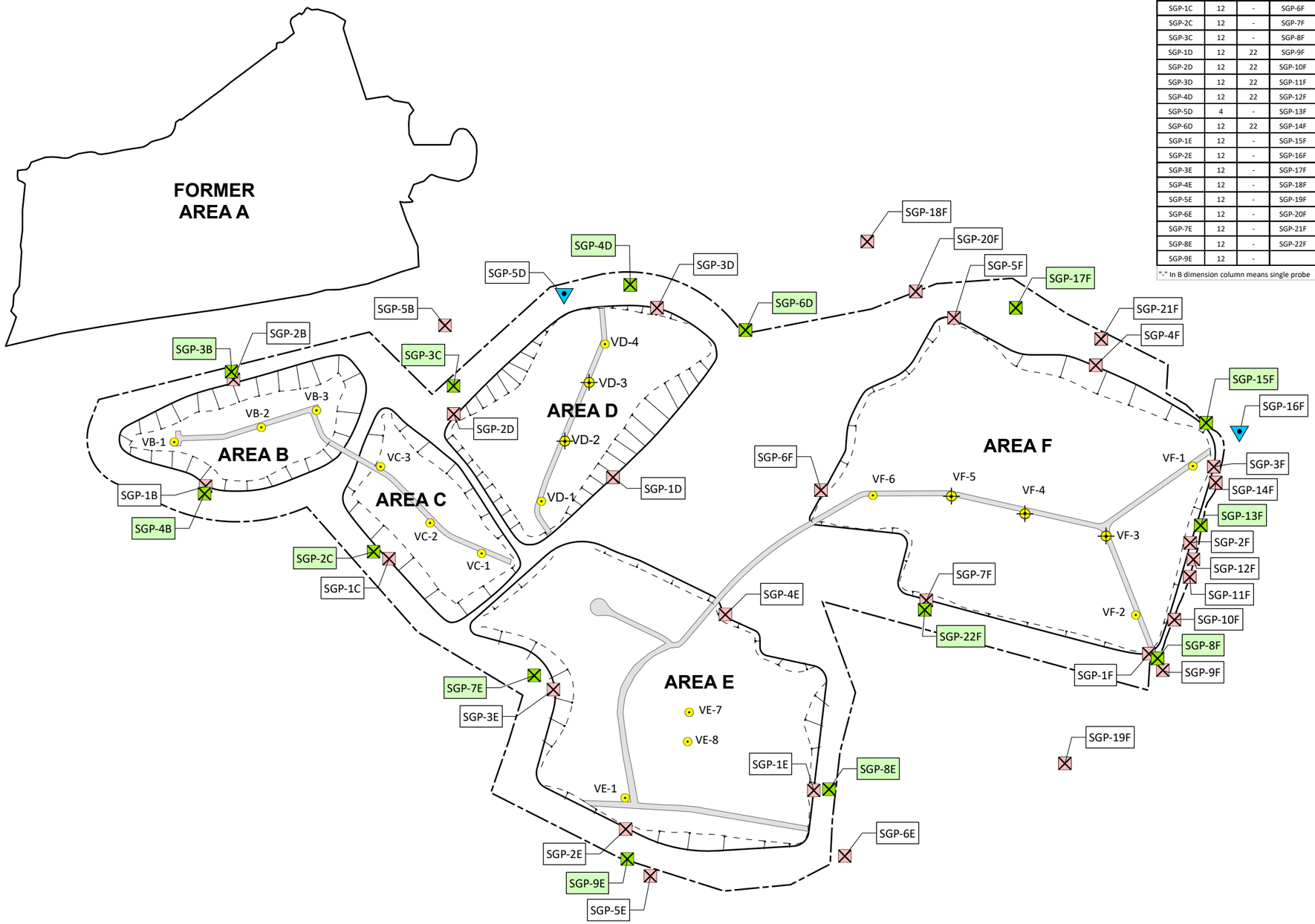
Abbreviations

BW	Backwash	MAX	Maximum
EF	Effluent	PI	Pressure Indicator
GAC	Granular Activated Carbon	POC	Point Of Compliance
GAL	Gallons	Q	Flow Rate
GPM	Gallons Per Minute	SP	Sample Port
GW	Groundwater (Untreated)	TW	Treated Water
GWTP	Groundwater Treatment Plant		

OU2 GROUNDWATER TREATMENT PLANT SCHEMATIC

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 5/17/2026 | Figure: **11**



PROBE DEPTH TABLE

PROBE	DIMENSIONS (FT)		PROBE	DIMENSIONS (FT)	
	A	B		A	B
SGP-1B	12	-	SGP-1F	12	22
SGP-2B	12	-	SGP-2F	12	32
SGP-3B	12	-	SGP-3F	12	32
SGP-4B	12	-	SGP-4F	12	32
SGP-5B	12	-	SGP-5F	12	32
SGP-1C	12	-	SGP-6F	12	32
SGP-2C	12	-	SGP-7F	12	32
SGP-3C	12	-	SGP-8F	12	22
SGP-1D	12	22	SGP-9F	22	-
SGP-2D	12	22	SGP-10F	12	22
SGP-3D	12	22	SGP-11F	12	32
SGP-4D	12	22	SGP-12F	32	-
SGP-5D	4	-	SGP-13F	12	32
SGP-6D	12	22	SGP-14F	12	32
SGP-1E	12	-	SGP-15F	12	32
SGP-2E	12	-	SGP-16F	4	-
SGP-3E	12	-	SGP-17F	12	32
SGP-4E	12	-	SGP-18F	12	32
SGP-5E	12	-	SGP-19F	12	22
SGP-6E	12	-	SGP-20F	12	32
SGP-7E	12	-	SGP-21F	12	22
SGP-8E	12	-	SGP-22F	12	32
SGP-9E	12	-			

"-" In B dimension column means single probe

EXPLANATION

- Landfill gas (LFG) perimeter probe used for quarterly compliance monitoring and annual VOC monitoring
- Additional LFG monitoring probe
- LFG extraction vent
- LFG vent
- Utility trench monitoring probe
- Access road
- Landfill parcel boundary

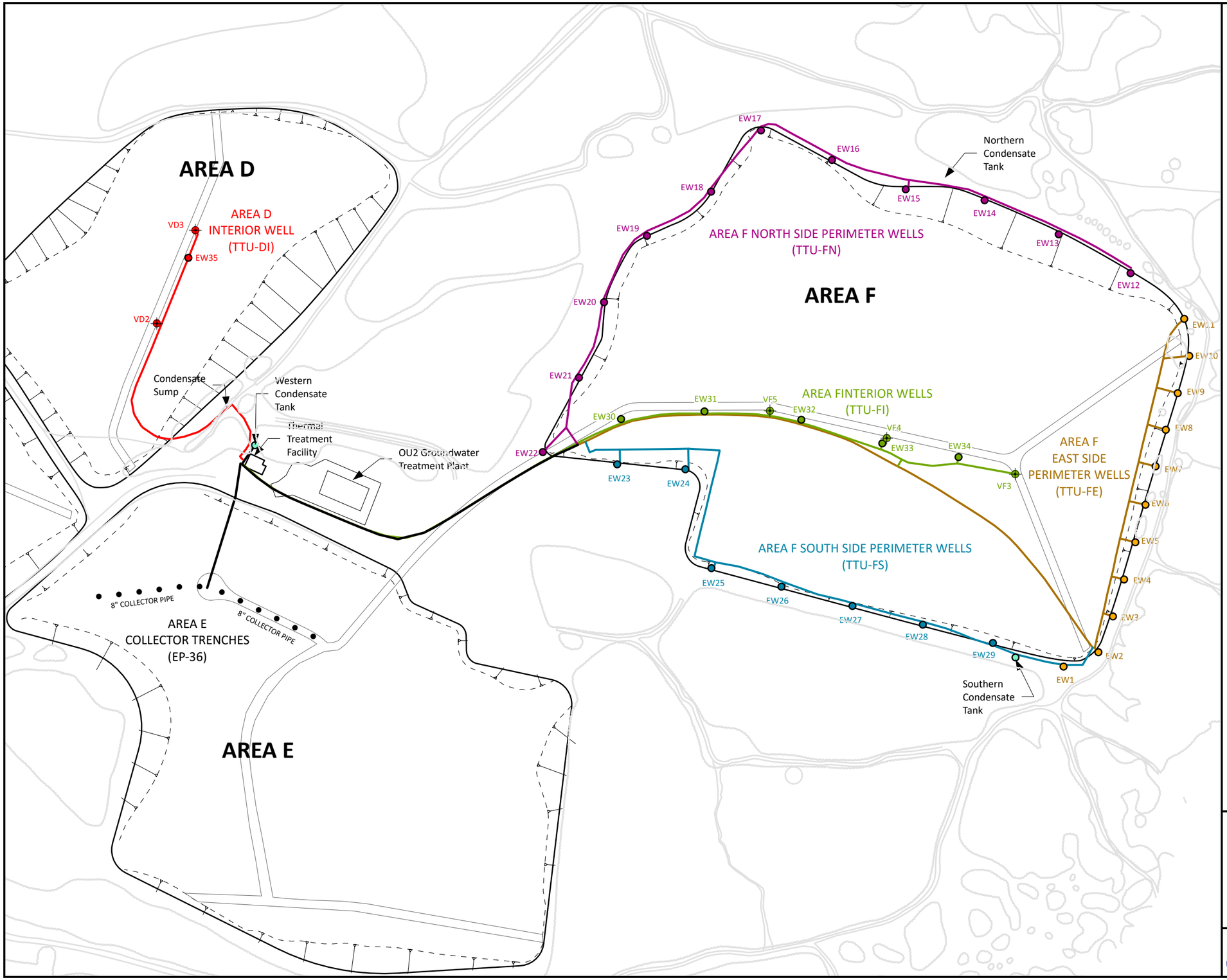
N
W E
S

0 500 1,000
Feet

OU2 LANDFILL GAS MONITORING LOCATIONS
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **12**

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EXPLANATION

- Area D Extraction Vent
- Area F Extraction Vent
- Area D Interior Probes
- Area F East Side Perimeter Probes
- Area F Interior Probes
- Area F North Side Perimeter Probes
- Area F South Side Perimeter Probes
- Area D Interior Header Pipe
- Area F East Side Perimeter Header Pipe
- Area F Interior Header Pipe
- Area F North Side Perimeter Header Pipe
- Area F South Side Perimeter Header Pipe
- Header Pipe
- Area E Collector Trench (EP-36)
- Condensate Sump
- Condensate Tank

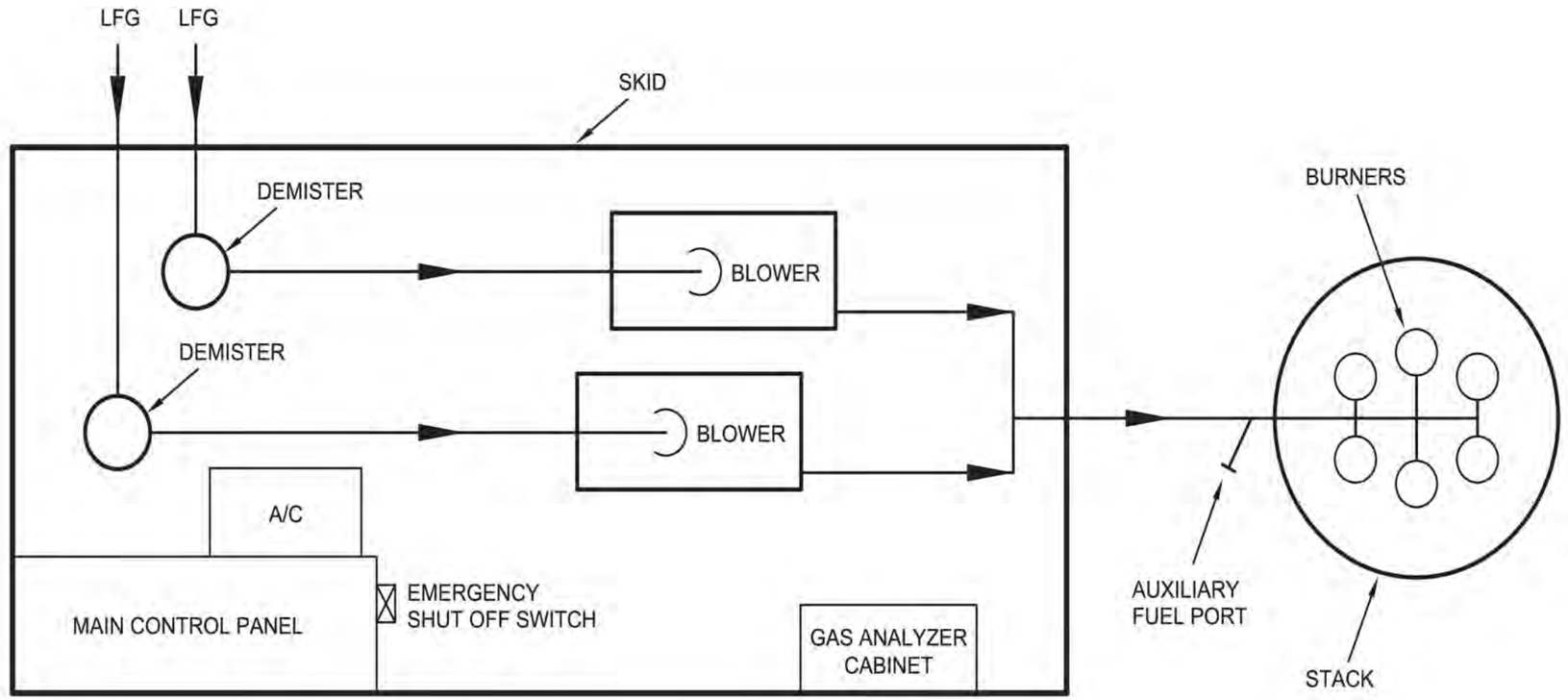
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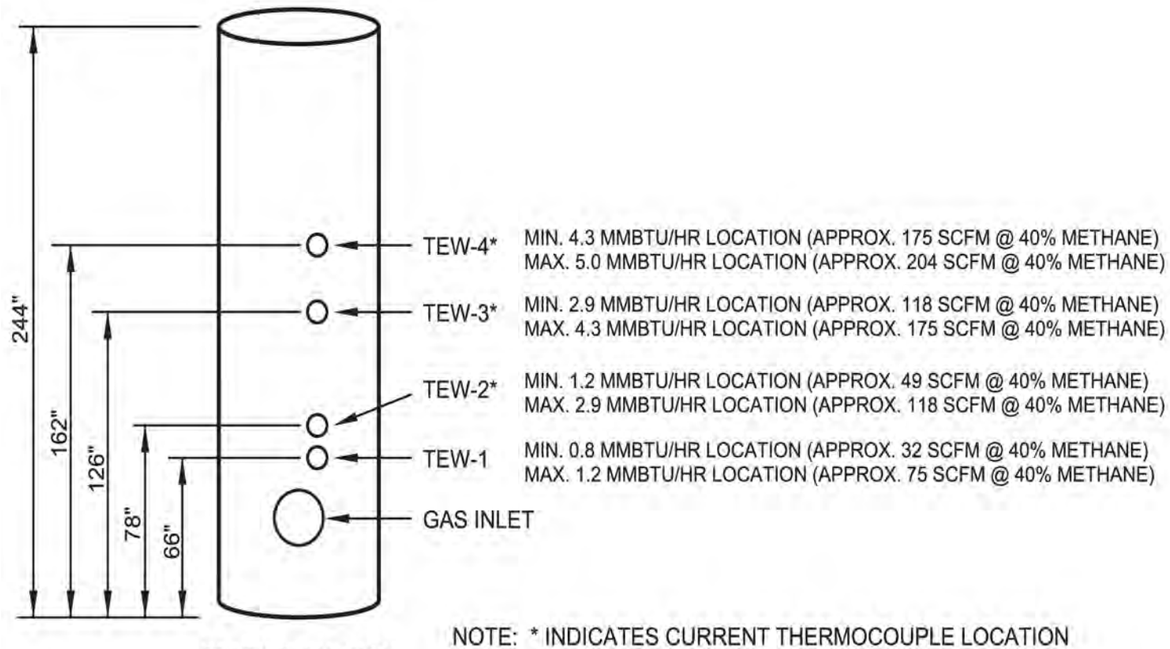
0 250 500
Feet

OU2 LANDFILL GAS EXTRACTION and TREATMENT SYSTEM
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **13**

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MIN. 4.3 MMBTU/HR LOCATION (APPROX. 175 SCFM @ 40% METHANE)
MAX. 5.0 MMBTU/HR LOCATION (APPROX. 204 SCFM @ 40% METHANE)

MIN. 2.9 MMBTU/HR LOCATION (APPROX. 118 SCFM @ 40% METHANE)
MAX. 4.3 MMBTU/HR LOCATION (APPROX. 175 SCFM @ 40% METHANE)

MIN. 1.2 MMBTU/HR LOCATION (APPROX. 49 SCFM @ 40% METHANE)
MAX. 2.9 MMBTU/HR LOCATION (APPROX. 118 SCFM @ 40% METHANE)

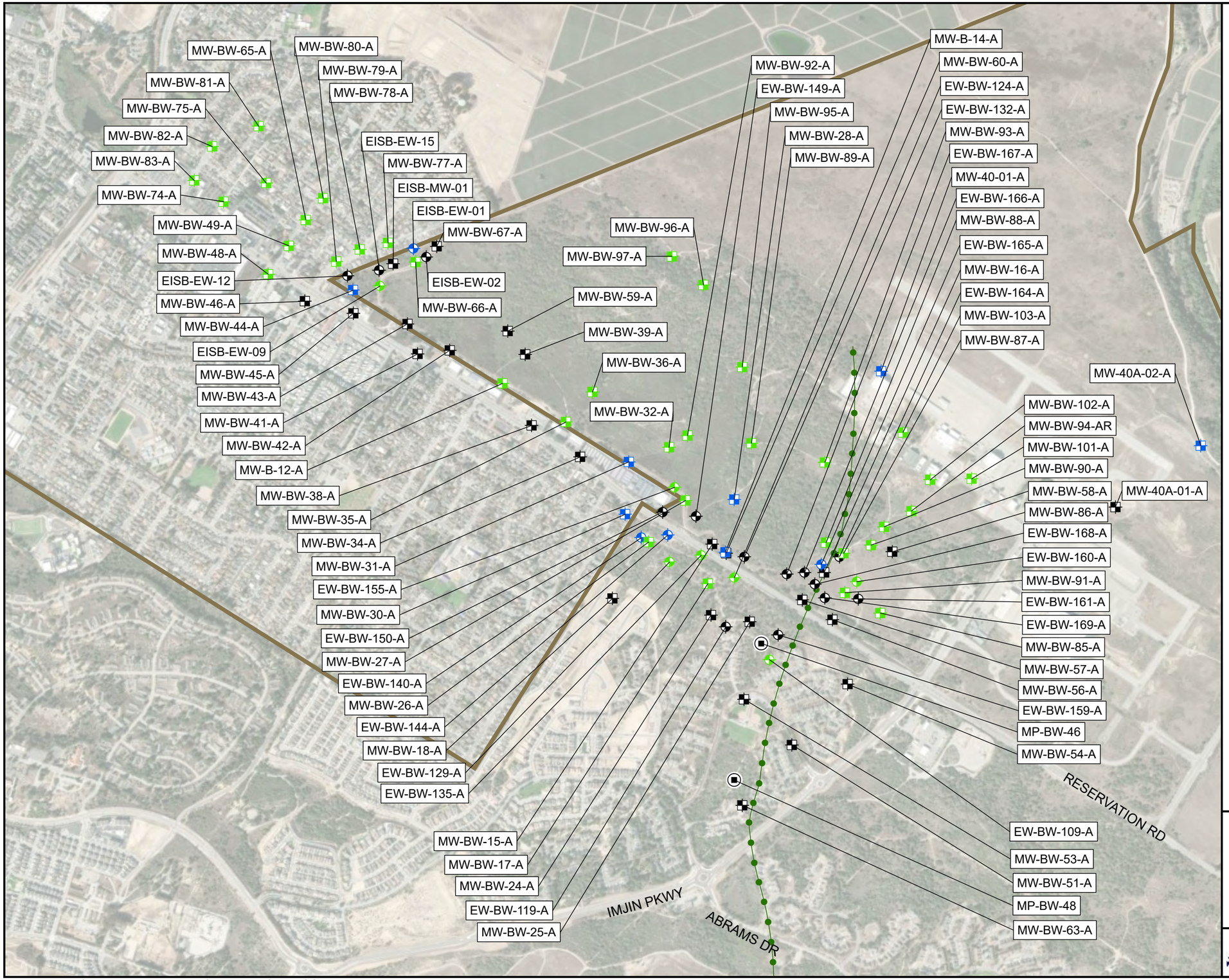
MIN. 0.8 MMBTU/HR LOCATION (APPROX. 32 SCFM @ 40% METHANE)
MAX. 1.2 MMBTU/HR LOCATION (APPROX. 75 SCFM @ 40% METHANE)

STACK ELEVATION

NOTE: * INDICATES CURRENT THERMOCOUPLE LOCATION

OU2 LANDFILL GAS
THERMAL TREATMENT UNIT SCHEMATIC
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas
Monitoring Former Fort Ord, California

Ahtna | Date: 6/19/2026 | Figure: **14**



EXPLANATION

- Approximate location of the A-Aquifer groundwater divide
- Former Fort Ord Boundary

Well Type and Sample Schedule

- Extraction well - Quarterly VOCs
- Extraction well - Annual VOCs
- Extraction well - Water-level only
- Monitoring well - Quaterly VOCS
- Monitoring well - Annual VOCs
- Monitoring well - Water-level only
- Multi-Port well - Water-level only

N
W E
S

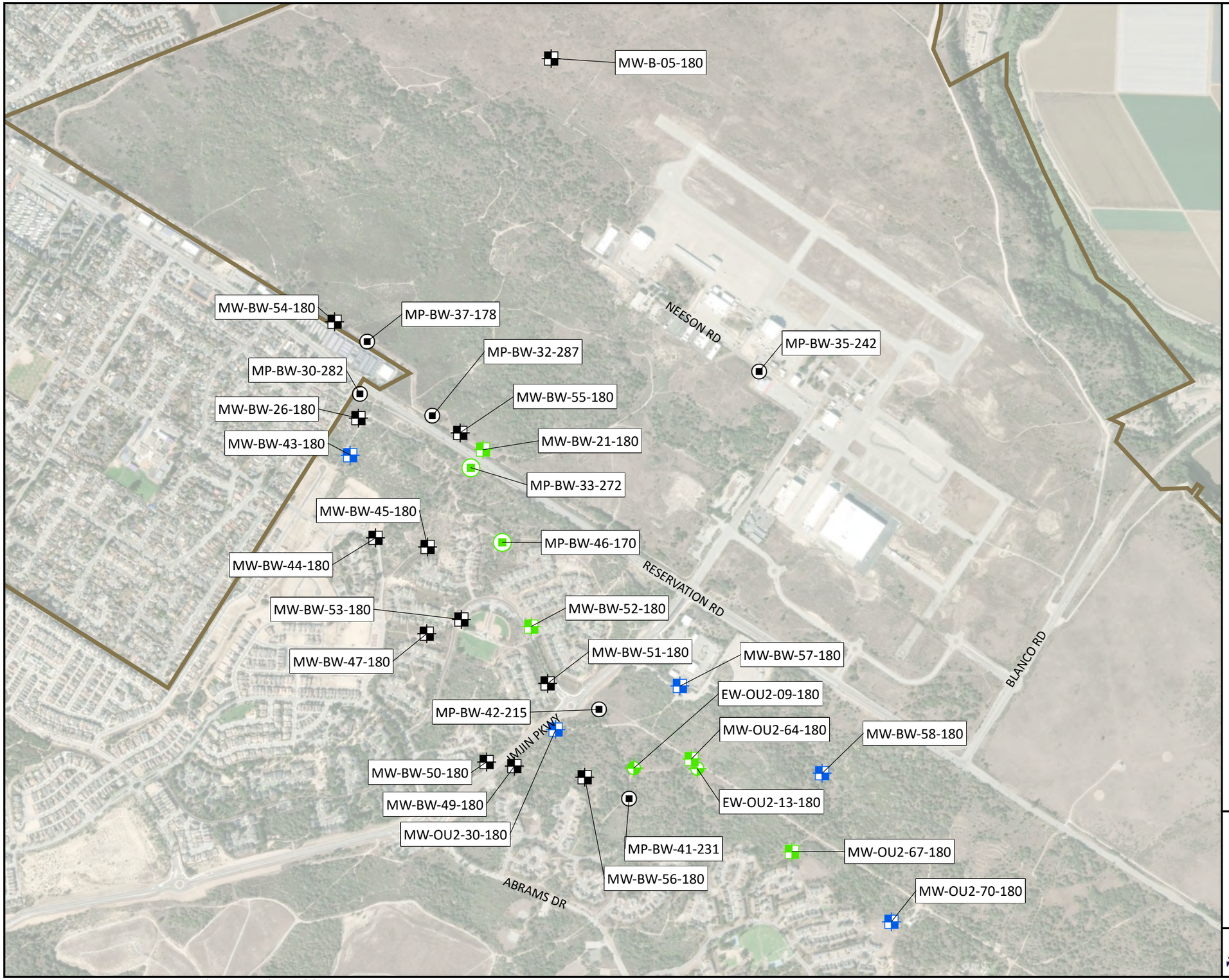
0 1,250 2,500
Feet

OUCTP A-Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **15**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Imagery Date: March 9, 2025

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EXPLANATION

- Former Fort Ord Boundary

Well Type and Sampling Schedule

- Extraction well - Quarterly VOCs
- Monitoring well - Quarterly VOCs
- Monitoring well - Annual VOCs
- Monitoring well - Water-level only
- Multi-Port well - Quarterly VOCs
- Multi-Port well - Water-level only

N
W E
S

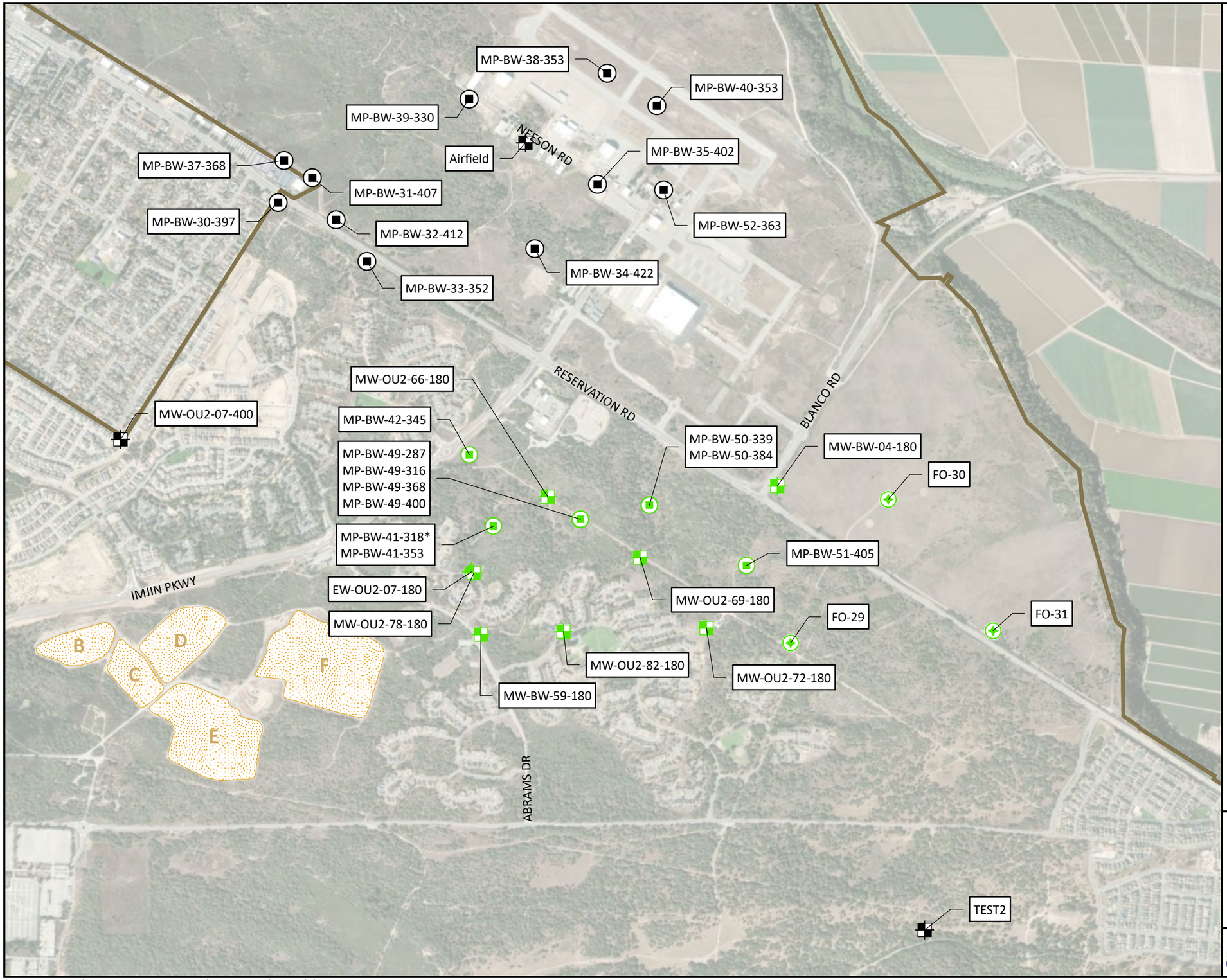
0 1,250 2,500
Feet

OUCTP Upper 180-Foot Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **16**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Imagery Date: March 9, 2025

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EXPLANATION

- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

Well Type and Sample Schedule

- MCWD production well - Quarterly VOCs
- Extraction well - Quarterly VOCs
- Monitoring well - Quarterly VOCs
- Multi-Port well - Quarterly VOCS
- Monitoring well - Annual VOCs
- Monitoring well - Water-level only
- Multi-Port well - Water-level only
- Roads

NOTE:
*MP-BW-41-318 requires annual VOC sampling;
MP-BW-41-353 requires quarterly VOC sampling.

N
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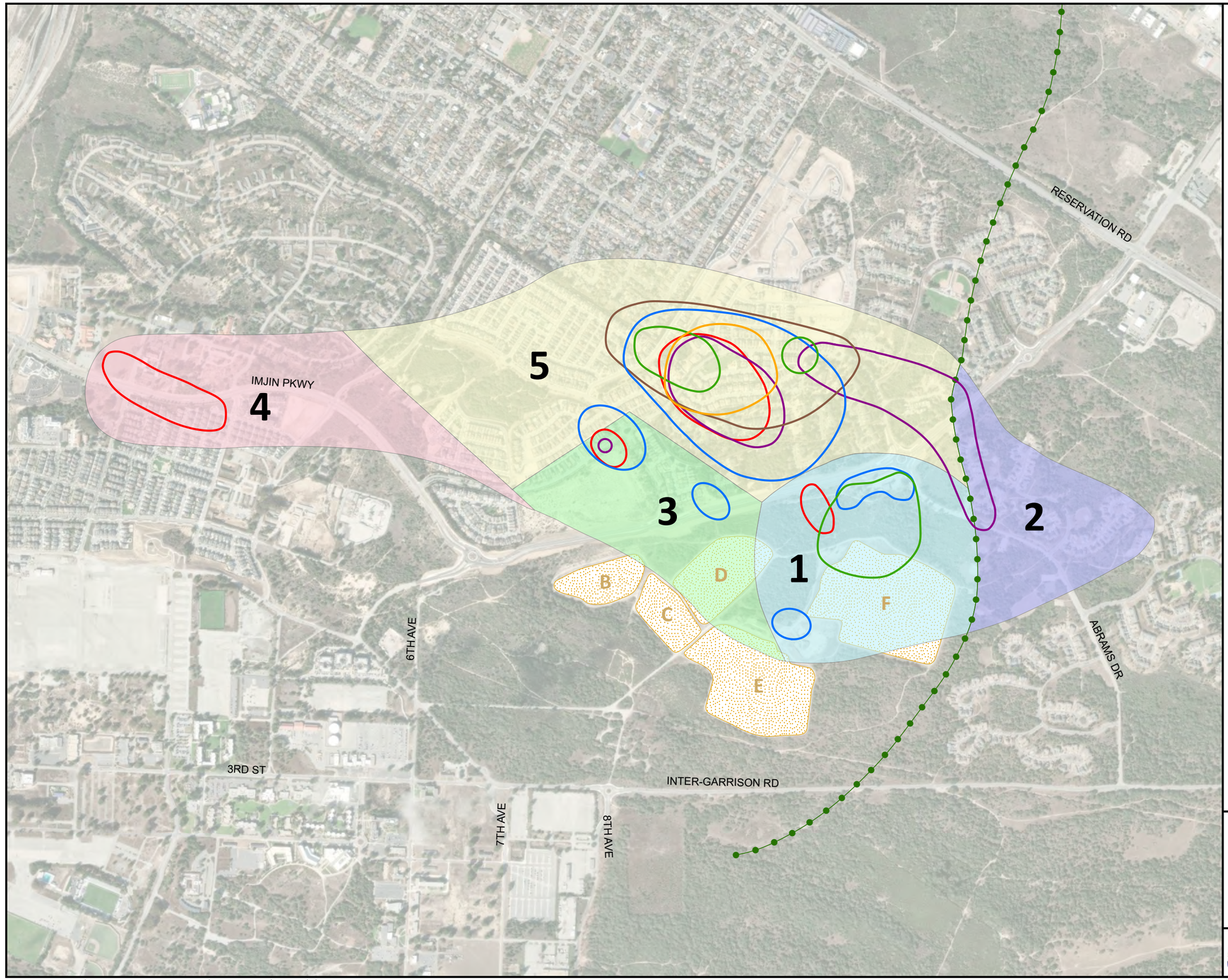
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Feet

OUCTP Lower 180-Foot Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **17**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Imagery Date: March 9, 2025

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EXPLANATION

- Approximate Location of the A-Aquifer Groundwater Divide
- Approximate edge of the Fort Ord-Salinas Valley Aquitard (FO-SVA)
- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

4Q2025 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

- 5 — Trichloroethene (TCE) plume extent
- 3 — Tetrachloroethene (PCE) plume extent
- 5 — 1,1-Dichloroethane (1,1-DCA) plume extent
- 0.5 — 1,2-Dichloroethane (1,2-DCA) plume extent
- 0.1 — Vinyl Chloride (VC) plume extent
- 6 — cis-1,2-Dichloroethene (cis-1,2 DCE) plume extent

OU2 A-Aquifer Hydraulic Zone

- 1
- 2
- 3
- 4
- 5

N
W E
S

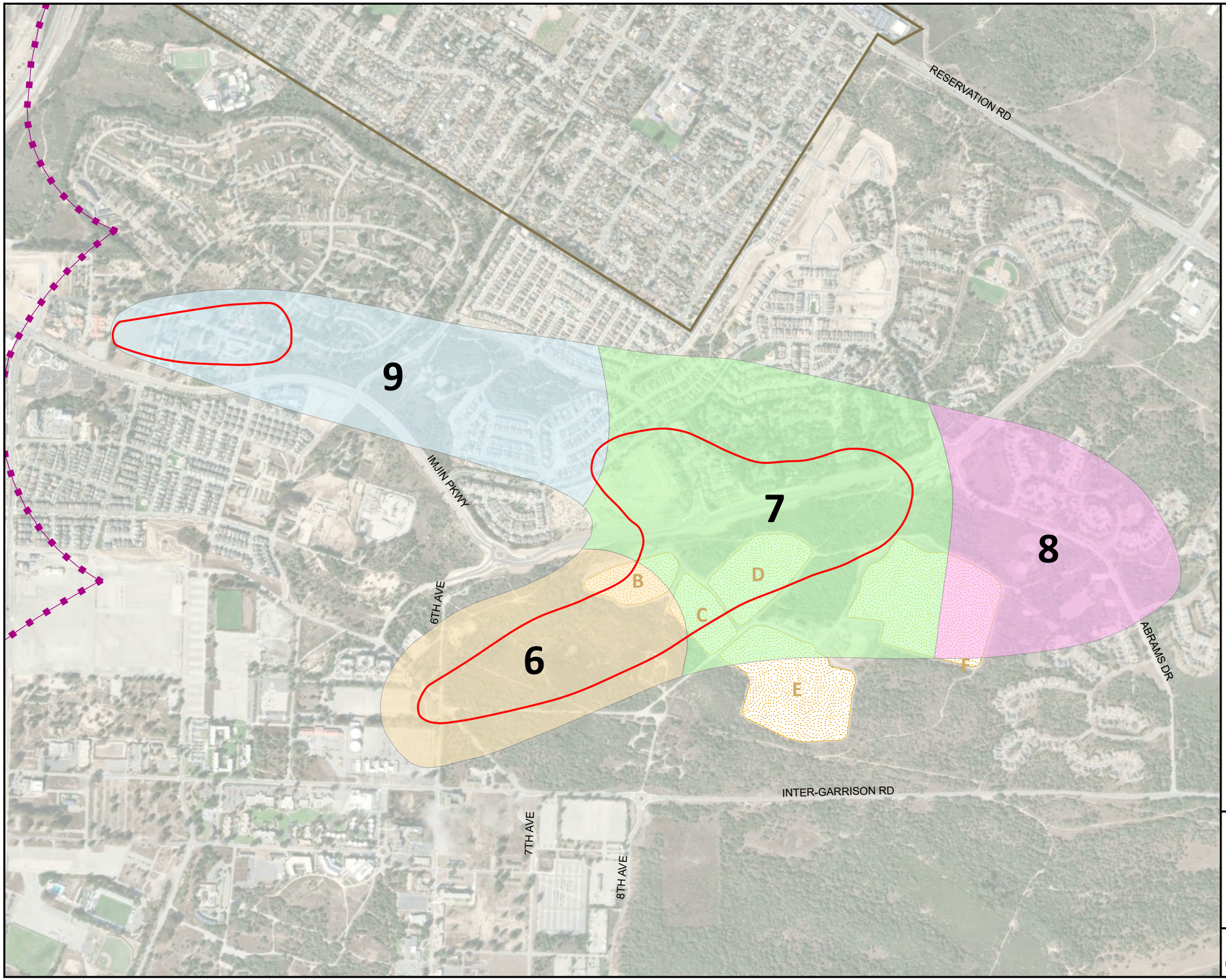
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Feet

OU2 A-Aquifer
Hydraulic Zone Map
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **18**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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EXPLANATION

- Approximate edge of the Fort Ord-Salinas Valley Aquitard (FO-SVA)
- Approximate location of the Upper 180-Foot Aquifer groundwater divide
- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord boundary

4Q2025 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

5 — Trichloroethene (TCE) plume extent

OU2 Upper 180-Foot Aquifer Hydraulic Zone

- 6
- 7
- 8
- 9

N
W E
S

0 1,000 2,000
Feet

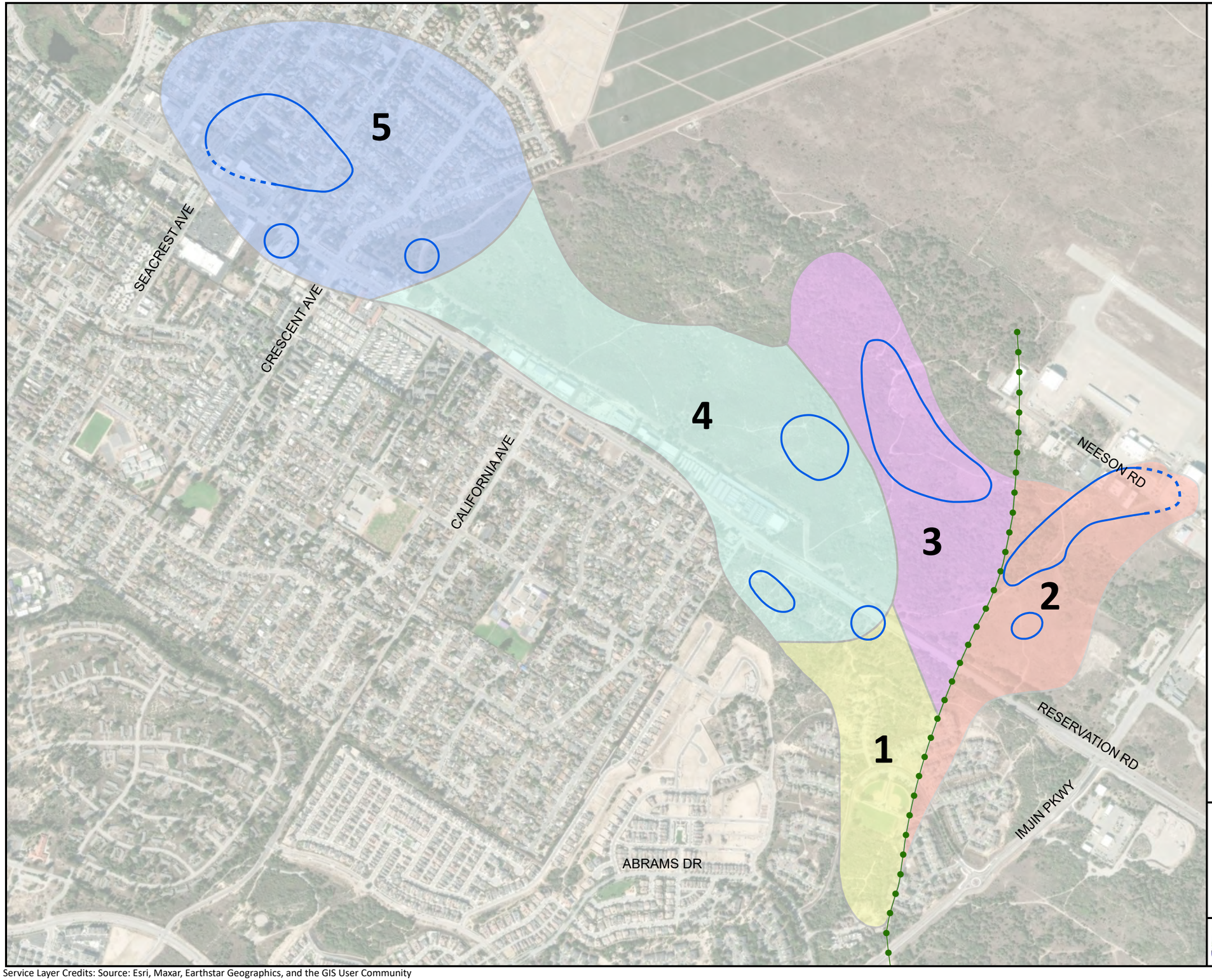
OU2 Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **19**

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EXPLANATION

Approximate location of the A-Aquifer groundwater divide

Former Fort Ord boundary

4Q2025 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

0.5 Carbon tetrachloride (CT) plume extent

0.5 CT plume extent inferred

OUCTP A-Aquifer Hydraulic Zone

1

2

3

4

5

N
W E
S

0 1,000 2,000
Feet

OUCTP A-Aquifer
Hydraulic Zone Map
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **20**

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EXPLANATION

Approximate extent of landfill areas (Areas B - F)

Former Fort Ord Boundary

4Q2025 Chemical of Concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L

0.5 Carbon tetrachloride (CT) plume extent

OUCTP Upper 180-Foot Aquifer Hydraulic Zone

6

N
W E
S

0 1,000 2,000
Feet

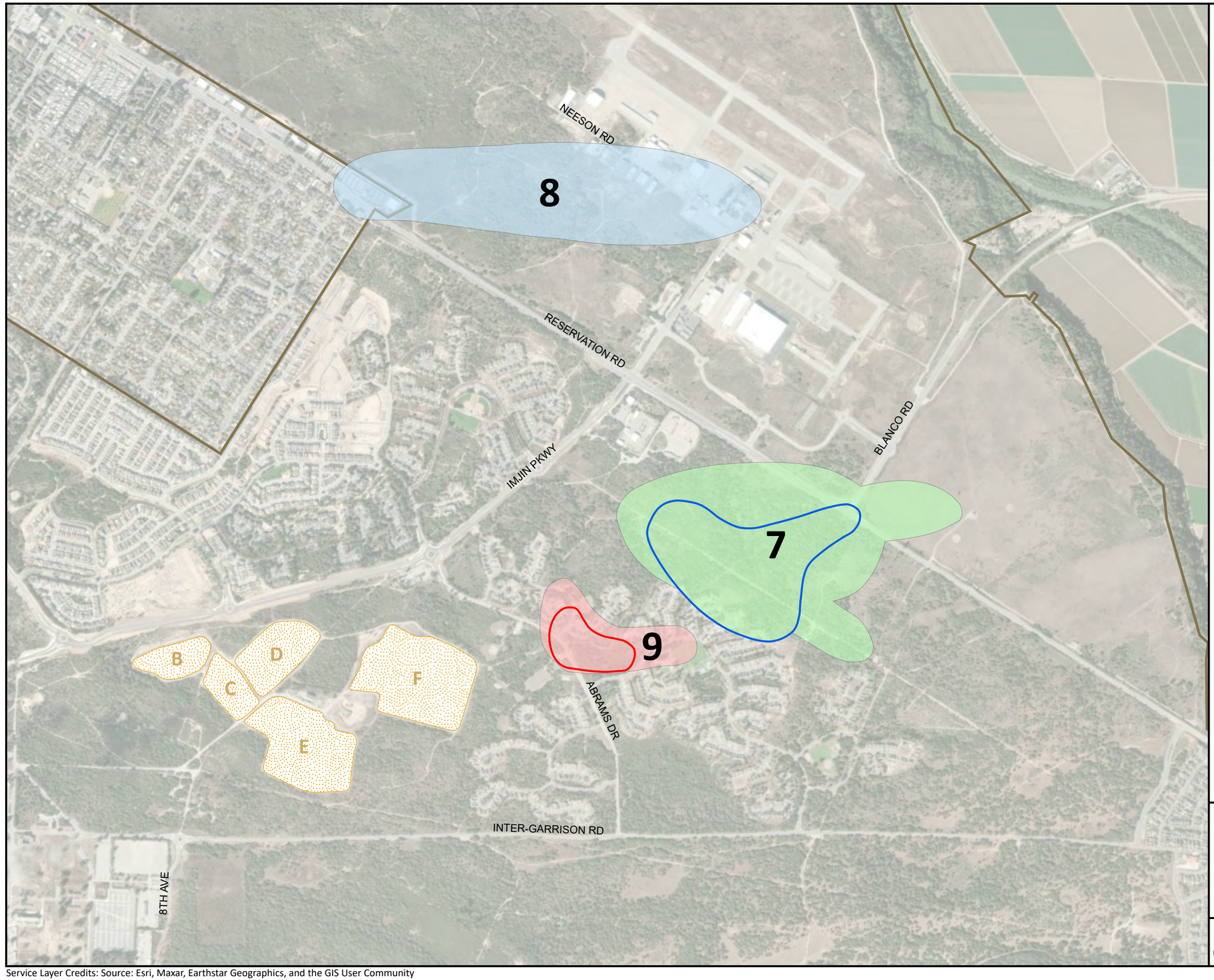
OUCTP Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **21**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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EXPLANATION

- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord boundary

4Q2025 Chemical of Concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L

- 0.5 — Carbon tetrachloride (CT) plume extent
- 5 — Trichloroethene (TCE) plume extent

OUCTP Lower 180-Foot Aquifer Hydraulic Zone

- 7
- 8
- 9

N
W E
S

0 1,500 3,000
Feet

OUCTP Lower 180-Foot Aquifer Hydraulic Zone Map
Quality Assurance Project Plan
Groundwater, Soil Gas, and Landfill Gas Monitoring
Former Fort Ord, California

Ahtna | Date: 7/14/2026 | Figure: **22**

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
Imagery Date: March 9, 2025

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APPENDICES

APPENDIX A
STANDARD OPERATING PROCEDURES (SOPs)

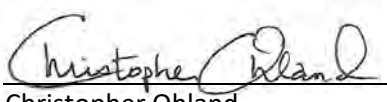
SAMPLING SOPs

SOP Number	SOP Title
FSOP-001	Fieldwork Documentation
FSOP-002	Sample Management
FSOP-201.00	Soil Classification
FSOP-301.00	Hollow Stem Auger
FSOP-302.00	Sonic Drilling
FSOP-303.00	Direct Push Drilling
FSOP-304.00	Mud Rotary Drilling
FSOP-305.00	Air Rotary Drilling
FSOP-408	Soil Vapor Sampling
FSOP-601.01	Well Installation
FSOP-602.02	Well Development
FSOP-603.01	Well Decommissioning
FSOP-606.00	Groundwater Well Rehabilitation
FSOP-802	Investigation Derived Waste Management
FSOP-A1	Supply and Irrigation Well Sampling Protocol
FSOP-A2	OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements
FSOP-A3	Low Flow Groundwater Quality Parameter Collection
FSOP-A4	Downhole Meter Groundwater Quality Parameter Collection
FSOP-A5	Source Test Protocol, Former Fort Ord, Monterey, CA. Thermal Treatment Unit (TTU). April 1, 2025
FSOP-A6	SVE Treatment System Sampling
FSOP-A7	SVE Treatment System Flow Meter Use
FSOP-E1	Field Sampling Procedure Using Canisters with Quick-Connect (QC) Fittings: Grab Sample Collection
FSOP-E2	Guide to Air Sampling Canister and Bags (Eurofins, 2014)
FSOP-E3	Helium Shroud Spec Sheet (Eurofins, 2014)
FSOP-GA1	Oil-Less Diaphragm Vacuum Pump & Compressors Operation & Maintenance Manual
FSOP-GE1	HydraSleeve Field Manual
FSOP-K1	Key Instruments 2500 Series Flowmeters; installation and operation manual
FSOP-L1	GEM™ 5000 Gas Analyzer and Extraction Monitor, Operation Manual (LANDTEC, 2018)
FSOP-S1	Westbay MOSDAX Sampler Probe – Model 2531 Operations Manual
FSOP-T1	Trimble Catalyst DA2
FSOP-USGS1	PDB Sampling Protocol
FSOP-Y1	YSI ProDSS Instruction Manual

Fieldwork Documentation

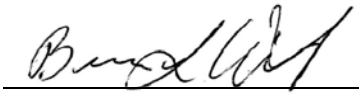
Document Number	FSOP-001
Revision	1
Department	Ahtna Southwest Operations
Previous Document Number	Original Document
Originally Released	April 1, 2022
Effective Date	October 10, 2022

Approvals



Christopher Ohland
SWE Quality Assurance Manager

October 10, 2022
Date



Bruce Wilcer

October 10, 2022
Date

Project-Specific Modification[1]

05/22/2023: References to Global Positioning System (FSOP-103) do not apply. Ahtna uses a Trimble Catalyst DA2. Manufacturer's instructions: https://rb.gy/lz13m

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS- friendly supplies and procedures.

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1.0 Introduction

1.1 Purpose

This SOP provides field personnel with the procedures for:

- Recording real-time, chronological logs of field activities and circumstances in field logbooks/notepads, field forms, and digital/electronic media
- Documenting fieldwork and fieldwork variances
- Ensuring documentation is reviewed, organized, and safely stored until the project closed out

Adequate documentation is necessary to describe the work performed and variances to work plans if any. Attention to detail is vital since field documentation protects our client and Ahtna with secure, legally defensible evidence and has been helpful in administrative, legal, and cost-recovery requirements. For example, field documentation may be used as evidence in legal proceedings to defend procedures and techniques employed during site investigations. Therefore, field documentation must be factual, complete, accurate, consistent, and not contain subjective language. These principles also apply when photographic or videography techniques document site activities. The goal of written, digital, and photographic/video graphics documentation is to represent field activities that accurately portray site conditions or procedures.

1.2 Scope

The scope of this SOP includes data entry and format requirements for various field documentation.

When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Project].

Written records

- Field logbooks
- Field notepads
- Field forms

Digital records

- Audio
- Photographic/video
- Data loggers

Digital data entry using field tablets is described in the EQuIS Collect User Guide.

- **Note**: *It is important to review contracts and Performance Work Statements to identify specific documentation and format requirements applicable to your project*.
- **Note**: *Contracts may contain requirements for field records. The typical* language states: "*The Contractor shall maintain field records sufficiently to recreate all field activities. The information shall be recorded in a permanently bound notebook with sequentially numbered pages. At the end of each workday, the Contractor shall complete a daily log.*"

- **Note**: *Contracts issued by the USACE may contain requirements for the project archive, both ongoing and after completion of the contract.*

1.3 Roles and Responsibilities

Field Team. A Field Team is one or more individuals working together. Each Field Team is responsible for maintaining a field log of their activities, as applicable

Field Team Lead (FTL). The FTL provides direction and oversight of the fieldwork. The FTL is responsible for reviewing and confirming the adequacy of the field documentation during fieldwork as soon as possible and before releasing the daily quality control report. The FTL keeps the Project (PL) informed of field variances or problems encountered in the field.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring that field staff has adequate experience and training to comply with this SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project. The PL documents changes as a variance to the plans and forwards the variance to the Program Manager (PgM) for approval. The PL is also responsible for confirming the adequacy of the field documentation after fieldwork. An entry confirming which information was reviewed must be added to the post-event field documentation package (Section 5.0).

Program Manager (PgM). For each SWE Program, the PgM is responsible for providing written instruction to their Field Team, which complies with the requirements of this SOP and the client-contracted specifications.

Site Supervisor.[1] The Site Supervisor is responsible for maintaining a project-specific FLB/notepad and field forms of their activities, as applicable, and providing copies to the PL for review.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control. Method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

SWE Quality Assurance Manager and SWE Field QC Manager report to the SWE Vice-President. When mentioned in this SOP, The "SWE" prefix is shown to distinguish from the QC Lead assignment shown in the project organization chart.

[1] In this context, a Site Supervisor is a person assigned to oversee long-term operations or construction work; the roles and responsibilities are like that of the Field Team Leader.

1.4 Definitions

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

> [PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

Field Notepad – An unbound, company notepad containing pre-printed heading block and space (straight-lined, grid lined, or open) for recording information. This can be an alternative to the FLB. The notepad can be paper or electronic (Word, Excel, Access, etc.) as long as a hard copy of the individual sheets is sequentially numbered and maintained in a properly labeled binder/file folder.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. A listing of the most commonly used SWE field forms is provided in Section 2, "Relevant Documents." Each data entry field should have an entry or indicate that data for that field is not available or not required.

> [PFAS Project]: Record of field events will be maintained on loose paper (PFAS-free) secured on Masonite or aluminum clipboards. Plastic clipboards, binders, or spiral hard cover notebooks are not acceptable. Field logbooks are permanently assigned to a specific project.
>
> In addition, Field Form FFRM-004.00 "Daily PFAS Sampling Checklist, must be completed each day of fieldwork when activities may compromise environmental media that is sampled.

Data Loggers – Field equipment providing digital/electronic information to supplement field forms. Examples include water-level transducers for aquifer tests, flow sensors and meters in pump and treat systems, and air monitoring equipment (Section 4.1.7).

Digital/Electronic Files – Any documentation that preserves an accurate historical record of field activities but is recorded electronically through field instruments and digital devices. These records should be referenced in the FLB. Digital/electronic information includes global positioning system (GPS) coordinates, photographs, and videos.

2.0 Relevant Documents

SWE file folder m:\\Environmental\Quality Control Procedures\SWE Field Forms\ has the current, approved form templates.

3.0 Equipment List

[PFAS Project]: Products containing waterproof features (e.g., Post-it-notes, waterproof coated paper) cannot be used on per- and polyfluoroalkyl substances (PFAS) projects.

- Applicable field forms

  [PFAS Project]: Work activities will be maintained on loose paper (PFAS-free) secured on Masonite or aluminum clipboards. Plastic clipboards, binders, or spiral hard cover notebooks are not acceptable.

- Bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation or notepad

  [PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink

  [PFAS Project]: Ball-point pens: do not use markers, felt pens, or pens with water resistant ink

- Digital camera/video, cell phone, or other devices capable of digital imagery
- Electronic device(s) for recording and storing field-related data (e.g., data loggers and GPS units)
- Batteries and charging blocks

4.0 Procedures

This section describes various mechanisms of recording documentation, including requirements and procedures. Before fieldwork, each project should define project instructions that identify the mechanism for documentation. The instruction is intended to promote procedural consistency, defined roles and responsibilities, and common language across project teams, promoting efficient reviews and cross-team utilization and training. Once established, project staff shall follow the project instruction.

4.1 Document Control and Storage

4.1.1 Project File

While in the field, the fieldwork documentation project file is managed by the FTL and consists of:

- Written records: FLB/notepads, field forms
- Digital/electronic records: photos, videos, GPS records
- Downloads from electronic devices such as data loggers

The PL is responsible for providing the location and details for storage. All field documentation is a part of the project file and should be maintained with safe document handling and archiving procedures. Hardcopy documentation and digital files are official records of fieldwork. Scans of official records are helpful for ease of access to project information and generating reports but are not official records.

The PL is responsible for all forms of field documentation, and scans of paperwork, digital records, and downloads from electronic devices are placed in the m:\\ drive project file. All original documents shall be assembled into a data package, submitted to the PL, and archived in the project file. The goal is that all documentation is organized by task/event and stored in a single location.

4.1.2 Problems in the Field and Variances from Project Plans

Variances or problems encountered during the fieldwork that cannot be resolved promptly must be communicated promptly in writing to the FTL /Site Supervisor, who will notify the PL. This may be completed by sending a variance notice by email or other means to promptly communicate the variance or problem and allow for the continuation of the fieldwork. The PL shall provide written approval of recommended solutions or provide an approved alternate solution.

The need for a corrective action addressing variances or problems in the field will be determined by the PL in collaboration with the FTL/Site Supervisor. The PL will notify the PgM and SWE Field QC Manager of any needed corrective action for their concurrence or follow-up.

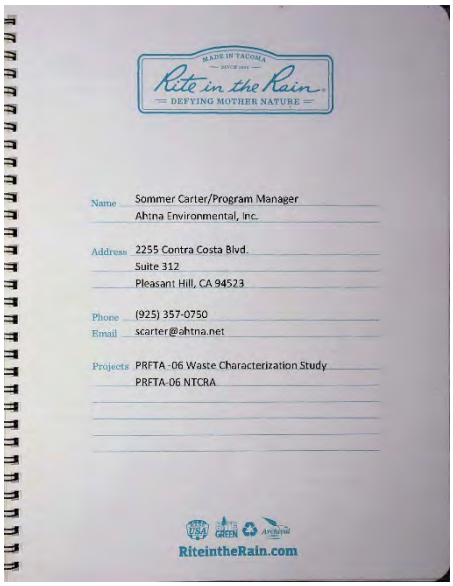
Documentation of variances to project plans, problems encountered, or corrective actions will be kept in the FLB/notepad or forms.

4.1.3 Field Logbook

Field logbooks can be spiral- or adhesive-bound and are distributed by the PgM or designee. The cover of the FLB is labeled with the project number and name of the Installation/Site(s).

The inside cover of the FLB contains the name, address, phone, and email address of the PgM and a list of projects the FLB is used to record. The information is updated if the project is assigned to another PgM.





The FLB shall be project/task-specific. The Field Team uses the FLB to record details of their responsibility (e.g., sampling, QC, safety, oversight, etc.) and provide them to the FTL/Site Supervisor for their review before submitting daily QC reports (DQCRs).

The FLB records are scanned, and the scan is saved as a PDF file on the Ahtna server in the project folder to create an electronic record for project reports. The PL shall ensure the FLBs are stored safely until project closeout. The field job box could be used for temporary storage.

4.1.4 Field Notepads

Three-ring punched, loose-leaf notepads or individual sheets can be printed on field form SWE-FFRM-001.[2] Each sheet contains a heading block, and block entries must be filled in on the first page of a new date.

Example Heading Block for Long-Term O&M or Construction

Installation/Site	Sharpe Army Depot/Sitewide	Project Number	05206.000.01.0000
Site Supervisor	Paul Marsden	Date	July 27, 2021
Subject	Telephone Record	Recorded By	Izzy Done

Example Heading Block for Environmental Studies

Project Number	05206.000.01.0000	FTL	Who Dunnit
Installation/Site	MOTCO Site 2	Recorded By	Izzy Done
Event Name	1Q 2021 GW Sampling and LF Inspection	Date	July 27, 2021

Notepads (loose-leaf paper) are used by the Field Team to record details of their responsibility (e.g., sampling, plant operations, QC, safety, oversight, etc.) and provided to the FTL/Site Supervisor for their review before submitting DQCRs.

The PL shall ensure the sheets are stored in three-ring binders or another filing system (Section 5.0), labeled with the Installation/Site name, project number, and a descriptive name of the project. If an FLB or field form is also used, a scanned copy of the FLB pages and original copies of the field forms are stored in the binder. The sheets are sequentially numbered and reviewed by the FTL/Site Supervisor. The PL reviews and approves the Site Supervisor's notepad sheets. The PL is responsible for safely storing the binder or other filing system until project closeout.

The notepad binder will be kept in the site office project file or job box. As soon as possible, the unbound records shall be scanned and saved on the Ahtna server in the m:\\ drive project folder to create an electronic record to ensure document preservation and use in project reports.

4.1.5 Field Forms

SWE-approved field form templates are available at M:\Environmental\Quality Control Procedures\SWE Field Forms\. Activity-specific SOPs reference the field forms that should be used. If preferred, individual sheets can be printed on pre-punched three-hole paper (or punched later). If the printer is capable, use a heavy paper stock for a durable form. Field forms supplement the FLB/notepad and provide a way to record detailed information using a structured format. When new forms are available, they will be posted

[2] Project-specific format designs may be used. Computer applications such as Microsoft Word or similar may also be used as long as the header information is shown, and printed copies are stored in three-ring binders.

in the template folder. The SWE Technical Writer oversees version control and will notify SWE staff when the form is posted.

Each sheet contains a heading block to enter the Installation/Site name, descriptive activity name, FTL, project number, and QAPP SOP number for the performed activity-specific fieldwork. Depending on the activity, the names of staff assigned with lead roles, weather conditions, date of recorded information, or other information may appear on the form. The heading block entries must be filled-in for each sheet to bind the field form to the project/activity.

Example Field Form Heading Block

Project Number	05108.001.02	FTL	Jared Wilson
Installation/Site	MOTCO/Site 1	SOP No.	FSOP-002
Activity Name	1Q 2021 GW Sampling and LF Inspection	Date	08/06/2021
Field Team (name/organization)	Jared Wilson/Ahtna, Izzy Done/Forever Waiting		
Weather Forecast	Sunny, 65–80°F, SW winds 5–10 mph		

Field forms are used by the Field Team to record details of their responsibility (e.g., sampling, O&M operations, QC, safety, oversight, etc.) and provided to the FTL/Site Supervisor for their review before submitting DQCRs.

The PL shall ensure the sheets are stored in three-ring binders or another filing system (Section 5.0), labeled with the Installation/Site name, project number, and a descriptive name of the project. If an FLB/notepad is also used, a scanned copy of the FLB/notepad pages and original copies of the field forms are stored in the binder. The sheets are sequentially numbered, reviewed, and approved by the PL. As soon as possible, the unbound forms shall be scanned and saved on the Ahtna server in the m:\\folder to create an electronic record to ensure document preservation and use in project reports.

The PL is responsible for safely storing the binder or other filing system until project closeout.

4.1.6 Electronic Files

Photographs and Video

All original digital field documentation (Section 1.4) shall be downloaded as soon as possible to a designated location for project use. Exclude files that are unnecessary due to unusable image quality or content. As soon as possible, the date/time, location, direction (compass point or radial degree), and purpose of the image should be documented before the information is forgotten. The use of metadata and smartphone applications to gather this information can assist. Files can be edited but maintain the original file and save the edited file with a suffix description. Alternately, use field form SWE-FFRM-002 to log photos. This form is helpful for tasks where few pictures will be taken.

The PL is responsible for providing the location and storage details. Files should be uploaded to the project folders and caption descriptions documented as soon as possible after the fieldwork ends.

Data Loggers

Examples of data loggers include equipment used in combination with:

- Water-level transducers for aquifer tests
- Flow sensors and meters in pump and treat systems
- Air monitoring equipment (e.g., particle counters)

The use of data loggers should be recorded in an FLB/notepad or field form and include the type of logger, make, model, S/N, calibration if required, and any input specifications used.

Document data acquisition activities using data loggers (data logging equipment) and related observations in the FLB.notepad. Written notes provide a permanent record of field activities that support digital data temporarily stored on various data loggers.

Specific steps and guidelines for the data acquisition activity being performed should be reviewed in the respective SOP guiding the activity.

The observations and data will be recorded in the FLB/notepad or field form. Because of the variability of features and operation of various data loggers, each field SOP and manufacturer's instructions should be carefully reviewed before beginning field activities.

The PL is responsible for providing the location and details for storage. Files should be uploaded to the project folders as soon as possible after the fieldwork ends. Files should not be edited. If needed, modifications to the captured data should be noted in the project reports. Hardcopy printouts in comma-delimited format (or similar) are recommended should the source file become corrupt.

Global Positioning Systems

GPS data acquisition activities and related observations will be digitally-recorded and later downloaded, and the file saved as described above.

Alternately, the GPS data can be recorded in field documentation to provide a permanent record of field activities supporting digital data that is temporarily stored on the GPS unit. As applicable, observations and data may be recorded in an FLB/notepad or field forms. The field forms will record the survey location identifier (e.g., well/boring location, structural feature) and corresponding coordinates and elevation.

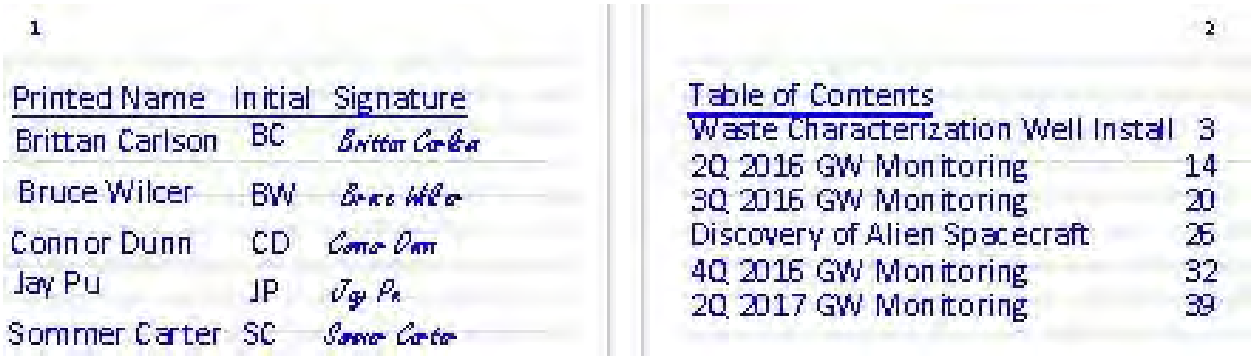
The GPS operator should also be thoroughly familiar with the manufacturer's instructions and SOP for Global Positioning System (FSOP-103) before performing GPS work in the field.

4.2 Field Logbook

The FLB is the written record of all fieldwork elements, such as Ahtna staff, subcontractors, visitors at the site, weather forecast/conditions, field equipment calibrations, construction activities, and sample collection activities. Fieldwork can be recorded on a notepad or forms described in Sections 4.3 and 4.4. When field forms are used, a brief description of the activity is added to the FLB/notepad, and details are added to the form.

4.2.1 Guidelines

Pages 1 and 2 of the FLB should be reserved to provide a signature page and table of contents. The signature page lists the employee's name, initials, and signature. The printed name and signature bind the employee to their written documentation, and the initial is helpful when limited space is available for writing a full name on subsequent pages. Each initial on page 1 must be unique. Page 2 is not required but helpful to quickly locate information in the FLB. If more space is needed, the back cover pages could be used. An entry for a significant event and the page number that initiates the documentation is typical. Open space on pages 1 and 2 does not need to be lined out, as the list will grow during work execution.



1

Printed Name	Initial	Signature
Brittan Carlson	BC	Brittan Carlson
Bruce Wilcer	BW	Bruce Wilcer
Connor Dunn	CD	Connor Dunn
Jay Pu	JP	Jay Pu
Sommer Carter	SC	Sommer Carter

2

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Field documentation shall adhere to the following guidelines:

- Write entries in blue or black waterproof ballpoint pen (older copier machines do not recognize other colors). Avoid felt tip pens. *Do not use a pencil*.
- List personnel making entries in the FLB and include initials and signatures on the inside cover page.
- Use a table of contents on page 2 (recommended but not required).
- Start a new page at the beginning of each day.
- Entries should be chronological – a time notation should introduce each entry.
- Language should be objective, factual, and free of personal feelings or inappropriate terminology.
- Do not erase or scratch out errors. Draw a single line through the error, then insert the corrected material. The person who corrected it shall initial and date the correction. If an explanation is needed, add that in the next available blank area in the FLB and cross-reference the error and explanation.
- The FLB shall be signed at the end of each day. Signatures shall be written on a single diagonal line drawn across the blank portion of the page following the day's last entry.
- All FLB shall be returned to the FTL/Site Supervisor for review and safe storage. The FTL/Site Supervisor shall review daily as soon as possible and before the DQCR is released.

4.2.2 Entries to Include

Initial daily entries shall include the following:

- **Date and time**: The time shall be based on military time (i.e., 2100 instead of 9 pm)
- **Field Team Leader**: Name of the Field Team Leader or Site Supervisor
- **Safety Representative**: Name of the task Safety Representative (meets EM 385-1-1 requirements)
- **QC Lead**: Name of the task QC Lead

- **Site Personnel**: Full name, title/role, and affiliation of personnel onsite, including visitors and subcontractors, with arrival and departure time noted
- **Planned Activities**: General description of various work activities for the day
- **Weather**: Weather forecast (temperature, cloud cover, wind speed, and direction). Changing weather that impact site conditions should be recorded throughout the day
- **Notes**: Taken By: Name(s) the FLB/notepad author(s)

The following are examples of ongoing daily entries. Use those and others as applicable:

- When field forms are used, record a brief description of the field activity, then record details on the field form. Do not duplicate information referenced on the field forms in the daily field documentation
- Participation in the Site Safety Tailgate Meeting, details can be added to the Site Safety and Tailgate Meeting form
- Level of personal protective equipment (PPE) and describe upgrade and downgrade of PPE levels
- Type of field instrumentation and calibrations performed, details can be added to the equipment calibration form
- Work start/stop times
- Time and location of activities
- Site physical conditions, changing weather conditions, major task decisions, or other valuable site investigation information and other essential observations
- Level of PPE and describe upgrade and downgrade of PPE levels
- All relevant field observations, major task decisions, or other valuable site investigation information
- Location of work areas if the survey has not been completed
- Survey and location of any sampling points, including swing-tie measurements
- Decontamination times and methods
- All field measurements. If field measurements of this type are being recorded on dedicated field forms, it is not necessary to record in the FLB, but the use of the form should be noted
- Type, amount, method, and location of storing and disposal for investigation-derived waste
- Changes/deviations/variances from the work plan and reason for deviations change/variance.
- Thoroughly document all FTL/Site Supervisor or PL-approved directives, guidance, or potential corrective actions from client and oversite government personnel. Directives that give personnel specific authority to make critical decisions must be documented in the FLB
- Communications with the FTL, Site Supervisor, or PL or client about decisions being made in the field
- Work deficiencies and corrective actions
- Approved work variances
- Persons contacted and topics discussed

4.2.3 Documentation of Project Variances

Thoroughly document all variances from the Performance Work Statements, Work Plans, and QAPP or changes in fieldwork procedures. Problems, delays, or any unusual occurrences such as improper equipment or breakdowns should be included, along with PL-approved resolutions. Summarize the content and conclusions of all relevant meetings, discussions, and telephone conversations that involve you.

4.2.4 References to Locations

This section applies to new locations. Established locations are referred to by the location name or code. Previously established locations are typically shown on site maps/figures.

Whenever an activity (sample collection, field measurement/monitoring, etc.) is performed at a new location (i.e., the location has not been surveyed and shown in a figure), mark the location with a survey stake or similar marker, a detailed description of the location must be recorded in the FLB/notepad or field form and accompanied by a photo, sketch, or point on an attached map as part of the daily field documentation package (sketches with accompanying photographs when appropriate, with north arrow and approximate scale). Record unusual site physical conditions or signs of contamination such as oily discharges, discolored surfaces, unusual odors, dead or distressed vegetation, including types of plants, if possible.

4.3 Notepads

When notepads are used, the requirement and procedures for the FLB (Section 4.2) also apply to the notepad documentation.

4.4 Field Forms

Field forms are used in addition to FLBs/notepads. Field forms are activity-specific and may be completed for each location/sample/well, etc., or one per field event as appropriate. Each form contains a heading block to bind the field form to the FLB/notepad. Field forms augment but do not replace the FLB/notepads. Avoid duplicating information recorded in the FLB/notepad and field form.

The forms include space (check box, table cell, and underlined space) for recording the information necessary for the project to ensure complete and proper information is recorded. Each space must be completed on a field form, and if not needed, then struck out or listing “not applicable.” Blank space can be misunderstood as missing information. Version-controlled template files of the forms are stored in the M:\Environmental\Quality Control Procedures\SWE Field Forms.

Field forms may be modified for project-specific use with the SWE Quality Assurance Manager’s approval.

All unbound data documentation is a part of the field records and should be maintained with safe document handling and archiving procedures. These records should be recorded in the same manner as notes in the FLB/field notpad using black or blue waterproof, indelible ink, and on weatherproof paper as necessary (projects testing for PFAS cannot use products with fluorinated constituents).

4.5 Field Documentation Data Package

After a short-term, specific event (e.g., well installation, sample collection, landfill inspection, and similar), copies of the FLB pages and hardcopies of loose-leaf documentation and relevant correspondence (emails and phone records) should be organized assembled into an event-based data package. The package should include a cover page listing the Installation/Site, project number, and event description.

The PL is responsible for the safe storage of the data package until project closeout. A copy of the package should be scanned and saved in the m:\\ drive project folder. The scan file could replace other scanned files described in the project instructions (Section 4.0).

If the fieldwork is a long-term task such as operating an O&M treatment system, remedial actions (e.g., excavation and disposal), or other qualifying fieldwork, the timeframe for producing the data package should be defined in the PgMs project instructions, but that period should not exceed one per year or end of the contract period.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and QC procedures for field documentation review will be performed by the FTL/Site Supervisor and checked by the PL to ensure the content and level of detail comply with this SOP. The FTL/Site Supervisor can approve variances and fieldwork problems in coordination with the PL. The FTL/Site Supervisor should try to resolve the issue so that work can continue; however, should the variance/incident/problem affect the contracted scope of work or a project decision made from the evaluation of date, the resolution must be coordinated with PgM and SWE Field QC Manager if corrective action is needed. The PgM should notify the SWE Quality Assurance Manager of all corrective actions.

6.0 Documentation Review

The FTL is responsible for the daily review of the fieldwork documentation for compliance with requirements (Section 4.0 “Procedures”) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

The PL is responsible for reviewing and signing approved documents stored in the project file (Section 4.1).

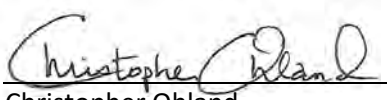
7.0 References

U.S. Department of Defense, 2013. *DoD Environmental Field Sampling Handbook, Revision 1.0*. April.

Sample Management

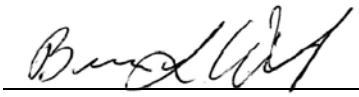
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Department	Southwest Operations
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Approvals



Christopher Ohland
SWE Quality Assurance Manager

October 10, 2022
Date



Bruce Wilcer
SWE Field Quality Control Manager

October 10, 2022
Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS-friendly supplies and procedures.

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation requirements to maintain sample custody and the labeling, packaging, and shipping of multimedia samples after they are collected.

Proper sample management from sample collection to laboratory receipt is essential to ensure the legal defensibility of the sample. Sample management is also needed to maintain sample integrity and successfully transport samples to the testing laboratory in an acceptable condition.

1.2 Scope

The scope of this SOP applies to field staff collecting samples. The field staff may be employed by Ahtna or by a subcontractor. Trained environmental professionals will be engaged in or directly supervise the subcontractors' collection and handling of environmental samples.

When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Project].

1.3 Responsibilities

Field Team. A Field Team is one or more individuals working together. The Field Team is responsible for the oversight of and/or collection of groundwater samples as specified in this SOP.

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Air or Ground Waybill. A shipping document that identifies the sender and addressee, transport carrier, size, and priority of a shipment transported by aircraft.

Chain of Custody. In legal contexts, is the chronological documentation or paper trail that records the sequence of custody, control, transfer, analysis, and disposition of materials, including physical or electronic evidence.

Dangerous Goods. Under the International Air Transport Association (IATA) definition, dangerous goods are articles or substances that can pose a hazard to health, safety, property, or the environment and are shown in the list of dangerous goods in the IATA regulations (IATA 1.0).

Environmental sample. According to the Department of Transportation (DOT) 49 Code of Federal Regulations (CFR) Section 172.101 Appendix A, any sample that has less than reportable quantities of any hazardous constituents.

Excepted Quantity (DOT & IATA Definition). A hazardous substance whose class is permitted on passenger aircraft but in such a small defined amount poses a low risk during transport by aircraft. Hazardous substances that meet the definition of Excepted Quantity may be exempted from documentation, packaging, marking, and labeling requirements typically required when presenting hazardous materials for passenger air transportation. Items shipped as excepted quantities are limited to volumes as specified in IATA Dangerous Goods Regulations, Table 2.6.A and DOT 49 CFR 173.4a.

Hazardous materials. DOT defines a hazardous material as any item or chemical which, when being transported or moved in commerce, is a risk to public safety or the environment and is regulated as such under its Pipeline and Hazardous Materials Safety Administration regulations (49 CFR 100-199), which includes the Hazardous Materials Regulations (49 CFR 171-180).

Sample label. An adhesive paper placed on sample containers or a tag tied to a sample container to designate a sample identification number and other identifying information.

2.0 Relevant Documents

This SOP is intended to be used in conjunction with the following SOPs, and as such, the equipment and materials needed for those activities are not included in this SOP:

Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-400 Series, various sampling SOPs

Field Forms

- SWE-FFRM-004, Daily PFAS Sampling Checklist
- SWE-FFRM-002, Chain of Custody

3.0 Equipment List

- Gel or bag ice (determine which is appropriate)

  [PFAS Project]: Ice in polyethylene bags

- Bubble wrap and/or foam inserts

  [PFAS Project]: Avoid packing materials that contain PFAS and materials that absorb water, including paper, cardboard, and styrofoam; as they become soggy, they lose cushioning properties.

- Clear, strapping, or duct tape

  [PFAS Project]: Use PFAS-free tape

- Coolers
- Heavy-duty plastic bags

  [PFAS Project]: Use HDPE bags[1]

- Plastic zip-top bags (i.e., quart and gallon)

  [PFAS Project]: Use HDPE bags[1]

- Air or Ground Waybills
- Sample container labels
- Custody seals for coolers

4.0 Procedures

4.1 Sample Custody

Five aspects of sample custody.

- Use appropriate sampling equipment
- Properly handle and document samples, starting from the time of collection
- Keep samples within temperature controls and safely located until offsite transport
- Properly pack and transport samples from the field site to the laboratory
- Verify laboratory receipt of samples
- Ensure laboratory has a custody program (subcontractor responsibility)

4.2 Proper Sampling Equipment

The supplies needed to collect samples must be made of material that will not release contaminants to the sample or hold contaminants to the sampling equipment. Equipment specifications are described in

[1] [PFAS Project]: LDPE bags may be used for bagging samples if special precautions are taken. LDPE bags should be kept separate from other sampling supplies in the staging area and should not come into direct contact with the sample media. Gloves should be changed after handling LDPE bags.

project work plans. Shipping coolers should be inspected for defects and must be decontaminated before use.

> [PFAS Projects]: Surfaces in contact with the sampled media should not contain Teflon® or other PFAS-containing material.

Use new, certified sample containers suitable for the media being analyzed. Containers should be provided by the analytical lab or supplier in the appropriate quantity to accommodate required volumes for the field sample, duplicates, and any amounts required for laboratory QC processes. Certification requirements are specified in the USEPA *Specifications and Guidance for Contaminant Free Sample Containers* (EPA, 1992).

4.3 Sample Collection and Handling

Each person handling the samples must document from whom and when the item was received and to whom and when it was delivered. Documentation of handling samples is part of the custody record, which provides the mechanism for tracking samples from the time of sample collection thru laboratory analysis and disposal.

A sample is considered to be "in custody" for legal proceedings if it is:

- In a person's actual possession
- In view after being in physical possession
- Locked up so that no one can tamper with it after having been in physical custody
- In a secured area, restricted to authorized personnel only.

If any one of these is not in place at all times, sample custody is broken. The FTL should notify the PL of actions taken and document the PL decision. If corrective action is needed, the Program Manager and SWE Field Quality Control Manager should be notified.

Sampling procedures are described in the SWE-FSOP-400 series of SOPs. The Field Team is responsible for logging the sample collection in field logbooks/notepads or field forms as described in SWE-FSOP-001, "Field Documentation."

Sample custody begins at the time of sample collection, and its custody is assigned to the Field Team sample custodian. Custody transfers must be documented. Typical transfers include:

- Transfer of samples from contractors, if used, to Ahtna staff
- Transfer of samples to a transporter
- Transfer of samples to the laboratory
- Transfer of samples within the laboratory

When samples are transferred, the transfer is noted in the field logbook/notepad or field form SWE-FFRM-002, "Chain of Custody," or similar form. The name of the organization/individual and date/time of the transfer and organization/name and date/time of the recipient. For samples shipped by ground or air carrier, the unique airbill number or bill of laden should be recorded.

4.4 Sample Integrity

To reduce the possibility of invalidating the results, all collected samples must be placed in laboratory-supplied containers and labeled (Figure 1).

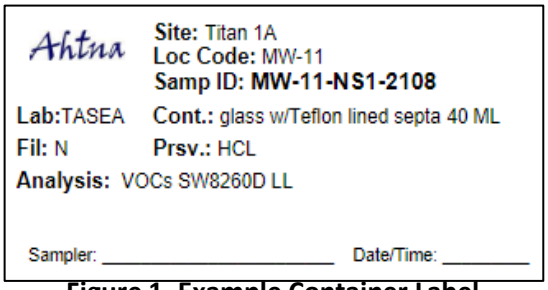


Figure 1. Example Container Label

Sample preservation before laboratory analysis is accomplished by adding the sample into pre-preserved sample containers or adding the preservative after filling the container. Preservation requirements are described in Worksheet# 19/30 of the project Quality Assurance Project Plan (QAPP).

With few exceptions (i.e., metal analyses), samples must be cooled as soon as possible after sample collection, and after that, maintained between 0°C–6°C. Samples must be kept in the custodians' possession or stored safely at all times.

Sample containers should be pre-labeled as much as practical before sample collection. Labels should be affixed to the sample container before or at sampling and must adhere firmly to the container. Labels can be further secured by placing clear packaging tape over the label, but not for volatile organic compounds (VOC) or gasoline range organics (GRO) analyses.

Sample containers that are weighed by the laboratory before use should not have any additional labels placed on the container, affecting the weight. For those containers, use the label already provided on the jar. Only one label should be placed on each sample container.

Use the specifications defined in the project work plans. Unless the QAPP specifies otherwise, sample labels should be written in indelible ink and contain, at a minimum, the following information:

- Project number/Site
- Field sample ID
- Container type and preservative
- Filtered (Y/N)
- Laboratory name
- Analysis requested (abbreviated)
- Sampler's organization and initials
- Collection date and time (24-hour clock)

4.5 Sample Packing

The following steps must be followed when packing sample containers for shipment:

1. Choose a cooler with structural integrity that will withstand shipment. Ensure the cooler is large enough to contain all the samples to be shipped along with the appropriate amount of ice. Use a cooler that has been pre-cooled and not one that has been in a hot vehicle or out in the sun. Secure and tape the cooler drain plug with duct tape.

   [PFAS Project]: Use ice in polyethylene bags.

2. Be sure that the caps on all sample containers are tight and do not leak but do not overtighten.
3. Fill out a chain of custody (COC) form or use the COC form filled out in the field. The COC should only list the samples and bottles (specific to analyses requested) added to the cooler. Check to ensure that the sample labels are intact, completed with the correct information, and that sample identification matches the COC record exactly. An original signed copy of the COC is sealed in a water proof zip-top bag taped to the lid of the cooler.

   [PFAS Project]: The COC record will be placed in a re-sealable plastic zip-lock bag, the bag sealed shut to prevent water intrusion from the bagged wet ice in the cooler, and the bag taped (using PFAS-free tape) to the inside lid of the cooler.

   A copy of the COC is kept with the field logbook/notepad or field form.

4. Wrap and package containers sufficiently to prevent cross-contamination or exposure to melt water and ensure that containers remain intact during shipment.

   [PFAS Project]: Seal each sample container in a HDPE bag to prevent melt water from getting into the sample or degrading the sample label. Taping the end of bags with Duct tape will provide added protection against melt water.[1]

5. Place the containers into the cooler with caps up. No containers should be placed on their sides, as there is significantly less chance of breakage when packed vertically.
6. Use enough ice (double-bagged) to ensure that samples are received by the laboratory at the proper temperature of 0°C–6°C. For temperature-sensitive analyses, it may be necessary to cool the samples in onsite chillers. Refer to the project work plans.

   <u>Recommended ice arrangement:</u>

   - Place a layer of ice on the bottom of the cooler.
   - Place a bag of ice vertically on one end of the cooler, followed by a set of samples. Follow this with another vertical bag of ice and repeat until the cooler is full. Make sure all samples are lined on both sides with ice.
   - Place more bags of ice flat on top of the samples.
   - Cover this with an insulating layer, such as bubble wrap.

     [PFAS Project]: Avoid packing materials that contain PFAS and materials that absorb water, including paper, cardboard, and Styrofoam; as they become soggy, they lose cushioning properties

7. Place a temperature blank in the cooler, and VOC/GRO trip blank is needed.
8. Fill excess space between sample containers and walls of the cooler with additional bubble wrap.
9. Place a signed and dated custody seal on the outside spanning the area where the cooler lid meets the cooler's body.

   [PFAS Project]: Custody seals will be pre-printed on PFAS-free paper.

10. Secure the cooler with packing tape over the Custody Seal.

    [PFAS Project]: PFAS-free tape will be placed over the seals to ensure that seals are not accidentally broken during shipment.

4.6 Offsite Transport

Samples taken over multiple days should be sent to the laboratory with sufficient time to allow the laboratory to meet holding time requirements. If the requested analyses have a short holding time (less than 48 hours), samples should be delivered to the laboratory for analysis as soon as possible following sample collection: preferably same day or overnight for morning delivery. Notify the laboratory Project Manager when short holding times are anticipated.

Samples can be stored onsite if sample custody is maintained and the samples are placed in transport containers (e.g., cooler or shipping box) for protection from breakage, contamination, and loss and in an appropriate controlled-temperature device (e.g., ice-packed cooler or onsite refrigerator)

Sample coolers are typically transported by a laboratory employee or air carrier. Only reliable services that provide a tracking number should be used when using professional services to transport physical samples. A copy of the shipping receipt and tracking number should be logged in the field logbook/notepad. The package should be addressed to the "Sample Custodian."

Transportation regulations followed by air carriers are airline-specific; some use only IATA, and others allow either IATA or DOT. Ground and vessel transportation is guided by DOT regulations. If shipping by highway or rail, no shipping paperwork is required as stated in 49 CFR 173.4a(h)1. These regulations have requirements to identify, document, label, and package samples if the shipment contains dangerous goods.

- **Note**: *United Parcel Service and Federal Express follow IATA for air shipments and DOT for ground shipments*

The shipper is responsible for identifying, documenting, and packaging samples for air shipment that contains dangerous goods or whether the shipment is exempted for limited quantities. Because most multimedia samples collected for environmental projects returned in preserved containers are exempted, specific procedures are not provided in this SOP. Contact the Field QC Manager if dangerous goods shipment is suspected.

Shipments of the following may contain dangerous goods:

- If the hazardous material has a UN code
- Unknown hazardous waste from drums, sludges, or appears suspicious
- Odor, PID measurements, and physical characteristics indicate a hazard

- Explosives or radioactive materials

Keep in mind that IATA requirements and the FAA and TSA "Prohibited Items List" will not allow shippers to check dangerous goods, in any quantity, as baggage on a commercial flight.

Each sample collected will be recorded on a COC form. Each COC form(s) in a cooler or shipping container should be specific to the samples in the cooler and not samples in multiple/other coolers.

4.7 Laboratory Acknowledgment

Once the samples arrive at the laboratory, the laboratory Sample Custodian checks the shipment for:

- Levels of liquid samples to assess whether leaks have occurred
- Shipment contents match the COC form
- Check the cooler temperaure and pH if preserved.

***Note**: VOC/GRO analyses are checked at the sample analysis time.*

The laboratory will provide notification of sample acknowledgment. The notification summarizes the work order, sample login descrepences and resolution, and discussions between the laboratory Project Manager and the Field Team. The FTL is responsible for reviewing the notification for completeness and accuracy.

4.8 Document Control

Sampling field forms should be completed in their entirety. If an entry is not applicable, indicate "n/a" (not applicable) or line out the entry.

After a task or project, all field documentation, including the field logbook, field datasheets, and electronic data, shall be scanned and placed in the appropriate folder on the server. All original documents shall be submitted to the PL and kept in the project file. See FSOP-001 (Field Documentation).

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control method described in the project work plans.

Verify the laboratory notice of sample acknowledgment.

6.0 Documentation Review

The FTL is responsible for daily review of the field sample management and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

International Air Transport Association (IATA), 2019. Dangerous Goods Regulations.

Code of Federal Regulations, 49 CFR 173.4a. Excepted Quantities

USEPA Specifications and Guidance for Contaminant Free Sample Containers. EPA540/R-93/051. (December 1992)

Soil Classification

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Christopher Ohland — April 1, 2022
Christopher Ohland — Date
SWE Quality Assurance Manager

April 1, 2022
Bruce Wilcer — Date
SWE Field Quality Control Manager

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1 Field Guide for Soil and Stratigraphic Analysis
2 Unified Soil Classification System (Modified from ASTM)

1.0 Introduction

1.1 Purpose

This Standard Operating Procedure (SOP) establishes uniform guidelines and procedures for field personnel when completing descriptions of soil samples obtained during field sampling efforts and entering the information into soil boring logs. Standardization is important to minimize variations in evaluations among geologists, which is essential for creating consistency in subsurface interpretations.

This procedure will be used during all field activities when borehole subsurface drilling, surface soil sampling, or reconnaissance geological mapping is performed. These activities should be documented as described herein and follow SWE-FSOP-001 (Field Documentation).

1.2 Scope

The scope of this SOP is to describe the data entry requirements for logging the physical properties of soil using procedures modifed from, but generally consistent with American Society for Testing Materials (ASTM) Method D2488 (Visual-Manual Procedure).

1.3 Responsibilities

Field Team. A Field Team is one or more individuals working together. The Field Team is responsible for the oversight of and/or collection of groundwater samples as specified in this SOP.

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Geologist. The Geologist (who may also be the FTL) is responsible for performing or having oversight over Field Team members performing the same work. The Geologist is responsible for the accurate and complete representation of the lithology encountered in the field, as well as review and approval of final logs to be stored in project files and presented in client deliverables.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the PL of safety deficiencies and incidents and actions to correct those. The PL approves those actions or notifies the Site Safety and Health Officer for their approval if the circumstance warrants involvement.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

gINT: Geotechnical and geoenvironmental software that manages borehole logs, well logs, cone penetration test (CPT), and geophysical logs.

2.0 Relevant Documents

This SOP is intended to be used in conjunction with the following documents as applicable:

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-405, Soil Sampling

3.0 Basic Equipment List

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Borehole log forms
- Color chart (Munsell™ or equivalent)
- Field charts of grain-size/grain percent examples
- Hand lens
- Compass
- Pocket knife
- Dilute hydrochloric acid in small dispenser/dropper bottle (if calcareous materials anticipated)
- Squirt bottle with water

4.0 Procedures

4.1 Description of Physical Properties

The following will be used as a guideline for logging lithology from surface and subsurface activities (i.e., potholing, borehole drilling, trenching, etc.). The Unified Soil Classification System (USCS) recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups. The USCS groups are outlined in Figure 1 and Figure 2 with some modifications from ASTM-D2488 Unified Soil Classification System.

4.1.1 Soil Descriptions

Figure 1 and Figure 2 summarize USCS classifications and designations to use when logging samples. The coarse-grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine-grained soils are subdivided into silts (M) and clays (C). Soils are also classified according to their plasticity and grading. Plastic soils are able to change shape under the influence of applied stress and to retain the shape once the stress is removed. Soils are referred to either low (L) or high (H) plasticity. The grading of a soil sample refers to the particle size distribution of the sample. A well-graded (W) sand or gravel has a wide range of particle sizes and substantial amounts of

particles sized between the coarsest and finest grains. A poorly-graded (P) sand or gravel consists predominately of one size or has a wide range of sizes with some intermediate sizes missing.

Soils that have characteristics of two groups are given boundary classifications using the names that most nearly describe the soil. The two groups are separated by a slash. The same is true when a sand could be well or poorly-graded. Again, the two groups are separated by a slash.

Soil description should be concise and stress major constituents and characteristics for fine-grained, organic, or coarse-grained soils.

4.1.2 Field Descriptions

Content of soil descriptions in the field should be based on requirements to support project objectives, utilizing criteria and nomenclature modified from ASTM D2488. Description categories may include, but are not limited to:

- **Group Name.** Name assigned to a particular lithology based on granular content, grading, and percentage of fines (specific grain sizes), described in the sections above.
- **Group Symbol**. USCS symbol corresponding to the group name, e.g., sandy silt (SM) or well-graded sand (SW).
- **Color**. The basic color of the soil, as well as staining or color change resulting from oxidation/reduction. Munsell™ soil color charts are commonly referenced for basic soil color.
- **Moisture Content**. The amount of soil moisture is described as dry, moist, or wet. Note saturated conditions and when groundwater is encountered.
- **Relative Density/Consistency**. An estimate of density of a fine-grained soil or consistency of a cohesive soil, usually based on standard penetration tests. An approximation of density/consistency can be determined by ease of penetration of the sample by thumb and/or fingers.
- **Particle (Grain) Size Distribution.** An estimate of the percentage and grain-size range of each of the soil's subordinate constituents with emphasis on clay-particle constituents. This description may also include a description of grain/particle angularity. This parameter is critical for assessing the hydrogeology of the site.
- **Soil Texture and Structure**. Description of arrangement of particles into aggregates and their structure. This description includes joints, fissures, slickened sides, bedding, veins, root holes, debris, organic content, and residual or relict structure, as well as other characteristics that may influence the movement or retention of water or contaminants.
- **Odor**. Odor is described from a warm, moist sample. The odor should only be described if it is organic or unusual. An organic odor will have a distinctive decaying vegetation smell. Unusual odors (petroleum product, chemical, and the like) should also be described.

4.1.3 Example Description

Below is an example for an interval from 7.2 feet (') to 9.1' below ground surface:

Poorly-graded sand (SP), light yellowish-brown (10YR 6/4), moist to 8.5', saturated below 8.5', loose- to medium-dense, ~85% fine-grained sand with trace amount of medium-grained sand, ~15% silt, thin (~1-2mm) bedding, oxidation/reduction color change to black below 8.5'; hydrocarbon-like odor.

4.1.4 Optional Descriptions

Field soil descriptions may also include the following additional information based on project requirements or as time permits:

- **Gradation or Plasticity**. Granular soil (sands or gravels) should be described as well-graded, poorly-graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soil (silts or clays) should be described as non-plastic, low plastic, medium plastic, or highly plastic.
- **Dry Strength**. Dry strength describes the crushing characteristics of a dry soil crumb of about 1/4-inch (5 millimeters [mm]) in diameter. If a crumb of dry soil is not available, remove particles larger than No. 40 sieve size, then mold at least three balls of soil about 1/4-inch (5 mm) in diameter to the consistency of putty, adding water if necessary. Allow the balls to dry completely by oven, sun, or air drying, and then test their strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
- **Dilatancy**. Dilatancy describes the soil's reaction to shaking. After removing particles larger than No. 40 sieve size, prepare a ball of moist soil about 1/2-inch (15 mm) in diameter. Add enough water, if necessary, to make the soil soft but not sticky. Place the ball in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the ball, which then changes to a gelatinous consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the ball stiffens, and finally cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
- **Toughness**. Toughness is the consistency of the soil near the plastic limit. After removing particles larger than the No. 40 sieve size, mold a ball of soil about 1/2-inch (15 mm) in diameter to the consistency of putty. If too dry, water must be added. If too sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. The thread is folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced. The specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
- **Cementation**. An estimate of cementation of a coarse-grained soil.
- **Relative Permeability**. An estimate of the permeability based on visual examination of materials (e.g., high permeability for coarse sand and gravel versus low permeability for silty clay). The estimate should address the presence and condition of fractures (open, iron-stand, calcite-filled, open but clay-lined, etc.), as well as fracture density and orientation.
- **Local Geologic Name**. Any specific local name or generic name (i.e., alluvium, loess).

4.1.5 Additional Borehole Descriptions

The soil logs should also include a description of any tests run in the borehole; sample intervals, blow counts for drive samples, placement and construction details of piezometers, wells, and other monitoring equipment; geophysical logging techniques used; and notes on readings obtained by air monitoring instruments.

4.2 Document Control

At the conclusion of a task or project, all field documentation, including the, FLB/notepad, field form, and electronic data, shall be scanned and placed on the server in the appropriate folder. All original documents shall be submitted to the PL and kept in the project file.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control method described in the project work plans.

Occasionally, soil classification procedures described in this document may need to be updated to incorporate new description requirements.

Before field logs and soil classifications are used in analysis or to generate portions of deliverables (e.g., gINT software logs), content and accuracy of descriptions, drawings, and other field-generated information related to the logging effort should be reviewed by a knowledgeable, experienced senior reviewer to ensure the information is of the appropriate quality for use.

Quality Assurance (QA) and QC procedures for field documentation review will be performed by the PL and/or Field QC Lead to confirm that content and level of detail are in compliance with the QAPP. Identification of errors and corrections made during QA/QC reviews will follow documentation requirements described in Section 4.0.

6.0 Documentation Review

The FTL is responsible for the daily review of the fieldwork documentation for compliance with requirements (Section 4.0 “Procedures”) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

The geologist is responsible for review and approval of soil descriptions, boring logs, well design, sieve analysis, etc. that will be used in client deliverables.

7.0 References

American Society for Testing Materials (ASTM) Method D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Figures

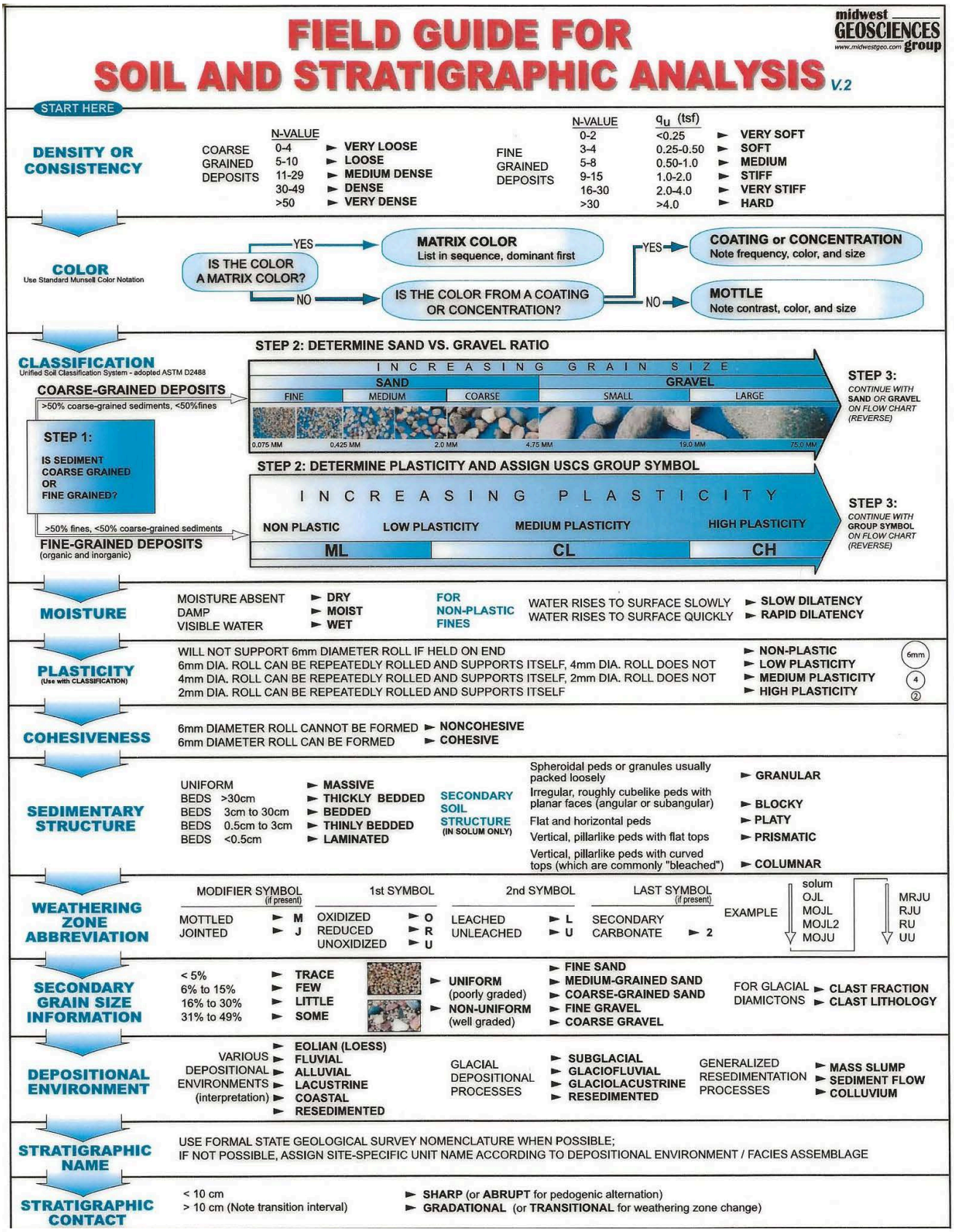


Figure 1. Field Guide for Soil and Strat 1

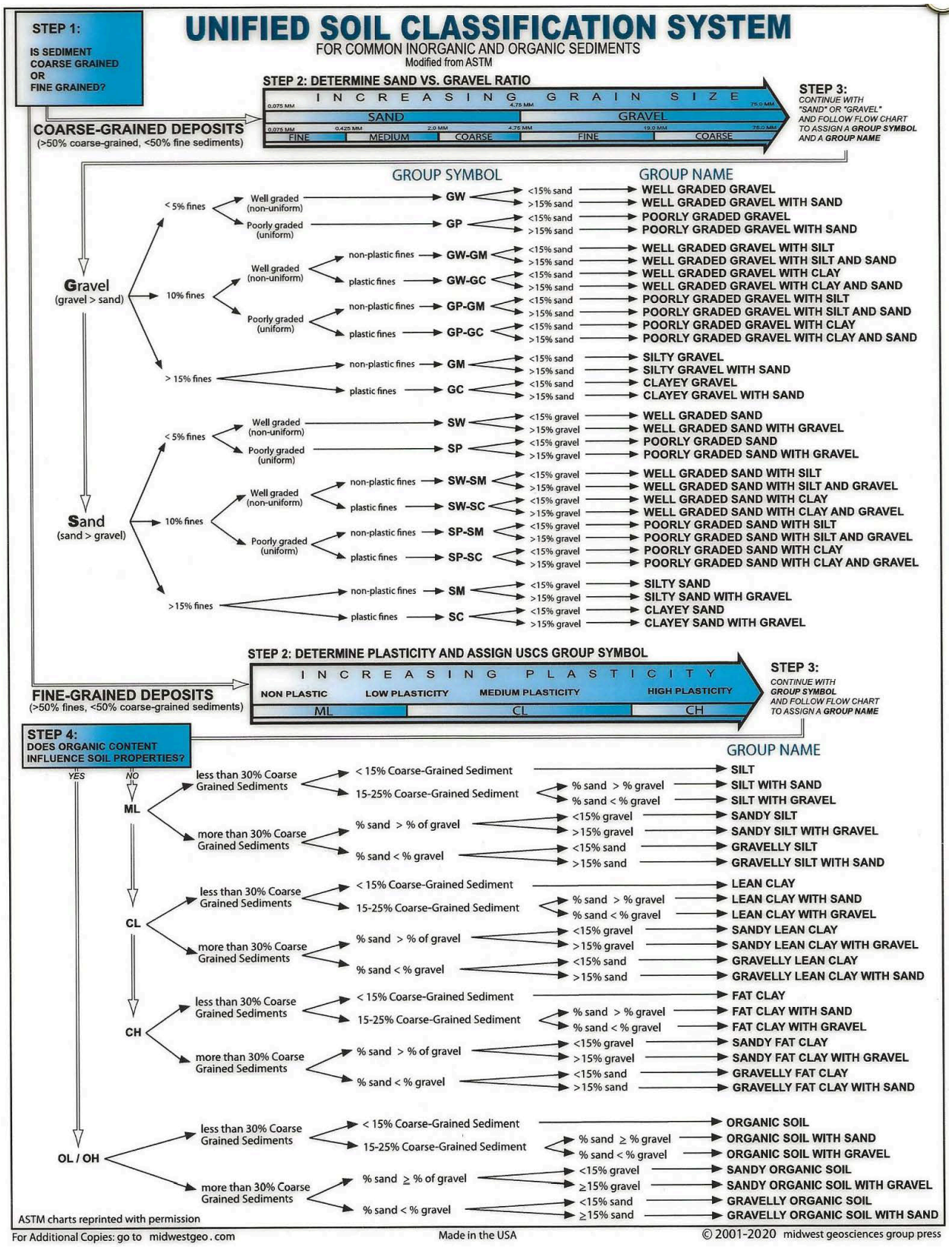


Figure 2 – Unified Soil Classification S 1

Hollow Stem Auger Drilling

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Christopher Ohland — April 1, 2022
Christopher Ohland — Date
SWE Quality Assurance Manager

Bruce Wilcer — April 1, 2022
Bruce Wilcer — Date
SWE Field Quality Control Manager

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation of drilling operations involving hollow stem auger (HSA).

1.2 Scope

The scope of this SOP applies to field staff conducting drilling oversight. The SOP includes guidance for activities related to the performance, management, and completion of HSA drilling activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to drilling are addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans.

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, logging geologic materials per SWE-FSOP-201, "Soil Classification," and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the boring logs.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Boring Log - A written and/or graphical description of exploration procedures and subsurface conditions encountered during drilling, sampling, and coring.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of HSA drilling activities and should be used in conjunction with other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001, Fieldwork Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-201, Soil Classification
- SWE-FSOP-601, Well Installation
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, Investigation Derived Waste Management

Field Forms

- SWE-FFRM-400, Soil Boring Log

Project-specific work plans should be reviewed to be familiar with the appropriate SOPs and related field forms necessary to complete the drilling activities.

3.0 Equipment List

The list below identifies equipment expected to be used by staff while supervising HSA drilling activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Color chart for logging soil (e.g., Munsell™ chart)
- Hand lens for examining soil
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

Refer to project work plans to confirm equipment required for the specific drilling activity. This may include, but is not limited to various field forms, sample containers, incremental sampling devices, and sample homogenizing equipment.

4.0 Procedures

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Drilling Procedures (Section 4.3)
- Borehole Abandonment (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

Hollow stem auger drilling is a method using rotating auger flights (typically in 5-foot lengths) connected to make an auger "string" with a bit on the bottom of the first flight (sometimes called the "lead auger"). Each HSA flight consists of a hollow pipe with an outer spiral plate, which, when rotated, forces soil cuttings upward along the borehole wall to the surface. The auger string is advanced by rotation, with a pressure exerted by the rig, forcing the bit to cut the soil at the bottom and direct cuttings to the augers.

A retractable plug with a pilot bit is placed at the bottom of the auger string to prevent cuttings from entering the hollow stem.

When the plug/bit assembly is retracted, a sampler may be sent through the hollow center to "push" or "drive" sample soil at the bottom of the borehole without requiring the augers to be removed. A wireline sampler may also be attached inside the lead auger to collect a continuous core as the borehole is advanced.

The HSA method is commonly used for drilling, sampling, and logging of soil, collecting soil gas and screening-level water samples, and installing smaller diameter soil vapor and groundwater monitoring wells. The most reliable method for logging soils during HSA drilling is collecting relatively intact samples through the hollow stem. An advantage of the HSA method is that soil samples can be readily obtained from the bottom of the hole without requiring the removal of the auger string (unlike air or mud rotary methods).

When constructing wells using HSA methods, the well casing assembly may be placed through the hollow stem, and the auger can be progressively pulled as construction materials are added to the borehole (see SWE-FSOP-601 Groundwater Well Installation).

The HSA methodology may also be used to drill out small diameter monitoring wells during decommissioning (see SWE-FSOP-603 Groundwater Well Decommissioning).

4.1 Pre-Field Tasks

Preparation and coordination tasks for HSA drilling generally include the activities described below.

4.1.1 Clearances

Before starting any HSA boring, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams that document the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.
- Confirm that, before drilling, the borehole location will be investigated to the maximum expected depth of any utilities (commonly 5 feet or greater) using a hand auger, shovel, or air knife.

4.1.2 Health and Safety

- Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating auger blades can snag or catch loose clothing and cause severe injury or death.
- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.1.3 Site Conditions and Drilling Logistics

The site will be prepared as per the project work plans. Before mobilizing, the logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction will be determined.

Before mobilization, the FTL and/or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include not only area for the rig, but also swing-out clearances, access for a support truck, and forklift carrying pipe or debris bins.
- The FTL and/or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- Appropriate cuttings and other IDW containment should be set onsite prior to the commencement of drilling.

Lubricating compound used on tools and augers must approved in advance and must not contain any compounds that are incompatible with project objectives, laboratory analyses, or water quality guidelines.

4.1.4 Rig Decontamination and Preparation

- All drilling and sampling equipment should be decontaminated before drilling.
- The drilling equipment shall be inspected for proper maintenance and appropriate decontamination before each time the rig is mobilized to a site.
- All clutches, brakes, and drive heads should be in proper working order.
- All cables and hydraulic hoses should be in good condition.
- All auger joints and bits should also be in good condition (e.g., no cracked or bent blades, bits are not excessively worn, etc.).
- Any observed leakage of fluids from the rig should be immediately repaired and decontaminated again before it is allowed to mobilize.

4.1.5 Calibration

Before mobilization, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

4.1.6 Personal Protective Equipment (PPE)

Don the appropriate PPE, as specified in the project work plans and APP.

4.2 Mobilization and Setup

The standard procedure for HSA drilling is described below. The drilling will be conducted per the project work plans.

4.2.1 Site Preparation

The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

- Appropriate barriers and markers should be in place prior to drilling, as per the site health and safety plan.
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig.
- Appropriate cuttings and other IDW containment should be set onsite prior to the commencement of drilling.
- If drilling is to be conducted in the saturated zone, provisions should be made to ensure adequate containment of formation water produced during drilling operations.

4.2.2 Discussion of Site Conditions

Before drilling operations begin, the following must be completed:

- The FTL should assess the drilling site with the driller. This assessment should identify potential hazards and determine how drilling operations may impact the environment.
- Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, as per the project work plans.
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the driller should be informed of the potential hazard before breaking ground. Drilling should then commence slowly to allow continuous visual inspection and/or monitoring, and if necessary, stop for probing.

4.2.3 Mobilization

- The drill rig is mobilized to the site and located over the borehole.
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig.

Note: *The driller should always raise the mast slowly and carefully to prevent tipping or damage to the drill rig. The driller should also avoid obstructions or hazards*.

4.3 Drilling Procedures

A hand auger will be used to advance the borehole from 0 to 5 ft bgs to check that underground utilities are not present at each borehole location. The driller should be informed of any known shallow subsurface hazards (unidentifiable utility, trapped vapors, etc.). Drilling the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

4.3.1 Borehole Drilling

During drilling operations, and as the borehole is advanced, the Field Geologist will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare the soil, soil vapor, and groundwater samples.
- For specific soil and groundwater sampling procedures, refer to the project-specific work plans and appropriate FSOP.

4.3.2 Ongoing Monitoring

As drilling progresses, the Field Geologist should observe and frequently communicate with the driller regarding drilling conditions. This includes relative penetration rates (indicative of fast or slow drilling) and chattering or bucking of the rig.

- The Field Geologist will oversee or conduct appropriate health and safety sampling and monitoring.
- The conditions described above, including the relative drilling rate, should be recorded on the boring log.
- The Field Geologist should know the total depth of the borehole at all times during drilling.
- During drilling, track and note changes in the drilling process (e.g., sounds, rotation speed, sudden drops, etc.) that may indicate changes in lithology, material density, etc., and collect representative soil samples as required by the project work plans.
- Drilling should not progress faster than the Field Geologist can adequately observe conditions, compile boring logs, and supervise safety and sampling activities.
- The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as other auger joints are added to the auger string.
- Any observed problems that include significant downtime, along with their causes, are recorded in the FLB.
- Cuttings and fluids containment during drilling should be observed and supervised by the Field Geologist, as per specifications in the project work plans.

If any potentially unsafe conditions are evident during the above drilling observations, the Field Geologist (or any onsite person) may suspend drilling operations at any time and take appropriate actions as per the health and safety plan.

In the event suspension of drilling activities occur:

- The FTL and Safety Representative must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the FLB.

4.3.3 Boring Log

During drilling, the Field Geologist compiles a boring log. Use field form SWE-FFRM-400. The log will be compiled preferably from soil samples recovered while drilling. Logs should only be compiled from cuttings if this is the only option. Observations of drilling conditions are also entered on the log. If total depth was reached prematurely due to refusal, the cause should be noted on the boring log and the FLB.

Subsurface soil samples may be collected with a split spoon sampler or other compatible devices during drilling. This is done with augers remaining in place. Soil samples can be readily obtained at discrete intervals with these methods.

If a monitoring well is to be installed in the borehole, activities will be supervised by the Field Geologist following FSOP-601, “Well Installation.”

4.4 Borehole Abandonment

If the borehole is to be abandoned after completion, expected quantities of grout to be used should be calculated in advance and tracked during placement.

In general, grout consists of a neat cement mixture containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. The type and composition of the grout mixture should be specified in the project work plans.

The borehole will be tremie-grouted from bottom to top through the inside of the augers as they are retracted to ensure that grout level does not fall below the bottom opening of the lead auger. When the grout has reached the prescribed level (e.g., ground surface or less if special site restoration is required), allow the grout to settle and cure.

Contain any water or fluids displaced by the neat cement and contain as IDW. Excess neat cement shall be placed in portable metal bins or equivalent and disposed of as solid IDW after it is allowed to set.

After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened, and no settlement has occurred.

Restore the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement, soil placement) as necessary.

If a monitoring well is to be installed in the borehole, activities will be supervised by the Field Geologist following FSOP-601, “Well Installation.”

4.5 Demobilization/Site Restoration

After drilling, sampling, and well installation or borehole abandonment is completed, the augers and tools should be laid down, the mast lowered, and the rig moved off the location. Demobilization/site restoration will be supervised by the FTL/Field Geologist or appropriate designee.

All debris generated by the drilling operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All abandoned borings should be topped off and completed per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PM to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PM should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited

Sonic Drilling

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Approvals

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Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation of drilling operations involving sonic (also known as Rotosonic) drilling equipment.

1.2 Scope

The scope of this SOP applies to field staff conducting drilling oversight. The SOP includes guidance for the performance, management, and completion of sonic drilling activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to drilling are addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans.

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, logging geologic materials per SWE-FSOP-201, "Soil Classification," and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the boring logs.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Boring Log - A written and/or graphical description of exploration procedures and subsurface conditions encountered during drilling, sampling, and coring.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of sonic drilling activities and should be used in conjunction with other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001, Fieldwork Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-201, Soil Classification
- SWE-FSOP-601, Well Installation
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, Investigation Derived Waste Management

Field Forms

- SWE-FFRM-400, Soil Boring Log

Review the project-specific work plans to become familiar with the appropriate SOPs and related field forms necessary to complete the drilling activities.

3.0 Equipment List

The list below identifies equipment expected to be used by staff while supervising sonic drilling activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Color chart for logging soil (e.g., Munsell™ chart)
- Hand lens for examining soil
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

Refer to project work plans to confirm equipment required for the specific drilling activity. This may include but is not limited to various field forms, sample containers, incremental sampling devices, and sample homogenizing equipment.

4.0 Procedures

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Drilling Procedures (Section 4.3)
- Borehole Abandonment (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

Sonic drilling is commonly used where the Project Geologist deems issues around difficult drilling and intact core sample recovery affect the success of the work.

Sonic drilling is a method of drilling that employs two opposite-rotating elements (oscillators) in the drill head that act as counterweights working against one another. By adjusting or tuning the oscillations, high-frequency resonance is generated down the tool string to the end of the core barrel (bit), driving the bit downwards.

Cuttings are recovered as core samples or displaced outside of the borehole. Cuttings are usually transferred into a polyethylene sample bag or Lexan liner for logging and storage.

The core barrel is advanced, and the casing is advanced over the core barrel before retraction. Water may be added when working at greater depths, but it is beneficial to drill dry if the depth to groundwater needs to be determined.

A continuous core provides a detailed look at the soil at the depths drilled. This results in a better understanding of the subsurface conditions. Cuttings produced by this method are typically intact as a core sample, allowing for accurate logging.

Additional considerations in using sonic drilling techniques include the potential of volatilizing contaminants due to the heat generated by the oscillating bit.

4.1 Pre-Field Tasks

Preparation and coordination tasks for sonic drilling generally include the activities described below.

4.1.1 Clearances

Before starting any sonic boring, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams that document the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.

4.1.2 Health and Safety

- Hold Tailgate Safety Meetings in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating or swinging drilling components can snag or catch loose clothing or strike personnel and cause severe injury or death.
- Hearing protection is especially critical when sonic drilling, as the rig can generate high-frequency noise and considerable noise when drilling through gravel and cobbles.
- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.1.3 Site Conditions and Drilling Logistics

Prepare the site per the project work plans. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction. The FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include an area for the rig and swing-out clearances, access for a pipe truck, and forklift carrying pipe or debris bins.
- The FTL or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- Lubricating compounds used on drill pipe and drive casing threads must be approved in advance and must not contain compounds incompatible with project objectives, laboratory analyses, or water quality guidelines.
- Drive casings of various lengths should be provided by the subcontractor to facilitate emplacement of the sand pack, bentonite seal, and grout during well construction. One 3-foot, two 5-foot, and two 10-foot lengths and enough standard-length drive casing joints are recommended.
- A hydraulic casing extractor must be used to remove the drive casing from the borehole. Do not extract the casing by "hammering up" with the casing hammer. The hydraulic casing extractor should have sufficient pulling capacity and clamping mechanisms to extract the casing safely and smoothly with the appropriate lifting force.

4.1.4 Rig Decontamination and Preparation

- All drilling and sampling equipment should be decontaminated before drilling

- The drilling equipment shall be inspected for proper maintenance and appropriate decontamination before each time the rig is mobilized to a site
- All clutches, brakes, and drive heads should be properly working
- All cables and hydraulic hoses should be in good condition
- Any observed leakage of fluids from the rig should be immediately repaired and decontaminated again before it is allowed to mobilize

4.1.5 Calibration

Before mobilization, calibrate the safety-related sampling and monitoring equipment.

4.1.6 Personal Protective Equipment (PPE)

Don the appropriate PPE as specified in the project work plans and APP.

4.2 Mobilization and Setup

The standard procedure for sonic drilling is described below and the project work plans may include additional specifications.

4.2.1 Site Preparation

The logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

- As per the site health and safety plan, appropriate barriers and markers should be in place before drilling
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig
- Appropriate cuttings and other IDW containment should be set onsite before the commencement of drilling
- If drilling is conducted in the saturated zone, provisions should be made to ensure adequate containment of formation water produced during drilling operations

4.2.2 Discussion of Site Conditions

Before drilling operations begin, the following must be completed:

- The FTL or Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards and determine how drilling operations may impact the environment.
- As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the driller should be informed of the potential hazard before breaking ground. Drilling should then commence slowly to allow continuous visual inspection and monitoring and, if necessary, stop for probing.

4.2.3 Mobilization

Once the site is prepared, the rig is mobilized and located over the borehole location.

- The drill rig is mobilized to the site and located over the borehole location
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig
- The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig and avoid obstructions or hazards

4.3 Drilling Procedures

Before drilling, use a hand auger, shovel, or air knife to clear the borehole to the maximum expected depth of any utilities (commonly 5 feet or greater) to check that underground utilities are not present at the borehole. The driller should be informed of any known shallow subsurface hazards (unidentifiable utility, trapped vapors, etc.). Drilling the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

4.3.1 Borehole Drilling

During drilling operations, and as the borehole is advanced, the Field Geologist will generally:

- Observe and monitor rig operations
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance
- Prepare a lithologic log from soil samples or cuttings per SWE-FSOP-201, “Soil Classification”
- Supervise the collection of, and prepare the soil, soil vapor, and groundwater samples
- Soil sampling for volatile organic compounds may require removing (tripping out) the entire inner drill string to collect a representative sample
- Groundwater sampling may be performed by retracting the outer casing and allowing water to flow in and be sampled using a bailer or by using a hydropunch-type sampler
- For specific soil and groundwater sampling procedures, refer to the project-specific work plans and appropriate FSOP

4.3.2 Ongoing Monitoring

The Field Geologist should observe and frequently communicate with the driller regarding drilling conditions as drilling progresses. This includes relative penetration rates (indicative of fast or slow drilling) and chattering or bucking of the rig.

- The Field Geologist oversees or conducts appropriate health and safety sampling and monitoring.
- The conditions described above, including the relative drilling rate, should be recorded on the boring log.
- The Field Geologist should know the total depth of the borehole during drilling.
- Drilling should not progress faster than the Field Geologist can adequately observe conditions, compile boring logs, and supervise safety and sampling activities.
- The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as sections are added to the drill string.

- During drilling, track and note changes in the drilling process (e.g., sounds, rotation speed, sudden drops, etc.) that may indicate changes in lithology, material density, etc., and collect representative soil samples as required by the project work plans.
- Any observed problems that include significant downtime and their causes are recorded in the FLB/notepad.
- Cuttings and fluids containment during drilling should be observed and supervised by the Field Geologist, as per specifications in the project work plans.

If any potentially unsafe conditions are evident during the above drilling observations, the Field Geologist (or any onsite person) may suspend drilling operations and take appropriate actions as per the health and safety plan.

In the event suspension of drilling activities occur:

- The FTL and Safety Representative must be informed of the situation
- Appropriate corrective action must be implemented before drilling may be continued
- The observed problem, suspension, and actions taken are entered on the FLB/notepad

4.3.3 Boring Log

During drilling, the Field Geologist compiles a boring log. Use field form SWE-FFRM-400. It is expected that the log can be compiled from continuous cores or fairly representative cuttings within the core barrel recovered while drilling. Observations of drilling conditions are also entered on the log. If total depth was reached prematurely due to refusal, the cause should be noted on the boring log and the FLB.

If a monitoring well is to be installed in the borehole, a Field Geologist must supervise the work following FSOP-601, “Well Installation.”

4.4 Borehole Abandonment

If the borehole is to be abandoned after completion, the anticipated quantity of grout determined in advance and tracked during placement.

Grout consists of a neat cement mixture containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. The type and composition of the grout mixture should be specified in the project work plans or as determined by the Project Geologist.

Tremie-grout the borehole from bottom to top through the inside of the casing as it is retracted to ensure the grout level does not fall below the bottom opening of the casing. When the grout has reached the prescribed level (e.g., ground surface or less if special site restoration is required), allow the grout to settle and cure.

Contain any water or fluids displaced by the neat cement and contain IDW. Excess neat cement shall be placed in portable metal bins or equivalent and disposed of as solid IDW after it is allowed to set.

After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement hardens, and no settlement has occurred.

Restore the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement, soil placement).

If a monitoring well is to be installed in the borehole, activities will be supervised by the Field Geologist following FSOP-601, "Well Installation."

4.5 Demobilization/Site Restoration

After drilling, sampling, and well installation or borehole abandonment is completed, the casing, drill string, and tools should be laid down, the mast lowered, and the rig moved off the location. The FTL or designee should supervise the demobilization/site restoration.

All debris generated by the drilling operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All abandoned borings should be topped off and completed per the project work plans. All monitoring wells should also have their surface completions finished per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited

Direct Push Drilling

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Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation of operations using the Direct Push Technology (DPT) method for collection of soil and/or groundwater samples. HydroPunch, CPT (Cone Penetration Testing), and MIHPT (Membrane Interface Hydraulic Profiling Tool) are related sampling methods using Direct Push methods; refer to specific SOPs to obtain more details for those applications.

1.2 Scope

The scope of this SOP applies to field staff conducting Direct Push Technology oversight. The SOP includes guidance for activities related to the performance, management, and completion of Direct Push activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to Direct Push Technology are addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans.

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the DPT subcontractor, logging geologic materials per SWE-FSOP-201, "Soil Classification," and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the boring logs.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality

deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Boring Log - A written and/or graphical description of exploration procedures and subsurface conditions encountered during drilling, sampling, and coring.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of Direct Push Technology activities and should be used in conjunction with other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001, Fieldwork Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-201, Soil Classification
- SWE-FSOP-402, Passive Groundwater Sampling
- SWE-FSOP-405, Soil Sampling
- SWE-FSOP-601, Well Installation
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, Investigation Derived Waste Management

Field Forms

- SWE-FFRM-400, Soil Boring Log

Project-specific work plans should be reviewed to be familiar with the appropriate SOPs and related field forms necessary to complete the drilling activities.

3.0 Equipment List

The list below identifies equipment expected to be used by staff while supervising Direct Push Technology activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink

- Color chart for logging soil (e.g., Munsell™ chart)
- Hand lens for examining soil
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

Refer to project work plans to confirm equipment required for the specific Direct Push Technology activity. This may include, but is not limited to various field forms, sample containers, incremental sampling devices, and sample homogenizing equipment.

4.0 Procedures

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Direct Push Procedures (Section 4.3)
- Soil Sampling (Section 4.4)
- Grab Groundwater Sampling (Section 4.5)
- Borehole Abandonment (Section 4.6)
- Demobilization/Site Restoration (Section 4.7)

Direct Push Technology, often referred to as DPT, uses the static weight of the rig combined with a hydraulic hammer and/or vibratory process to advance the tooling or instrumentation through the subsurface. Insertion methods may include static push, impact, percussion, other vibratory/sonic driving, and combinations of these methods using direct push equipment adapted to drilling rigs, cone penetrometer units, and specially designed percussion/direct push combination machines. Hammers providing the force for insertion include drop style, hydraulically activated, air activated, and mechanical lift devices. Sampling and logging tools are advanced by rearrangement and compression of soil and sediment particles due to the high frequency percussive force of the hammer and weight of the machine when using the DPT method. Essentially no drill cuttings are generated by the DPT method. This minimizes generation of potentially hazardous waste during contaminated site investigation and reduces the potential for worker exposure to hazardous contaminants relative to many traditional rotary drilling techniques.

Sampling depths of 50 to 100 feet and deeper can be achieved, depending on the local soils and geology. However, DPT methods are not designed to penetrate rock (granite, gneiss, limestone, etc.) and may have difficulty penetrating dense tills, sediments rich in cobbles and boulders, or soils with thick cemented zones.

A DPT tool string includes the sample collection tool and extension rods. There are two types of rod systems: 1) single-tube and 2) dual-tube. Both allow for soil and ground water sampling. However, strengths and limitations associated with each should be considered.

With the single tube (rod) system, samples are retrieved by removing the tool with the sample from the borehole (leaving the borehole open), removing the sample, and reinserting the empty tube with a disposable tip or latched “piston” at the end back into the borehole and driving to the start of the next

sample interval. The disposal tip is then dislodged (or piston is unlatched), and the tube is driven to collect the next sample interval. The single-tube rod system is not an ideal method because the probe is removed from the borehole after each sample is collected and reinserted to collect the next interval, which may allow the borehole to collapse or slough. A second drawback of single-tube systems is the potential for formation or saturated zone cross-contamination during continuous sampling. For these reasons the single tube system isn't considered a preferred method.

The dual-tube sampling system is recommended for continuous sampling in most environmental applications because the sampler is placed and retrieved within an outer drive casing that remains in the borehole. The outer casing prevents sloughing and cross-contamination from other depths. Because the hole is cased, continuous sampling is simplified and expedited.

Most DPT machines are track mounted, but some machines are installed in trucks and a few in specialized vehicles. The large surface area of the tracks provides a lower ground pressure per unit area so that these machines can move across softer ground with less compaction than typical wheeled vehicles. Small DPT machines can squeeze through a 36-inch-wide doorway to access building interiors and to sample in limited access spaces.

4.1 Pre-Field Tasks

Preparation and coordination tasks for DPT operations generally include the activities described below.

4.1.1 Clearances

Before starting any DPT boring, confirm that borehole locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams that document the selected location of the DPT location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.
- Confirm that, before any subsurface activities are initiated, the borehole location will be investigated to the maximum expected depth of any utilities (commonly 5 feet or greater) using a hand auger, shovel, or air knife.

4.1.2 Health and Safety

- Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during advancement of the subsurface tools. The downward movement of the tools can snag or catch loose clothing or strike personnel and cause severe injury or death.

- Hearing protection is especially critical when using Direct Push methods, as the rig can generate considerable noise due to the percussion hammer.
- Establishing clear communication signals with the rig crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.1.3 Site Conditions and Direct Push Logistics

The site will be prepared as per the project work plans. Before mobilizing, the logistics of the Direct Push operations, logging, sampling, cuttings/fluid containment, and/or well construction will be determined.

Before mobilization, the FTL and/or the Field Geologist should assess the site with the rig operator. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

4.1.4 Rig Decontamination and Preparation

- All tools and sampling equipment should be decontaminated before work begins.
- The DPT equipment shall be inspected for proper maintenance and appropriate decontamination before each time the rig is mobilized to a site.
- All clutches, brakes, and drive heads should be in proper working order.
- All cables and hydraulic hoses should be in good condition.
- All tool joints and bits should also be in good condition (e.g., no cracked barrels, bits are not excessively worn, etc.).
- Any observed leakage of fluids from the rig should be immediately repaired and decontaminated again before it is allowed to mobilize.

4.1.5 Calibration

Before mobilization, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

4.1.6 Personal Protective Equipment (PPE)

Don, the appropriate PPE, as specified in the project work plans and APP.

4.2 Mobilization and Setup

The standard procedure for Direct Push Technology is described below. The DPT work will be conducted per the project work plans.

4.2.1 Site Preparation

The logistics of DPT work, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

- Appropriate barriers and markers should be in place prior to DPT work, as per the site health and safety plan.
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig.

- Appropriate cuttings and other IDW containment should be set onsite prior to the commencement of subsurface activities.
- If DPT work is to be conducted in the saturated zone, provisions should be made to ensure adequate containment of formation water produced during DPT operations.

4.2.2 Discussion of Site Conditions

Before DPT operations begin, the following must be completed:

- The FTL should assess the work site with the rig operator. This assessment should identify potential hazards and determine how DPT operations may impact the environment.
- As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.
- The FTL or PL should inform the rig operator of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the rig operator should be informed of the potential hazard before breaking ground. DPT work should then commence slowly to allow continuous visual inspection and/or monitoring, and if necessary, stop for probing.

4.2.3 Mobilization

- The Direct Push rig is mobilized to the site and located over the borehole.
- The Direct Push rig is leveled by tilting/adjusting the attached feet at the front of the rig and utilizing the small blade/scrapper at the rear of the rig.

Note: *The rig operator should always raise the mast slowly and carefully to prevent tipping or damage to the rig. The rig operator should also avoid obstructions or hazards*.

4.3 Direct Push Procedures

A hand auger will be used to advance the borehole from 0 to 5 ft bgs to check that underground utilities are not present at each borehole location. The rig operator should be informed of any known shallow subsurface hazards (unidentifiable utility, trapped vapors, etc.). Advancing the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

- Lubricating compound used on tooling rods and downhole equipment must be approved in advance and must not contain any compounds that are incompatible with project objectives, laboratory analyses, or water quality guidelines.
- Drive rods of various lengths should be provided by the subcontractor to facilitate emplacement of sand pack, bentonite seal, and grout during well construction.

4.3.1 Direct Push Operations

During DPT operations, and as the borehole is advanced, the Field Geologist will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;

- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare the soil, soil vapor, and groundwater samples.
- For specific soil and groundwater sampling procedures, refer to the project-specific work plans or appropriate FSOP.

4.3.2 Ongoing Monitoring

As the DPT method progresses, the Field Geologist should observe and frequently communicate with the operator regarding tool advancement conditions. This includes relative penetration rates (indicative of fast or slow subsurface penetration) and chattering or bucking of the rig.

- The Field Geologist will oversee or conduct appropriate health and safety sampling and monitoring.
- The conditions described above, including the relative penetration rate, should be recorded on the boring log.
- The Field Geologist should know the total depth of the borehole at all times during drilling.
- Advancement of the tools should not progress faster than the Field Geologist can adequately observe conditions, compile boring logs, and supervise safety and sampling activities.
- The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as additional rods are added to the string. Any observed problems that include significant downtime, along with their causes, are recorded in the FLB.

If any potentially unsafe conditions are evident during the above DPT observations, the Field Geologist (or any onsite person) may suspend DPT operations at any time and take appropriate actions as per the health and safety plan.

In the event suspension of drilling activities occur:

- The FTL and Safety Representative must be informed of the situation;
- Appropriate corrective action must be implemented before tool advancement may be continued; and
- The observed problem, suspension, and corrective action are entered on the FLB.

4.3.3 Boring Log

During DPT tool advancement, the Field Geologist compiles a boring log. Use field form SWE-FFRM-400. It is expected that the log can be compiled from continuous cores or representative material from the single or dual tube methods. Observations of tool advancement conditions are also entered on the log. If total depth was reached prematurely due to refusal, the cause should be noted on the boring log and the FLB.

4.4 Soil Sampling

There are two types of soil samplers used with DPT: sealed and non-sealed. Sealed samplers remain closed until they reach the sampling depth. A commonly used sealed sampler is the closed barrel sampler. The non-sealed soil samplers remain open as they are pushed into the ground. Three possible non-sealed samplers are: open solid-barrel; split-spoon; and the thin-walled tubes. Many of these samplers allow for a liner to be inserted to contain the sample interval and allow for easy extraction from the sample barrel.

With the use of liners, samples can be easily removed for volatile organic compound (VOC) analysis or for observation of soil structure.

4.4.1 Closed Barrel Sampler

Closed-barrel samples are sometimes referred to as piston samplers or discrete-depth samplers. They are like open solid-barrel samplers, except the barrel opening is sealed with a rigid, pointed piston that displaces soil as it is advanced into the ground. These samplers are pushed to the desired depth (without the need to collect shallower soil cores), the piston is unlocked by releasing a retaining device, and subsequent pushing or driving forces soil into the sampler. The assembly can then be withdrawn from the ground and the soil extracted. Piston samplers are typically air and watertight; however, the O-ring seals may leak if not properly maintained.

4.4.2 Open Solid-Barrel Sampler

The open solid-barrel sampler consists of a drive head assembly, a non-sealed barrel, and a cutting shoe. The sampler is attached to the rods at the head assembly. A check valve is located within the head assembly. The purpose of the check valve is to allows air or water to escape as the barrel fills with soil which improves the amount of soil recovered in the tube.

4.4.3 Split-Spoon Sampler

Split-barrel samplers are also often used with hollow-stem augers and are like open solid-barrel samplers except the non-sealed barrels are split lengthwise, so the sampler can be easily opened. The major advantage of split-barrel samplers is they allow direct observation of soil cores without the use of liners and without physically extruding the soil core which makes split-spoon samplers good for geologic logging; they may cause more soil compaction than open solid-barrel samplers because the tool wall thickness is often greater.

4.4.4 Thin-Walled Tube Sampler

Thin-walled tube samplers are commonly referred to as Shelby tubes. Shelby tubes are used with both DPT and hollow-stem augers for collecting undisturbed samples. The non-sealed sampling tube is typically attached to the sampler head using recessed cap screws or rubber expanding bushings. The sampler walls, made of thin steel with a sharpened cutting edge, minimize soil compaction compared to other types of samplers; therefore, their use results in relatively undisturbed soil samples which are required for certain geotechnical analyses such as permeability.

4.5 Grab Ground Water Sampling

There are two common types of ground water sampling equipment used in DPT methods: tools for obtaining one-time grab samples (i.e., groundwater grab samplers, such as Hydropunch™), and wells installed using DPT for short-term sampling (i.e., temporary monitoring wells). DPT is a useful cost-effective method for groundwater delineation and can facilitate determining the need for and/or placement of permanent monitoring wells. Refer to SWE-FSOP-601 (Well Installation) and SWE-FSOP-602 (Well Development) for additional information regarding temporary monitoring wells.

DPT grab ground water samplers can be grouped into two classes: sealed protected screens; and exposed screens. Dual-tube systems allow for some protection of cross-contamination, therefore, are more advantageous if multiple level sampling is desired from a single boring.

4.5.1 Exposed-Screen Samplers

Exposed-screen samplers are also known as open screen samplers because they consist of a well screen to allow the influx of ground water and a riser pipe permitting the extraction of a water sample. Exposed-screen samplers are driven to the approximate sample depth below the ground surface and a sample is taken with either a bailer or tubing/pump combination. Purging and development must be conducted prior to sampling. An advantage of the exposed-screen sampler is it can be pushed to different depths so multi-level water samples can be taken without having to remove the tool string. This allows for collection of a vertical profile of the groundwater. Exposed-screen samplers have significant disadvantages such as clogging of the well screen in silty or clay rich soils and because of the small screen diameter, development of the formation can be difficult when abundant fines are present in the screened interval. Additionally, whenever multiple depths are sampled, there is a possibility of drawing contamination to deeper depths, potentially biasing results.

4.5.2 Sealed-Screen Samplers

Sealed-screen samplers are also known as closed-screen sampler. These samplers are protected, sealed sampling devices consisting of a well screen housed within a protective sheath to which are attached an expendable drive point, drive rod(s) and drive head. Rubber O-rings keep the device watertight ensuring sample integrity. Once the desired depth is reached, the screen is held in place and the outer casing is retracted to expose the screen to formation water. After a sample is obtained, the expendable drive point is left in place and the sampling assembly is removed. Since the screen is only exposed after the tool has been placed at the target depth, susceptibility of the screen to clogging is reduced and the O-ring seals reduces the possibility of cross contamination. Additionally, some closed-screen samplers have been designed to leave the outer casing and screen with an attached riser (usually polyvinyl chloride) in place as a temporary monitoring device. Vertical profiling can be accomplished with a single-tube closed-screen sampler or dual-tube inner rod screen by sampling from the shallowest to deepest intervals. Prior to sample collection at each interval, the sampler must be retracted, decontaminated, reassembled, and redeployed to new target depth, and then purged to best obtain the formation water at the new sample interval. Development of the formation can be difficult due to the small screen diameter when significant amounts of fines are present.

4.6 Borehole Abandonment

If the borehole is to be abandoned after completion, expected quantities of grout to be used should be calculated in advance and tracked during placement.

In general, grout consists of a neat cement mixture containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. The type and composition of the grout mixture should be specified in the project work plans.

For shallow borings in cohesive formations, it may be acceptable to simply pour bentonite chips down the open hole. The bentonite should be hydrated with clean water incrementally as the bentonite is added.

However, for deeper borings and in formations prone to collapse, the borings should be grouted in a bottom-up fashion. With some tools, it is possible to grout directly through the tool string as it is removed. For many dual-tube systems, the operator can lower a tremie tube down the outer casing to grout bottom-up. However, for some single-tube systems, it will be necessary to lower a tremie tube down the open boring, or in non-cohesive soils, install a second rod string with expendable point to inject grout into the borehole. When the grout has reached the prescribed level (e.g., ground surface or less if special site restoration is required), allow the grout to settle and cure.

Contain any water or fluids displaced by the neat cement and contain as IDW. Excess neat cement shall be placed in portable metal bins or equivalent and disposed of as solid IDW after it is allowed to set.

After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened, and no settlement has occurred.

Restore the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement, soil placement) as necessary.

4.7 Demobilization/Site Restoration

After Direct Push operations such as water or soil sampling, injection, well installation or borehole abandonment is completed, the casing, drill string, and tools should be laid down, the mast lowered, and the rig moved off the location. Demobilization/site restoration will be supervised by the FTL/Field Geologist or appropriate designee.

All debris generated by the Direct Push operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PM to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PM should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the Direct Push operations and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited

Mud Rotary Drilling

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Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation during drilling operations involving mud rotary techniques.

1.2 Scope

The scope of this SOP applies to field staff conducting drilling oversight. The SOP includes guidance for the performance, management, and completion of mud rotary drilling activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to drilling are addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans (SSHP).

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, logging geologic materials per SWE-FSOP-201, "Soil Classification," and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the boring logs.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Boring Log - A written and/or graphical description of exploration procedures and subsurface conditions encountered during drilling, sampling, and coring.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB/notepad. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of mud rotary drilling activities and should be used in conjunction with other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001, Fieldwork Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-201, Soil Classification
- SWE-FSOP-602, Well Installation
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, Investigation Derived Waste Management

Field Forms

- SWE-FFRM-400, Soil Boring Log

Project-specific work plans should be reviewed to familiarize with the appropriate SOPs and related field forms necessary to complete the drilling activities.

3.0 Equipment List

The list below identifies basic equipment expected to be used by staff while supervising mud rotary drilling activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Color chart for logging soil (e.g., Munsell™ chart)
- Hand lens for examining soil
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

4.0 Procedure

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Drilling Procedures (Section 4.3)
- Borehole Abandonment (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

Mud rotary drilling is an open hole, fluid-based recirculatory drilling method. The borehole is advanced in rock or sediments by rotating a drill bit mounted at the end of drill rods. Drilling fluid circulates in the borehole as it is pumped down through the drill-rod string, where it picks up drill cuttings and carries them to the surface. The drilling fluid also lubricates the drill bit and provides hydrostatic pressure in the borehole to keep the hole open and stable for sampling and well installations. Mud rotary drilling is an option for bedrock, dense sand, or tight gravel formations where hollow stem augers would be ineffective.

Applications: Best used in highly saturated silts and other unconsolidated sediments where soil sampling is necessary. Mud rotary is effective up to about 1,000 feet.

4.1 Pre-Field Tasks

Preparation and coordination tasks for mud rotary drilling generally include the activities described below.

4.1.1 Clearances

Before starting any mud rotary boring, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams documenting the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.

4.1.2 Health and Safety

- Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating or swinging drilling components can snag or catch loose clothing or strike personnel and cause severe injury or death.

- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the Field Geologist of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.1.3 Site Conditions, Drilling Logistics, and Equipment

Prepare the site per the project work plans. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction.

Before mobilization, the FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include an area for the rig and swing-out clearance for the cyclone, access for a pipe truck, and forklift carrying the pipe or debris bins.
- Appropriate cuttings and other investigation-derived waste (IDW) containment should be set onsite before drilling.
- The FTL or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- The lubricating compound used on drill pipe and drive casing threads must be approved in advance and must not contain any incompatible compounds with project objectives, laboratory analyses, or water quality guidelines.

4.1.4 Rig Decontamination and Preparation

- All drilling and sampling equipment should be decontaminated before drilling.
- The drilling equipment shall be inspected for proper maintenance and appropriate decontamination before each time the rig is mobilized to a site.
- All clutches, brakes, and drive heads should be properly working.
- All cables and hydraulic hoses should be in good condition.
- Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to mobilize.

4.1.5 Calibration

Before mobilization, calibrate safety sampling and monitoring equipment per the project work plans.

4.1.6 Personal Protective Equipment (PPE)

Don the appropriate PPE specified in the project work plans and APP.

4.2 Mobilization and Setup

The standard procedure for mud rotary drilling is described below. Conduct drilling following this SOP and the project work plans.

4.2.1 Site Preparation

Prepare the site per the project work plans. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction.

- As per the site health and safety plan, appropriate barriers and markers should be in place before drilling.
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig.
- Appropriate cuttings and other IDW containment should be set onsite before drilling.

4.2.2 Discussion of Site Conditions

Before drilling operations begin, the following must be completed:

- The FTL or Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards and determine how drilling operations may impact the environment.
- Potential hazards should be evaluated and corrected, or the borehole location changed or shifted.
- The FTL or PL should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the driller should be informed of the potential hazard before breaking ground. Drilling should then commence slowly to allow continuous visual inspection and monitoring, if necessary, stop for probing.

4.2.3 Mobilization

Once the site is prepared, the rig is mobilized and located over the borehole.

- The drill rig is mobilized to the site and located over the borehole.
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig.
- The driller should always raise the mast slowly and carefully to prevent tipping or to damage the rig and avoid obstructions or hazards.
- As per the site health and safety plan, appropriate barriers and markers should be placed before drilling.

4.3 Drilling Procedures

Hand auger, shovel, or air knife the borehole location to the maximum expected depth of any utilities (commonly 5 feet or greater) before drilling. The driller should be informed of any known shallow subsurface hazards (unidentifiable utility, trapped vapors, etc.). Drilling the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

Before beginning drilling, the drilling fluid or mud should be “made up” in the mud pits. The drilling mud properties (as specified in the project work plans) should then be verified to the satisfaction of the Field Geologist before allowing drilling to proceed. These observations should also be documented by the site Field Geologist on the Field Activity Daily Log.

4.3.1 Borehole Drilling

During drilling operations, and as the borehole is advanced, the Field Geologist will generally:

- Observe and monitor rig operations
- Conduct health and safety monitoring and sampling, as applicable, and supervise health and safety compliance

- Prepare a lithologic log from cuttings, core, or soil samples
- Document drilling progress and other appropriate observations
- Supervise the collection and preparation of any soil, soil vapor, or groundwater samples
- For specific soil and groundwater sampling procedures, refer to the project-specific work plans and appropriate FSOP.

4.3.2 Ongoing Monitoring

The field geologist should observe and frequently communicate with the driller regarding drilling conditions as drilling progresses. This includes relative penetration rates (indicative of fast or slow drilling), chattering or bucking of the rig, lost circulation zones, hard or sticky drilling, drilling refusal, etc.

- The Field Geologist oversees or conducts appropriate health and safety sampling and monitoring.
- The conditions described above, including the relative drilling rate, should be recorded on the boring log.
- The Field Geologist should know the total depth of the borehole during drilling.
- Drilling should not be allowed to progress faster than the Field Geologist can adequately observe conditions, compile boring logs, and supervise safety and sampling activities.
- The Field Geologist should also observe the rig operations, including the make-up and tightening of connections and any observed leaks.
- During drilling, track and note changes in the drilling process (e.g., sounds, rotation speed, sudden drops, etc.) that may indicate changes in lithology, material density, etc., and collect representative soil samples as required by the project work plans.
- Any observed problems that include significant downtime and their causes are recorded in the FLB/notepad or field form.
- Cuttings and fluids containment during drilling should be observed and supervised by the rig geologist/engineer, as per specifications in the project work plans.

If any potentially unsafe conditions are evident during the above drilling observations, the Field Geologist (or any onsite person) may suspend drilling operations and take appropriate actions per the health and safety plan.

In the event suspension of drilling activities occur:

- The FTL and Safety Representative must be informed of the situation.
- Appropriate actions must be implemented before drilling may be continued.
- The problem, suspension, and actions taken are entered on the FLB/notepad or field form.

4.3.3 Boring Log

The Field Geologist compiles a boring log during drilling, preferably from recovered, undisturbed soil samples. Use field form SWE-FFRM-400. Logs should only be compiled from cuttings if there is no other option. Soil classification descriptions included in the boring log show follow procedures in the soil classification FSOP in Section 2.0.

Subsurface soil samples may be collected with a split spoon sampler, Shelby tube, wireline sampler, or other compatible devices during drilling. This usually requires tripping out (removing) the inner rotary drill

string. The Field Geologist supervises sampling. Soil samples can be readily obtained at discrete intervals with these methods.

Observations of drilling conditions are also entered on the log. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the FLB.

4.3.4 Geophysical Testing

Geophysical testing may be conducted at any depth by interrupting the advancement of the drill bit, cleaning the borehole of cuttings, stopping mud circulation, and removing the drill-rod column from the borehole.

Borehole geophysical tests may be run at various depths before completing the well. The Field Geologist should note the type(s) of tests run, logging conditions, distribution of log copies and originals, and any observed problems in the FLB/notepad or field form.

4.4 Borehole Abandonment

If the borehole is to be abandoned after completion, expected quantities of grout to be used should be calculated in advance and tracked during placement.

Grout consists of a neat cement mixture containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. The type and composition of the grout mixture should be specified in the project work plans.

Tremie-grout the borehole from bottom to top and through the inside of the casing as it is retracted. Ensure that the grout level does not fall below the bottom opening of the casing. When the grout has reached the prescribed level (e.g., ground surface or less if special site restoration is required), allow the grout to settle and cure.

Contain any water or fluids displaced by the neat cement and as IDW. Excess neat cement shall be placed in portable metal bins or equivalent and disposed of as solid IDW after it is allowed to set.

After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.

Restore the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement, soil placement).

If a monitoring well is installed in the borehole, the Field Geologist supervises activities following FSOP-601, “Well Installation.”

4.5 Demobilization/Site Restoration

After drilling, sampling, well installation, or borehole abandonment is completed, the drill rod, bit, and tools should be laid down, the mast lowered, and the rig moved off the location. The Field Geologist or appropriate designee supervises demobilization/site restoration activities.

All debris generated by the drilling operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All abandoned borings should be topped off and completed per the project work plans. All monitoring

wells should also have their surface completions finished per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited

Air Rotary Drilling

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Christopher Ohland — April 1, 2022
Christopher Ohland — Date
SWE Quality Assurance Manager

Bruce Wilcer — April 1, 2022
Bruce Wilcer — Date
SWE Field Quality Control Manager

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques to use during the supervision of drilling operations involving air rotary techniques and equipment.

1.2 Scope

The scope of this SOP applies to field staff conducting drilling oversight. The scope of this SOP includes guidance for activities related to the performance, management, and completion of air rotary drilling activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to drilling are addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans (SSHP).

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, logging geologic materials per SWE-FSOP-201, "Soil Classification," and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the boring logs.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 Safety and Health Requirements. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Air Rotary Drilling—General term for methods of drilling that employ a rotating drill string (pipe and bit) to advance the borehole, using air as a circulating medium. Air is forced through the center of the drill pipe and exits the bit at the bottom of the borehole and then upward in the annular space between the borehole wall and drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

Air Rotary Casing Hammer—A variation of the air rotary method. The air rotary drill string is contained inside a slightly larger diameter heavy-walled drive casing. The drive casing is advanced simultaneously with the air rotary bit using a rig-mounted hydraulic or air hammer but does not rotate with the bit. The casing maintains borehole stability, temporarily isolates aquifer/contaminated zones, and reduces lost circulation of the subsurface air stream.

Boring Log —A written and/or graphical description of exploration procedures and subsurface conditions encountered during drilling, sampling, and coring.

Field Documentation—The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms—Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB)—A portable, bound, weatherproof notebook with consecutively numbered pages.

2.0 Relevant Documents

Relevant documents applicable to this SOP for air rotary drilling activities commonly include SOPs related to field documentation, soil sampling, and logging, groundwater and soil gas sampling, sample management, and monitoring well construction:

Standard Operating Procedures

- SWE-FSOP-001, Fieldwork Documentation
- SWE-FSOP-002, Field Sample Management
- SWE-FSOP-201, Soil Classification
- SWE-FSOP-601, Well Installation
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, Investigation Derived Waste Management

Field Forms

- SWE-FFRM-400, Soil Boring Log

Review the project-specific work plans to become familiar with the appropriate SOPs and related field forms necessary to complete the drilling activities.

3.0 Equipment List

The list below identifies basic equipment expected to be used by staff while supervising air rotary drilling activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Color chart for logging soil (e.g., Munsell™ chart)
- Hand lens for examining soil
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

Refer to project work plans to confirm equipment required for the specific drilling activity. This may include but is not limited to various field forms, sample containers, incremental sampling devices, and sample homogenizing equipment.

4.0 Procedures

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Drilling Procedures (Section 4.3)
- Borehole Abandonment (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

Air rotary drilling without a casing is commonly limited in environmental projects to drilling in hard consolidated rock or highly consolidated sediment or soil for coring and installing wells. This method commonly has problems when drilling in unconsolidated coarse sediment or soil because the air does not provide sufficient density or viscosity to keep the borehole open while drilling, and air circulation is lost through invasion into coarse, permeable beds. Therefore, air rotary casing hammer (ARCH) drilling is covered in the remainder of this document.

ARCH drilling is applicable when installing monitoring wells as there is reasonable depth control, and the drive casing can be progressively pulled as well construction materials are placed in the borehole. Use the drive casing in unconsolidated soil and sediment to maintain borehole stability during drilling and well construction.

A variety of drilling bits may be used to penetrate various formations encountered. Cone-type bits and down-hole hammers with button bits are typically used to drill through consolidated rock, boulders, and granular soils and may incorporate an eccentric under-reaming bit assembly such as the ODEX™ or STRATEX™ systems in the drill string. Drag (fishtail) type bits are commonly used to progress through clayey and silty soils.

A disadvantage of ARCH drilling is that cuttings are typically disaggregated, making bedding and fabric determination difficult. Undisturbed soil samples can be obtained from the bottom of the hole; however, it typically requires removing the entire drill string for each sample interval.

Additional considerations in using air rotary drilling techniques include the potential of pushing vapor phase contaminants into the surrounding soil/rock matrix and flushing samples and the possibility of vapors exiting the borehole.

***Note**: Foam additives or other materials to improve air circulation in the borehole must not be used during ARCH drilling on environmental projects.*

4.1 Pre-Field Tasks

Preparation and coordination tasks for ARCH drilling generally include the activities described below.

4.1.1 Clearances

Before starting any ARCH boring, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include using a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams documenting the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.
- Before drilling, the borehole location should be investigated to the maximum expected depth of any utilities (commonly 5 feet or greater) using a hand auger, shovel, or air knife.

4.1.2 Health and Safety

- Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- As per the site health and safety plan, appropriate barriers and markers should be placed before drilling.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating mechanisms can snag or catch loose clothing and cause severe injury or death.
- Hearing protection is critical when ARCH drilling, especially as the rig drive hammer strikes the drive casing as it is advanced.
- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the Field Geologist of any unforeseen hazard—or when anyone is approaching the exclusion zone.
- Close attention must be paid at all times to compressor air lines and hoses conveying cuttings to the cyclone during drilling. Obstructed lines can rupture under pressure, releasing hose sections and cuttings and debris at high velocities.

4.1.3 Site Conditions, Drilling Logistics, and Equipment

Prepare the site per the project work plans. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction.

Before mobilization, the FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include an area for the rig and swing-out clearance for the cyclone, access for a pipe truck, and forklift carrying the pipe or debris bins.
- Appropriate cuttings and other investigation-derived waste (IDW) containment should be set onsite before drilling.
- The FTL or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- Rigs used for ARCH drilling must have an integrated hammer handling system built into the mast assembly. A rig that requires personnel to climb onto the mast to attach or detach the hammer is unacceptable.
- The casing hammer/drill string assembly should have a sealing system sufficient to control air pressure and ensure that all cuttings, fluids, and air are discharged through the hammer exit spout.
- The hammer spout will have an attachable and removable discharge hose of sufficient size and length to reach the cyclone when the hammer is raised to the top of the mast. The hose shall be adequately anchored and attached to a cyclone that effectively decelerates cuttings from the air stream.
- An air compressor or combination of compressors should be adequate to meet minimum discharge requirements at specified pressures. Incorporated in-line filters into the air conveyance lines from the compressor(s) to remove impurities (e.g., compressor lubricating oil). Inspect the filters and change them regularly.
- The lubricating compound used on drill pipe and drive casing threads must be approved in advance and must not contain compounds incompatible with project objectives, laboratory analyses, or water quality guidelines.
- The subcontractor should provide drive casings of various lengths to facilitate emplacement of the sand pack, bentonite seal, and grout during well construction. One 3-foot, two 5-foot, and two 10-foot lengths and a sufficient number of standard length drive casing joints are recommended.
- Use a hydraulic casing extractor to remove the drive casing from the borehole. Do not extract the casing by “hammering-up” with the casing hammer. The hydraulic casing extractor should have sufficient pulling capacity and clamping mechanisms to extract the casing safely and smoothly with the appropriate lifting force.

4.1.4 Rig Decontamination and Preparation

All drilling and sampling equipment should be decontaminated before drilling as per SWE-FSOP-801, Equipment Decontamination, and the project work plans.

The driller and Field Geologist should inspect the drilling equipment for proper maintenance and appropriate decontamination before each time the rig is mobilized to a location.

- All clutches, brakes, and drive heads should be properly working.
- All cables and hoses should be in good condition.
- All drill pipes, drive casing, and bits should also be in good condition (e.g., no damaged threads on the drive casing or drill pipe or damaged or excessively worn bits).
- Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to mobilize.

4.1.5 Calibration

Before mobilization, calibrate safety sampling and monitoring equipment per the project work plans.

4.1.6 Personal Protective Equipment (PPE)

Don the appropriate PPE specified in the project work plans and APP.

4.2 Mobilization and Setup

The standard procedure for ARCH drilling is described below. Conduct drilling following the project work plans and this SOP.

4.2.1 Site Preparation

The logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

- As per the site health and safety plan, appropriate barriers and markers should be placed before drilling.
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig.
- Appropriate cuttings and other IDW containment should be set onsite before the commencement of drilling.
- If drilling is conducted in the saturated zone, provisions should ensure adequate containment of formation water produced during drilling operations.

4.2.2 Discussion of Site Conditions

Before drilling operations begin, the following must be completed:

- The FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards and determine how drilling operations may impact the environment.
- As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the driller should be informed of the potential hazard before breaking ground. Drilling should then commence slowly to allow continuous visual inspection and monitoring and, if necessary, stop for probing.

4.2.3 Mobilization

Once the site is prepared, the rig is mobilized and located over the borehole.

- The drill rig is mobilized to the site and located over the borehole.
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig.
- The driller should always raise the mast slowly and carefully to prevent tipping or to damage the rig and avoid obstructions or hazards.
- The cyclone should be positioned to easily collect cuttings as they drop out of the bottom opening.
- As per the site health and safety plan, appropriate barriers and markers should be placed before drilling.

4.3 Drilling Procedures

Use a hand auger to advance the borehole from 0 to 5 ft bgs to check that underground utilities are not present at each borehole location. The driller should be informed of any known shallow subsurface hazards (unidentifiable utility, trapped vapors, etc.). Drilling the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

4.3.1 Borehole Drilling

During drilling operations, and as the borehole is advanced, the Field Geologist will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare the soil, soil vapor, and groundwater samples;
- Soil sampling for volatile organic compounds may require removing (tripping out) the entire inner drill string to collect a representative sample;
- Groundwater sampling may be performed by retracting the drive casing and allowing water to flow in and be sampled using a bailer or by using a hydropunch-type sampler;
- For specific soil and groundwater sampling procedures, refer to the project-specific work plans and appropriate FSOP.

4.3.2 Ongoing Monitoring

The field geologist should observe and frequently communicate with the driller regarding drilling conditions as drilling progresses. This includes relative rates of penetration (indicative of fast or slow drilling) and chattering or bucking of the rig.

- The Field Geologist oversees or conducts appropriate health and safety sampling and monitoring.
- The conditions described above, including the relative drilling rate, should be recorded on the boring log.
- The Field Geologist should know the total depth of the borehole during drilling.
- Drilling should not be allowed to progress faster than the Field Geologist can adequately observe conditions, track depth, compile boring logs, and supervise safety and sampling activities.

- The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as additional drill pipe and drive casing are added to the drill string.
- During drilling, track and note changes in the drilling process (e.g., sounds, rotation speed, sudden drops, etc.) that may indicate changes in lithology, material density, etc., and collect representative cutting and soil samples as required by the project work plans.
- No leaks should be evident in the air system on the rig, including the drill pipe extending from the top head drive through the casing hammer.
- Any observed problems that include significant downtime and their causes are recorded in the FLB/notepad or field form.
- Cuttings and fluids containment during drilling should be observed and supervised by the Field Geologist, as per specifications in the project work plans.
- To improve air circulation in the borehole, foam additives or other materials, including water, must not be used during ARCH drilling on environmental projects.

If any potentially unsafe conditions are evident from the above drilling observations and the health and safety sampling and monitoring, the Field Geologist (or anyone on the Field Team) may suspend drilling operations and take appropriate actions as per the health and safety plan.

In the event suspension of drilling activities occur:

- The FTL and Safety Representative must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the FLB.

4.3.3 Boring Log

The Field Geologist compiles a boring log during drilling, preferably from recovere, undisturbed soil samples. Use field form SWE-FFRM-400. Logs should only be compiled from cuttings if there is no other option. Soil classification descriptions included in the boring log show follow procedures in the soil classification FSOP in Section 2.0.

Subsurface soil samples may be collected with a split spoon sampler, Shelby tube, wireline sampler, or other compatible devices during drilling. This usually requires tripping out (removing) the inner rotary drill string. The Field Geologist supervises sampling. Soil samples can be readily obtained at discrete intervals with these methods.

Observations of drilling conditions are also entered on the log. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the FLB.

4.4 Borehole Abandonment

If the borehole is to be abandoned after completion, expected quantities of grout to be used should be calculated in advance and tracked during placement.

Grout consists of a neat cement mixture containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. The type and composition of the grout mixture should be specified in the project work plans.

Tremie-grout the borehole from bottom to top and through the inside of the casing as it is retracted. Ensure that the grout level does not fall below the bottom opening of the casing. When the grout has reached the prescribed level (e.g., ground surface or less if special site restoration is required), allow the grout to settle and cure.

Contain any water or fluids displaced by the neat cement as IDW. Excess neat cement shall be placed in portable metal bins or equivalent and disposed of as solid IDW after it is allowed to set.

After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.

Restore the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement, soil placement).

If a monitoring well is installed in the borehole, the Field Geologist supervises activities following FSOP-601, "Well Installation."

4.5 Demobilization/Site Restoration

After drilling, sampling, and well installation or borehole abandonment is completed, the drill string, bits, and tools should be laid down, the mast lowered, and the rig moved off the location. The Field Geologist or appropriate designee supervises demobilization/site restoration activities.

All debris generated by the drilling operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All abandoned borings should be topped off and completed per the project work plans. All monitoring wells should also have their surface completions finished per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be properly contained, clearly labeled, and maintained in compliance with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited

Soil Vapor Sampling

Document Number	SWE-FSOP-408
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Approvals

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May 30, 2024
Date

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May 30, 2024
Date

Project-Specific Modification[1]

Project-Specific Modifications for Project Number 21065.000.01.0000

- Section 2, “Relevant Documents.”

Replace field form SWE-FFRM-304, “Soil Vapor Well/Probe Sampling” with FFRM-304, “Soil Vapor Well/Probe Sampling-Project Specific.”

- Section 4.4.5, “Soil Vapor Sampling.”

Replace procedural steps with the following.

1. After the soil vapor purge and the SVPIT is complete, disconnect the quick-connect on the manifold that goes to the purge line. This will prevent any outside air from entering the manifold. Close the shroud and apply enough helium to create a 30 percent ambient around the manifold. Use the shroud gloves to turn the valve on the SUMMA canister to the open position. Then, record the sample collection start time and the initial helium concentration within the shroud. The laboratory commonly pre-sets sampling flow rates between 100 and 200 mL/min and vacuum rates not above 100 inches of water or 7.4 inHg. Confirm flow rates per the work plan or PL instructions.
2. During soil vapor sampling, check the helium concentration in the shroud every two minutes to ensure that it remains at a concentration between 20 percent and 30 percent and record the value. Monitor the sample for vacuum remaining and turn it off between −4 and −8 inHg. Depending on the subsurface conditions, sampling time may vary. Theoretically, the sampling period for a 1.0L SUMMA canister at a 200 mL/min flow rate, without flow restriction, is completed in 5 minutes (i.e., 5 minutes at 200 mL/min equals 1 L).
3. Once the vacuum in the SUMMA canister is between −4 and −8 inHg, use the shroud glove to shut the canister's valve.
4. Record the sample collection end time and helium concentration in the shroud.
5. Disassemble the sample manifold and shroud and replace the end cap on the SUMMA canister (if necessary).
6. Use a vacuum gauge (same gauge as used in Section 4.4.1, step 1) to determine the current vacuum in the SUMMA canister. Record all pertinent information on the label of the SUMMA canister and the data sheets.
7. Replace the well cover.

Follow the documentation and sample handling procedures below.

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

May 30, 2024. Grammatical edits throughout. Update the list of field forms in Section 2. Procedures in Section 4.4.2, “Shut-In Test,” and 4.4.3, “Soil Vapor Purge,” were edited for clarity.

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation requirements to collect soil vapor samples from temporary and permanently installed soil vapor probes and wells using SUMMA® canisters, helium shrouds, and other related equipment. The details within this SOP should be used with project-specific work plans.

1.2 Scope

This SOP includes guidance for the performance, management, and completion of soil vapor sampling activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control.

This SOP was developed using the following guidelines:

- California Department of Toxic Substances Control (DTSC) and California Environmental Protection Agency (Cal EPA), 2011. *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air* (Vapor Intrusion Guidance). October. Available from: https://dtsc.ca.gov/vapor-intrusion/
- DTSC/Cal EPA, 2015. *Advisory, Active Soil Vapor Investigations*. July. Available from: https://dtsc.ca.gov/wp-content/uploads/sites/31/2021/11/VI_ActiveSoilGasAdvisory_FINAL_a.pdf
- DTSC/Cal EPA, 2023. *Final Draft Supplemental Guidance: Screening and Evaluating Vapor Intrusion* (Supplemental Guidance). February. Available from: https://dtsc.ca.gov/vapor-intrusion/
- Department of Defense (DoD), 2009. *DoD Vapor Intrusion Handbook*. January. Available from: http://www.clu-in.org/download/char/dodvihdbk200901.pdf.

The project-specific Accident Prevention Plan and Site Safety and Health Plan address potential hazards related to soil vapor sampling.

1.3 Responsibilities

Field Team Lead (FTL). The FTL reviews project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL also reviews and confirms the adequacy of the fieldwork documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current U.S. Army Corps of Engineers EM-385-1-1 *Safety and Occupational Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and

takes action to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Helium Detector. A device for verifying the seal integrity of the sampling train and soil vapor probe seal.

Sample Train. A system of tubing that forms a gas-tight train from the probe to the sample container, controlling the sample flow rate and gauging the vacuum in the system.

Shut-In Test. A 15-minute test using a manual pressure gauge to ensure the integrity of the sample train and SUMMA canister.

Soil Vapor Probe. A temporary or permanently installed probe, typically constructed from stainless steel, with a filter screen at the end installed at a specific depth to allow trapped vapors to be removed and sampled.

Soil Vapor Probe Integrity Test (SVPIT). This 15-minute test using helium as a trace gas ensures that the sample train and the soil vapor probe seal are leak-free.

SUMMA® Canister. Stainless steel vacuum sampling devices are cleaned, evacuated, and used to collect whole-air samples for laboratory analysis. They are commonly used for sampling gas-phase volatile organic compounds (VOCs).

Vacuum Gauge. The gauge used to measure the initial vacuum of the canister before sampling and the final vacuum upon completion.

Vacuum Pump. A device that removes gas molecules or air particles from a sealed volume to achieve a pressure difference, creating a partial vacuum.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of soil vapor sampling activities. It should be used in conjunction with guidelines listed in References (Section 7.0) and other applicable SOPs and forms, including the following:

Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-002, Field Sample Management

Field Forms

- SWE-FFRM-302, Chain of Custody
- SWE-FFRM-304, Soil Vapor Well/Probe Sampling

Project-specific work plans should be reviewed to familiarize the field technician with the appropriate SOPs and related field forms necessary to complete the sampling activities.

3.0 Equipment and Materials List

The following materials should be utilized during soil vapor sampling:

Documentation/Labels

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation
- Waterproof, indelible pens/markers in black or blue ink
- Sample labels (typically attached to sample canisters provided by the laboratory)
- Sample Forms (SWE-FFRM 304.00)
- Chain of Custody (SWE_FFRM-302, Chain of Custody or equivalent)

Site Setup

- Tools to open well if it is a flush mount well box (3/4-inch or 15/16-inch wrench usually)
- 9/16-inch wrench to remove canister caps and attach gauges and flow regulators
- Tubing cutter
- 1/4-inch nylon or Teflon tubing, approximately 1 foot (ft) per probe
- 3/8-inch silicone tubing, approximately 3” per probe
- Small zip ties
- Ferrules and 1/4-inch compression caps (extras in case laboratory-provided ones do not work)
- Cones for delineation of the exclusion zone

Soil Vapor Purging

- Vacuum pump
- Vacuum gauge (provided by lab)
- Rotameter

Soil Vapor Probe Integrity Test (Helium Test)

- Laboratory-provided items, confirm in advance:
  - Helium compressed gas cylinder
  - Helium cylinder regulator and tubing with connection to shroud
  - Inline helium detector
  - Shroud helium detector
  - Shroud assembly
- Plastic sheeting to protect the shroud
- Weights to hold shroud down
- Cardboard cover for above-grade well completions

Sampling (provided by the laboratory)

- Sample containers – 1- or 6-liter (L) SUMMA canisters

- Flow regulator – between 100 and 200 milliliters per minute (mL/min) (usually a part of the shroud sampling manifold assembly)
- Sample manifold (T-manifold for duplicate samples)
- Vacuum gauge

4.0 Sampling Procedures

4.1 Sample Locations and Schedule

Note: Soil vapor sampling should not occur during a significant rain event and should only occur after five days without a significant rain event (½ inch or greater precipitation in 24 hours); however, soil vapor sampling after rainfall can proceed where infiltration has not occurred, such as under buildings or beneath high-integrity pavement (DTSC/Cal EPA, 2015).

4.2 Preparation

- Gather materials listed in Section 3.0.
- Once onsite, follow the safety guidelines in the Accident Prevention Plans. Wear a high-visibility safety vest, steel-toe boots, and eye protection as necessary.
- Set up safety cones around the site to delineate pedestrian and vehicle areas.

4.3 Ambient Air Sampling

Ambient air sampling assesses ambient conditions while collecting field samples. Refer to the project-specific Work Plan/Quality Assurance Project Plan to confirm ambient air sampling design and requirements.

Before collecting soil vapor probe samples, set up the ambient canister for sampling ambient conditions if specified in the work plan:

- Identify the appropriate ambient sample location based on wind direction and general site conditions.
- Confirm that the valve is closed (clockwise motion).
- Attach the flow controller with a pre-set flow rate (typically to achieve an 8-hour sample) to the canister via a quick-connect coupler.
- Remove the brass cap from the flow controller and open the canister valve a ½ turn.
- Record the initial vacuum and start time.
- Observe and record vacuum gauge readings throughout the day. Close the SUMMA canister valve when the can vacuum is between −4 and −8 inches mercury (inHg). Close the valve by hand-tightening the knob clockwise.
- Verify and record the final vacuum of the canister displayed on the gauge and the time.
- Detach the flow controller and replace the brass cap.
- Complete the canister sample tag (make sure the sample ID and collection date recorded on the tag match exactly those recorded on the Chain of Custody).

4.4 Canister Sampling

This section describes various steps commonly performed during sampling using SUMMA canisters. In addition to actual sample collection, steps include, but may not be limited to, pre-sampling procedures, Shut-In Test, soil vapor purge, and SVPIT (helium test).

4.4.1 Pre-Sampling Procedures

Follow the procedures for each soil vapor probe sample collected:

1. Attach a vacuum gauge to the SUMMA canister (it may be a quick-connect fitting).
2. Open the SUMMA canister valve to check for proper vacuum (minimum -25 inHg) (Figure 1).
3. Close the SUMMA canister valve and remove the gauge.
4. Record the initial canister vacuum.

4.4.2 Shut-In Test

1. Before sampling begins, tighten the brass cap.
2. Attach the sample manifold fitting to the SUMMA canister (Figure 2).
3. Perform the equipment Shut-In Test by opening the manifold assembly flow valve on the SUMMA canister and wait until both gauges have stabilized at their maximum vacuum.
4. Close the flow valve and record the initial canister vacuum.
5. Confirm the starting vacuum does not drop over 1 inHg after 15 minutes of observation.
6. If the Shut-In Test fails, reassemble connections and retry the test. Do not use the canister if the initial vacuum is less than -25 inHg. Try a different flow regulator or ferrules and compression caps if necessary. Contact the laboratory for further guidance if Shut-In Test failures become a consistent problem.

4.4.3 Soil Vapor Purge

1. After the Shut-In Test passes, set the shroud over the soil vapor probe (Figure 3).
2. Once the helium shroud is in place, join the soil vapor nesting probe tubing to the purge pump tubing via a 16-inch (or less) piece of Teflon tubing and short silicone tubing connector or “jumper” (securing tubing connections with small zip ties if necessary) and attach the pump tubing to the rotameter. Turn the pump on and look at the vacuum gauge on the right to ensure it is pulling between 5 and 7.4 inHg. Adjust the rotameters to pull either 200 mL/min (≤10 ft probe) or 400 mL/min (all other probe depths). Record the beginning time and flow rate. Purge each soil vapor probe at the pre-determined flow rate and time prescribed in the work plan.
3. Once the purging is complete, remove the brass cap and attach the SUMMA canister and manifold to the purge line (quick-connect) and the sample manifold inlet to the compression fitting with a compression cap and ferrule. Tighten connections with a 1/2-inch and 9/16-inch wrench one-quarter turn after it is hand-tight; do not overtighten.

4.4.4 Soil Vapor Probe Integrity Test (Helium Test)

Once purging is complete, begin the SVPIT. The SVPIT will take 15 minutes to complete.

1. Attach the gas regulator to the helium-compressed gas cylinder and connect the attached ¼-inch tubing to the helium inlet on the shroud.
2. Place the shroud's helium detector inside and turn it on. Record the measurement, which should read 0 percent helium.
3. Turn on the inline helium detector. Record the measurement, which should read 0 percent helium.

   Note: If the helium exceeds 0 percent, the detector(s) should be checked and replaced.

4. Attach the inline helium detector to the sample manifold outlet tubing before the rotameter. Set the rotameter to 200 mL/minute.

   Note: Windy conditions can cause leaks in the shroud and require more helium than desired. To prevent helium leaks, block any gaps and weigh down the shroud opening as much as possible.

5. Begin applying helium to the shroud at approximately 30 percent (as measured by the shroud helium detector). Avoid letting the helium go below 20 percent during the 15-minute SVPIT. Adjust the helium flow control valve between the regulator and shroud to maintain helium at approximately 30 percent.
6. Record the shroud and inline helium detector readings every 5 minutes for 15 minutes. A 5 percent ambient air leak is acceptable; therefore, when the shroud helium detector reads 20 percent helium, a 1 percent drop in helium from the inline detector is acceptable. If all measurements pass, then the SVPIT passes.
7. If one of the measurements does not pass, action is necessary before sampling, like the Shut-In Test corrective action (e.g., re-checking fittings, etc.).

4.4.5 Soil Vapor Sampling

1. After the soil vapor purge, sampling may begin by turning the sample manifold valve to the closed position and turning the valve on the SUMMA canister to the open position. Then, record the sample collection start time and vacuum. The laboratory commonly pre-sets sampling flow rates between 100 and 200 mL/min and a vacuum rate not above 100 inches of water or 7.4 inHg. Confirm flow rates per the work plan or PL instructions.
2. During soil vapor sampling, periodically monitor the sample for vacuum remaining and turn it off between −4 and −8 inHg. Depending on the subsurface conditions, sampling time may vary. Theoretically, the sampling period for a 1.0L SUMMA canister at a 200 mL/min flow rate, without flow restriction, is completed in 5 minutes (i.e., 5 minutes at 200 mL/min equals 1 L).
3. Close the SUMMA canister valve when the can vacuum is between −4 and −8 inHg.
4. Record the sample collection end time and vacuum level.
5. Disassemble the sample manifold and shroud and replace the end cap on the SUMMA canister (if necessary).
6. Replace the well cover.
7. Follow the documentation and sample handling procedures below.

4.5 Field Duplicate Samples

Collect field duplicate samples at the frequency stated in the work plans. Collect the normal and duplicate samples simultaneously using a duplicate "T" splitter sample manifold provided by the laboratory.

4.6 Sample Handling

Follow SWE-FSOP-002, "Field Sample Management."

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control methods described in the project work plans.

The FTL or PL performs Quality Assurance (QA) and Quality Control (QC) procedures for field documentation to check that procedures, documentation content, and the level of detail comply with this SOP. The PL documents SOP deficiencies or variances and determines the need for corrective action in coordination with the QA Manager.

6.0 Documentation Review

The FTL is responsible for reviewing the activities performed at the site and fieldwork documentation daily for compliance with requirements (Section 4.0) and legibility.

7.0 References

California Department of Toxic Substances Control (DTSC) and California Environmental Protection Agency (Cal EPA), 2011. *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*. October. Available from: http://www.dtsc.ca.gov/SiteCleanup/Vapor_Intrusion.cfm.

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Figures

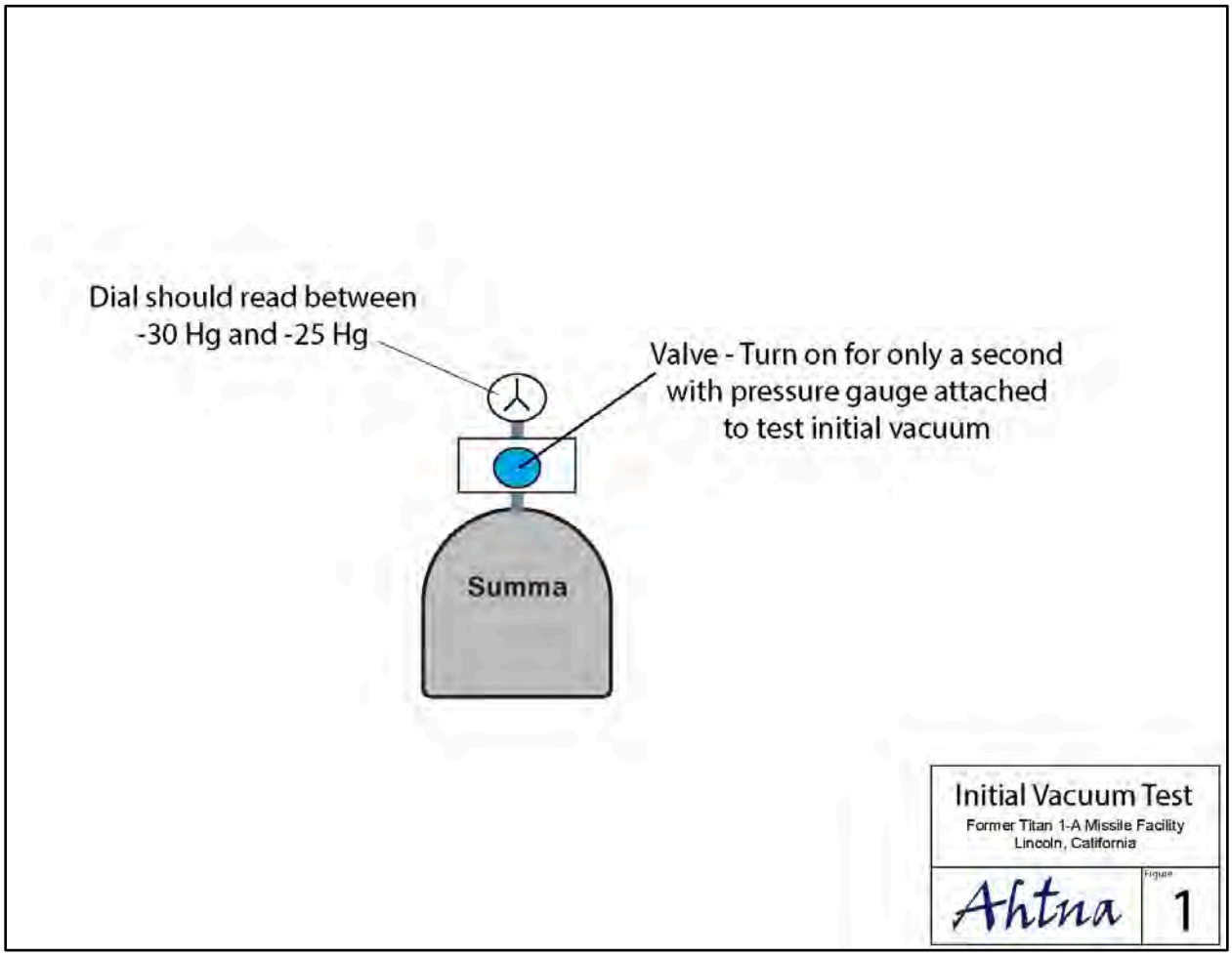


Figure 1. Initial Vacuum Test

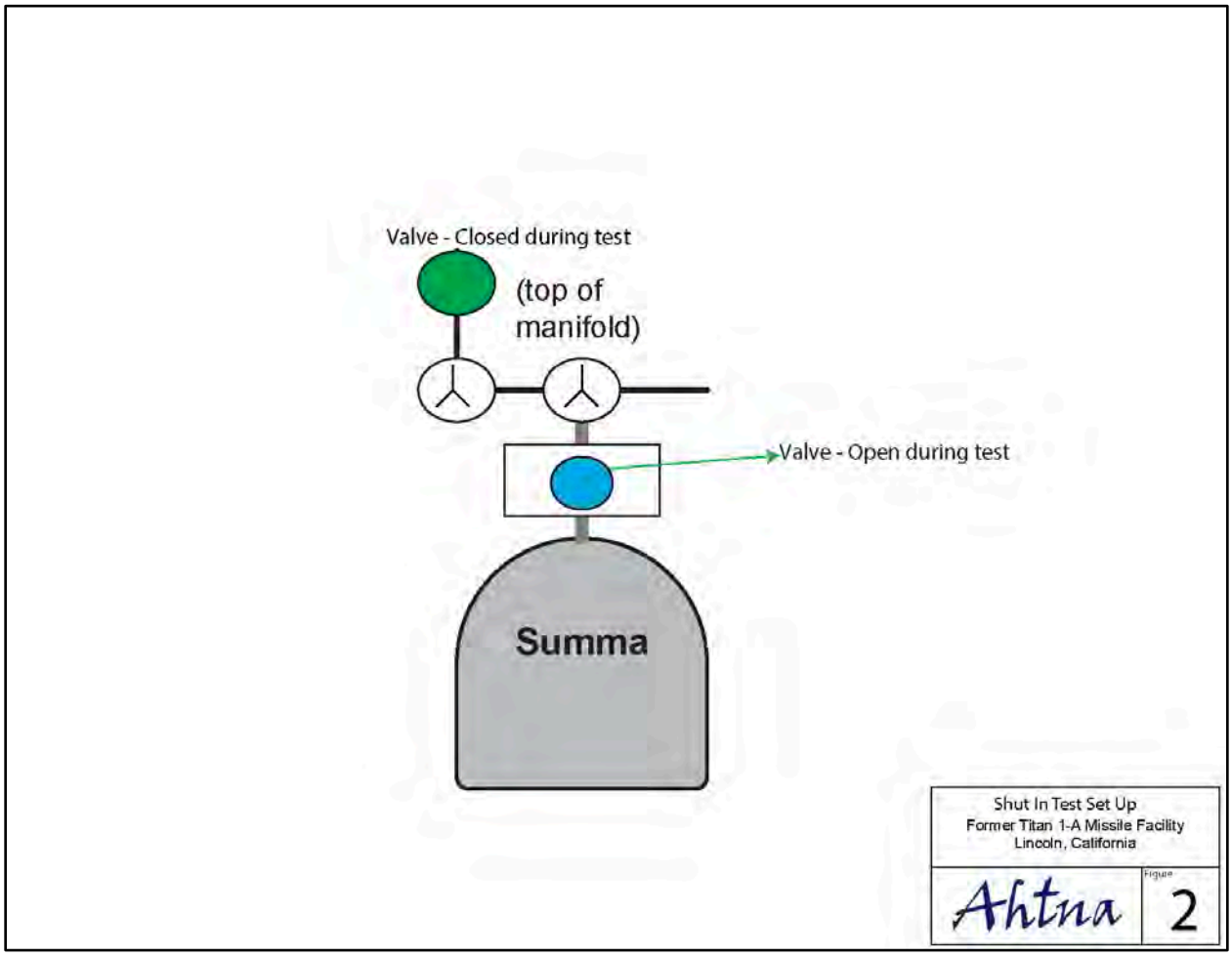


Figure 2. Shut-In Test

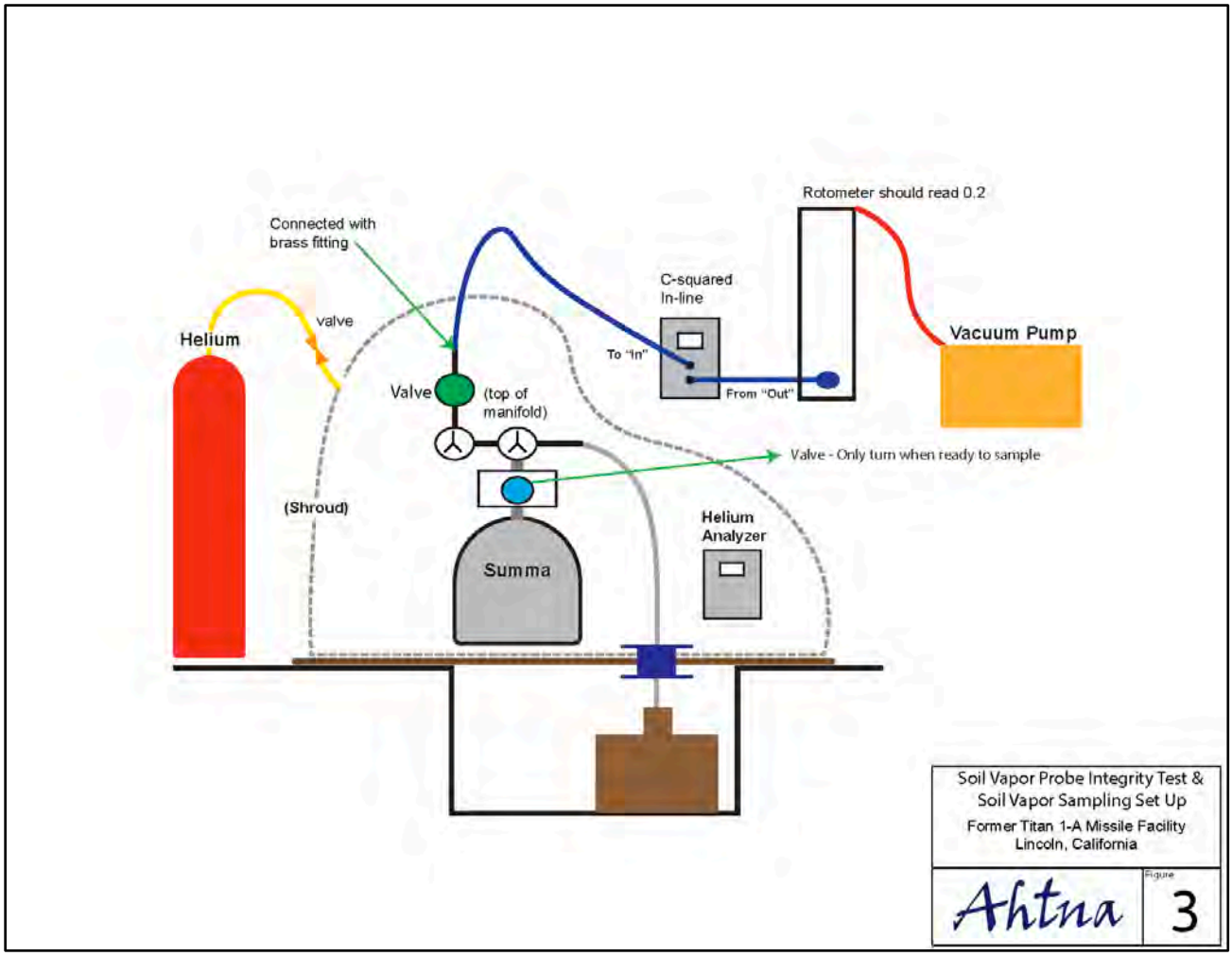
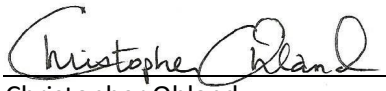


Figure 3. Soil Vapor Probe Integrity Test

Groundwater Well Installation

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October 10, 2022
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October 10, 2022
Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS-friendly supplies and procedures

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Introduction

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide field staff with the proper techniques and documentation requirements to install groundwater monitoring, extraction, and temporary wells (hereafter referred to as "groundwater wells")

1.2 Scope

The scope of this SOP applies to field staff conducting well installation oversight. The SOP includes guidance for the performance, management, and completion of installation activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Project-specific accident prevention plans (APP) and Site Safety and Health Plans address potential hazards related to well installation.

Per- and polyfluoroalkyl substances (PFAS) friendly procedures are also provided in this SOP. When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Projects].

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for field completion drilling activities, including borehole logging and well construction according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, well design, well installation activities, and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness, and accuracy of field documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Air Rotary Casing Hammer Drilling. A drilling method using a nonrotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. Air is forced down through the center drill pipe to the bit, and the upward return stream through the space between the drive casing and the drill pipe removes cuttings from the bottom of the borehole.

Annular Space. The space between any of the following:

- Concentric drill pipes
- An inner drill pipe and outer drive casing
- Drill pipe or drive casing and the borehole wall
- Well screen or casing and the borehole wall

Borehole. Any hole drilled into the subsurface to identify lithology, collect soil samples, and install groundwater wells.

Cuttings. Pieces of soil, sediment, or rock-cut by a bit in drilling borings.

Extraction Well. A well used primarily to remove contaminated groundwater.

Filter Pack. Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

Grout. For this SOP, the term "grout" consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry. When correctly set and cured, it can restrict the movement of water.

Hollow Stem Auger Drilling. A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

Monitoring Well. A well that provides the collection of representative groundwater samples, the detection and collection of representative light and dense non-aqueous phase organic liquids, and the measurement of fluid levels.

Mud Rotary Drilling. For this SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit, and drilling mud is pumped through the inside of the drill pipe and the bit. The mud flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension to the surface.

Sonic Drilling. A drilling method using high-frequency, resonant energy generated inside the sonic head to advance a core barrel or casing into subsurface formations. Sonic drilling is most often used when

drilling (whether through particular ground materials or to a particular depth) is difficult, and the integrity of the core sample is extremely important.

Tremie. A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.

Well Screen. A perforated, wire-wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand and fine particulates.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of well installation activities and should be used in conjunction with state, county, and local well standards and other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001 Field Documentation
- SWE-FSOP-300 Series (various drilling methods)
- SWE-FSOP-801 Equipment Decontamination
- SWE-FSOP-802 Investigation Derived Waste Management

Field Forms

- SWE-FFRM-401, Well Construction
- SWE-FFRM-004, Daily PFAS Sampling Checklist [PFAS Projects]

3.0 Equipment and Materials List

The list below identifies equipment expected to be used by staff while supervising well-installation activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation

  [PFAS Project]: Field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink

  [PFAS Project]: Use ball-point pens. Do not use markers, felt pens, or pens with water resistant ink.

- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

The following materials are usually required for monitoring well installation. Review project-specific work plans for specific or unique materials or installation procedures.

- Steel protective locking cover or flush-mount well box and locking cap

- Flush-threaded riser pipe/"blank casing, " typically Schedule 40 or Schedule 80 polyvinyl chloride (PVC), typically sized at two-inch or four-inch diameter for permanent monitoring wells and work-plan-specified diameters for temporary wells, extraction wells, etc.
- Flush-threaded well screen, typically matching diameter and wall thickness of the riser pipe/"blank casing," with a slot size determined in advance based on site conditions and project objectives
- Measuring tape
- Plastic sheeting to protect decontaminated well materials

  [PFAS Project]: Clean, dry well materials should be stored within a protective medium (e.g., HDPE bag) or staged in a clean area for future use.

- Threaded or slip end cap
- Centralizer(s), as needed
- Silica sand (sized based on the formation material)
- Bentonite pellets or chips (for well seal or borehole fill according to project requirements)
- Pure bentonite powder and cement (for grouting wells; confirm the type of each and mixture specifications)
- Tremie pipe

4.0 Procedures

Procedures are provided for:

- Pre-Fieldwork tasks (Section 4.1)
- Field Preparation (Section 4.2)
- Mobilization and Set-Up (Section 4.3)
- Well Installation (Section 4.4)
- Temporary Monitoring Wells (Section 4.5)
- Demobilization/Site Restoration (Section 4.6)

4.1 Pre-Fieldwork Tasks

It is essential to be thoroughly familiar and compliant with state, county, or local well installation standards, codes, etc. They may contain requirements that must be used in conjunction with procedures presented in this SOP.

Site-specific factors must be considered in the selection of well installation and completion materials, specification of well designs, and well-drilling methods. The well design and other specifications are incorporated into project work plans or as the FTL/PL directs.

4.1.1 Clearances

Before starting any sonic boring, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811, etc.) and

completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

- Review available forms and diagrams that document the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.
- Copies of the site clearance documents should be kept onsite.

4.1.2 Health and Safety

- Hold Tailgate Safety Meetings in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating or swinging drilling components can snag or catch loose clothing or strike personnel and cause severe injury or death.
- Hearing protection is especially critical when sonic drilling, as the rig can generate high-frequency noise and considerable noise when drilling through gravel and cobbles.
- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.1.3 Site Conditions and Drilling Logistics

Prepare the site per the project work plans. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings/fluid containment, and well construction. The FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include an area for the rig and swing-out clearances, access for a pipe truck, and forklift carrying pipe or debris bins.
- The FTL or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter, etc.) to penetrate the surface cover (e.g., asphalt, concrete, cement, etc.).
- Lubricating compounds used on drill pipe and drive casing threads must be approved in advance and must not contain compounds incompatible with project objectives, laboratory analyses, or water quality guidelines.
- Drive casings of various lengths should be provided by the subcontractor to facilitate emplacement of the sand pack, bentonite seal, and grout during well construction. One 3-foot, two 5-foot, and two 10-foot lengths and enough standard-length drive casing joints are recommended.
- A hydraulic casing extractor must be used to remove the drive casing from the borehole. Do not extract the casing by "hammering up" with the casing hammer. The hydraulic casing extractor should have sufficient pulling capacity and clamping mechanisms to extract the casing safely and smoothly with the appropriate lifting force.

4.1.4 Rig Decontamination and Preparation

- All drilling and sampling equipment should be decontaminated before drilling per SWE-FSOP-801. "Equipment Decontamination"
- The drilling equipment shall be inspected for proper maintenance and appropriate decontamination before each time the rig is mobilized to a site
- All clutches, brakes, and drive heads should be properly working
- All cables and hydraulic hoses should be in good condition
- Any observed leakage of fluids from the rig should be immediately repaired and decontaminated again before it is allowed to mobilize

4.1.5 Calibrations

Before mobilization, calibrate the safety-related sampling and monitoring equipment.

4.1.6 Personal Protective Equipment (PPE)

Provide workers with the appropriate PPE as specified by the project work plans.

4.2 Mobilization and Set-Up

The standard procedure for installing groundwater wells is described below, and the project work plans may include additional specifications.

4.2.1 Site Preparation

The logistics of drilling, cuttings/fluid containment, and well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

- As per the site health and safety plan, appropriate barriers and markers should be in place before drilling
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig
- Appropriate cuttings and other IDW containment should be set onsite before the commencement of drilling
- If drilling is conducted in the saturated zone, provisions should be made to ensure adequate containment of formation water produced during drilling operations
- Clear the work site of all brush and minor obstructions and then mobilize the rig to the monitoring well location

4.2.2 Discussion of Site Conditions

Before drilling operations begin, the following must be completed:

- The FTL or Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards and determine how drilling operations may impact the environment.
- As per the project work plans, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.
- If a shallow subsurface hazard (i.e., unidentifiable utility or trapped vapors) may exist, the driller should be informed of the potential hazard before breaking ground. Drilling should then commence slowly to allow continuous visual inspection and monitoring and, if necessary, stop for probing.

4.2.3 Mobilization

Once the site is prepared, the rig is mobilized and located over the borehole.

- The drill rig is mobilized to the site and located over the borehole location
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig
- The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig and avoid obstructions or hazards

4.3 Well Installation Procedures

4.3.1 Drilling

The following procedures assume that the drilling of the borehole occurred per the project work plan and appropriate SOPs (see SWE-FSOP-300 Series [various drilling methods]).

During fieldwork, the Field Geologist will generally:

- Observe and monitor rig operations
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance

4.3.2 Borehole Preparation

At total depth, remove soil cuttings through circulation or rapidly spin the augers before constructing the well. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect the well installation. Condition the hole or take other actions mutually agreed upon by the Field Team (FTL, PL, Field/Project geologist, driller) to aid in the well installation.

Remove the drill pipe and bit if using rotary techniques, or remove the center bit if using the hollow stem auger technique. Install the well construction materials inside the open borehole or through the drive casing or augers center.

Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not heaved to fill the borehole. If heaving has taken place, discuss cleaning, re-drilling, or installation options in the open section of the boring with the Field Team (FTL, PL, Field/Project geologist, or driller).

4.3.3 Grouting Overdrilled Boreholes

If the hole was over drilled to a depth greater than needed for well installation, backfill material such as grout, bentonite pellets, or bentonite chips (as specified in the project work plans) may be added to the bottom of the boring to raise the bottom of the hole to the desired depth.

- Before placing materials, confirm the borehole dimensions and calculate the estimated volume of material required, including allowances for hydration of dry materials.
- Closely monitor the progress of borehole backfilling by frequently tagging the level in the borehole and comparing against estimated fill quantities. This is especially important if irregularities in the borehole are suspected (e.g., voids, sloughing).

- Pump grout through a tremie pipe and fill the borehole from the bottom of the boring upward. During grouting, submerge the tremie pipe below the top of the grout column in the borehole to prevent free fall and bridging.
- Add gradually to prevent bridging if bentonite solids (chips/pellets) are used.
- Obtain approval of the final depth of the borehole in advance from the FTL or PL. Stop grout or bentonite addition when the general level has reached approximately one foot below the desired base of the well string (casing, screen, end plug or sump, etc.). Hydrate the bentonite plug for at least one hour before installing a filter pack.

4.3.4 Assembling and Installing Well Casing

Before installation, inspect the casing, screen, silt traps, end caps, centralizers, locking covers, and any other well construction materials to confirm that no damage has occurred during shipment and decontamination activities.

During the inspection, confirm that all well component materials, dimensions, and quantities are accurate before proceeding. This includes confirming that the slot size on well screens matches project specifications.

If centralizers (commonly stainless steel) are used, confirm placement throughout the well string with the FTL, PL, or Field/Project geologist as appropriate.

Assemble and carefully lower the well string through the open borehole, drive casing, or inside the augers until the well string is at the desired depth. Suspend the well string by the installation rig, so it does not rest on the bottom of the boring. If the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the string should be removed from the boring and inspected.

In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment (drill pipe, hammers, etc.) to prevent the casing from rising.

The Field Geologist notes the amount of rise and consults with Project Geologist for an appropriate course of action.

Record the following information in the FLB/notepad or field form SWE-FFRM-401, “Well Construction.”

- Diameter of the well boring
- Total depth of well boring
- Length of blank casing
- Length of well screen
- Length of the well end cap or silt trap
- Depth to base of well string
- Depth to top and bottom of well screen
- Depths of centralizers, if used

4.3.5 Installing Filter Pack

Based on borehole and well casing dimensions, calculating volumes of filter pack, bentonite pellets/slurry, and grout required. If the project work plans require, determine the filter pack and well screen slot size for the monitoring or extraction well.

Place a layer of filter pack (one to two feet, unless otherwise specified in the project-specific work plans) at the bottom of the borehole.

- When constructing wells within a cased hole or through hollow stem augers, install the filter pack by pouring and allowing it to free-fall through the center of the drive casing/augers or tremie according to project work plans. Add filter pack slowly while withdrawing the drive casing/augers. Take care to minimize the height of the filter pack inside the auger/drive casing during pouring to avoid potentially "sand locking" the well casing and pulling it up with the auger/drive casing.
- Using drive casing or augers, pull the drive casing or augers slowly during filter pack installation in increments no greater than five feet.
- For the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. If approved, clean, potable water may be used to assist with the filter pack tremie operation.

Monitor filter pack settlement by initially measuring the sand level (before beginning to withdraw the drive casing/augers). Repeatedly take depth soundings using a weighted tape to continually monitor the level of the sand in the auger/drive casing as it is removed. Monitor the top of the well casing to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement, which could cause the well casing to bend or break in the borehole.

Add filter pack until its height is approximately two feet above the top of the screen (unless otherwise specified in the project work plans), and conduct verification of its placement (by sounding). Then gently surge the filter pack using a surge block or swab to settle the packing material and reduce the possibility of bridging.

Resound the height of the filter pack and add more filter pack, placed as necessary. Once filter pack placement is complete, measure and record the depth to the top of the pack in the FLB/notpad or field form SWE-FFRM-401, "Well Construction."

4.3.6 Installing Seals

Install a three-foot thick (unless otherwise specified in the project work plans) bentonite seal on top of the filter pack. If pellets or chips are used, add them gradually to avoid bridging. Take repeated depth soundings using a weighted tape to ascertain the top of the bentonite seal. Allow the seal to hydrate for at least 30 minutes before proceeding with the grouting operation.

After hydration of the bentonite seal, pump grout through a tremie pipe and fill from the top of the bentonite seal upward.

- Unless otherwise specified, cement grouts should be mixed using approximately 6 to 7 gallons of water per 94-pound bag of Type I/II Portland cement to a density of approximately 15 pounds/gallon.
- If needed, add bentonite (5 to 10 percent) to the cement grout to strengthen the mix and delay the setting time.
- Specific mixtures and other types of cement and grout proposed should be evaluated on a case-by-case basis by the field geologist and communicated to the drillers.

During grout installation, maintain the bottom of the tremie pipe below the top of the grout to prevent free fall and bridging. When using drive casing or hollow stem auger techniques, raise the drive casing/augers in short increments during grout pouring, keeping the bottom of the drive casing/augers below the top of the grout. It is essential to calculate the approximate volume of grout required; note reduced/excessive volumes, which may indicate irregularities in the annulus or grout flow into a formation. Cease grouting when the grout level has risen to approximately one to two feet of the ground surface, depending on the surface completion type (flush-mount versus aboveground). Monitor grout levels to ensure that grout taken into the formation is replaced by additional grout. If settling occurs, additional topping off of the grout may be necessary.

4.3.7 Protective Casing

For aboveground completions, place the protective steel casing (e.g., lockable "stovepipe") over the top of the well casing and insert it into the freshly grouted annulus. Before installation, place a 2-inch thick temporary spacer between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap. Note: confirm the final clearance required between the top of the well casing and the cover; additional room may be needed for dedicated well equipment.

After the protective casing is set in the grout, a drainage hole may be drilled into the protective casing if required in project work plans. The drainage hole is positioned approximately two inches above ground surface. Paint the protective casing with rust-preventive colored paint. Make sure the well is protected from potential vapors from paint.

Label the wellhead to provide information such as well number, depth, and date of the installation based on project requirements.

Wait 24 hours after grouting before installing concrete pad and steel guard posts (bollards) for aboveground completions or street boxes or vaults for flush-mount completions.

Aboveground Completions

A concrete pad, usually 3-foot by 3-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete is sloped away from the protective casing to promote surface drainage away from the well.

Where traffic conditions warrant extra protection, embed three to four steel guard posts (bollards) to a depth approximately 1.5 feet below ground surface with three to four feet of stickup depending on project requirements. Install the posts in concrete-filled post holes spaced equally around the well, commonly at 1.5 feet from the protective steel casing (check work plan for exact specifications). Where posts are removed for well access, embed mounting sleeves into the concrete.

Flush-Mount (or Subgrade) Completions

Before installing any street box or vault over a well, confirm all clearances between the well cap and inside vault lid and the final height of the vault top above ground surface. Where installations are in parking lots, roads, concrete slabs, etc., consider the final height of the surrounding surface.

Set and cement into position a street box or vault, usually one inch to a few inches above ground surface, depending on design requirements. Raise the top of the street box or vault slightly above grade, and the cement sloped to grade to promote surface drainage away from the well.

4.4 Temporary Monitoring Wells

4.4.1 Temporary Well Materials

Materials used in installing temporary monitoring wells are the same standard materials used in the installation of permanent monitoring wells.

Sand used for the filter pack (if any) should be as specified in the work plan. The well screen and casing should be stainless steel (for ruggedness and suitability for steam cleaning and solvent rinsing) or polyvinyl chloride. Appropriate Quality Assurance (QA) and Quality Control (QC) must be performed to ensure no introduction of contaminants.

4.4.2 Temporary Well Borehole Construction

Ensure that borehole construction for temporary wells is of sufficient diameter to accommodate the well casing and associated well construction materials.

For well installation in an open borehole using a drill rig, ensure the annular space is approximately 2 inches to allow the uniform deposition of well materials around the screen and riser and allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. Alternatively, boreholes may be constructed using hand augers or portable powered augers (generally limited to depths of ten feet or less). If a drill rig is used to advance the borehole, the augers must be pulled back the length of the well screen or entirely removed before sampling.

When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). When borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled above ground. When the well is completely assembled, a final auger bucket of material is quickly removed, and the well is immediately inserted into the borehole, pushing, as needed, to achieve maximum penetration into the saturated materials.

4.4.3 Temporary Monitoring Well Types

Temporary monitoring wells are constructed in various ways depending on project requirements and site conditions. A few acceptable examples are described below. Because temporary well purposes and construction are project-specific, detailed procedures for construction should be included in project work plans.

1. **No Filter Pack.** After the borehole is completed, the casing and screen are simply inserted. This is the least expensive and fastest well to install. **Note:** *This type of well is extremely sensitive to*

turbidity fluctuations because there is no filter pack. Take care not to disturb the casing during purging and sampling.

2. **Traditional Filter Pack**. The screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. **Note**: *Occasionally, it may be difficult to effectively place a filter pack around shallow open boreholes due to collapse. This method requires more sand than the "inner filter pack." As the filter pack is placed, it mixes with the muddy water in the borehole, which may increase the amount of time needed to purge the well to an acceptable level of turbidity*.
3. **Well-in-a-Well**. The borehole is advanced to the desired depth. A 1-inch well screen and sufficient riser are inserted into a 2-inch well screen with sufficient riser and then centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, approximately 6 inches above the screen. The assembled well is then inserted into the borehole.

Temporary wells are commonly used for short periods (days/weeks) and should be decommissioned when no longer needed. See FSOP-603 Well Decommissioning for procedures.

4.5 Demobilization/Site Restoration

All debris generated by the drilling operation/well construction should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All monitoring wells should finish their surface completions as per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for well installation field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs/forms.

6.0 Documentation Review

The FTL is responsible for the daily review of the fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

The PL is responsible for the review and signoff of final approved documents stored in the project file.

7.0 References

None cited.

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Approvals

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Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS-friendly supplies and procedures
Rev 2, 07/30/2024: Removed the term “PFAS-friendly” to avoid confusion with PFAS-free.

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Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation of for developing temporary and permanent groundwater monitoring and extraction wells (hereafter referred to as "groundwater wells") after their installation and before their designated use. This method may also be used as part of rehabilitation or re-development of a well during its lifecycle.

The details within this SOP should be used in conjunction with project-specific work plans, Accident Prevention Plans (APP) and Site Safety and Health Plans.

1.2 Scope

The scope of this SOP applies to field staff performing or conducting oversight of groundwater well development. The SOP includes guidance for the performance, management, and completion of development activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Project-specific APP and Site Safety and Health Plans address potential hazards related to well development.

When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Projects].

1.2.1 Resources and Requirements

In addition to project-specific procedures and requirements, it is essential to be thoroughly familiar and compliant with state, county, or local well installation (and development) standards, codes, etc. as they may contain requirements that must be used in conjunction with, or instead of procedures presented in this FSOP.

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing development activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the well development subcontractor and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness and accuracy of field documentation, and approval of the well development completion.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 *Safety and Health Requirements*. The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Bailer. A bottom-filling cylindrical tube with an open top and check valve at the bottom used to remove water and sediment from a borehole or well.

Bailing. A well development technique uses a bailer raised and lowered in the well to create a strong inward and outward movement of water from the formation, break sand bridges, and remove water and fine-grained materials from the well.

Extraction Well. A well designed to extract fluids (such as water, gas, free product, or a combination) from the subsurface.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

> [PFAS Project]: Record of field events will be maintained on loose paper (PFAS-free) secured on Masonite or aluminum clipboards. Plastic clipboards, binders, or spiral hard cover notebooks are not acceptable. Field logbooks are permanently assigned to a specific project.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

> [PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

Investigation Derived Waste (IDW). Waste that is generated in the process of investigating or examining a contaminated site.

Monitoring Well. A well that provides the collection of representative groundwater samples, the detection and collection of representative light and dense nonaqueous phase organic liquids, and the measurement of fluid levels.

Mudwall. A layer of fine-grained soils formed around the boring annulus during drilling can impede the formation water's free flow into a well.

Piezometer. A tube placed in soil to depths below the water table extends to the soil surface and opens to the atmosphere. The bottom of the piezometer is perforated or slotted to allow groundwater water under positive hydrostatic pressure to enter the tube.

Surging. A well development technique in which a surge block is alternately raised and lowered within the well casing or screen to create a strong inward and outward movement of water through the well screen. Surging helps remove fine-grain material from the boring wall and the filter pack.

Turbidimeter. An instrument measuring the turbidity (the cloudiness or haziness of fluid caused by individual particles) of a liquid.

Well Casing. A durable pipe placed in a borehole to prevent the walls of the borehole from caving in, and to seal off surface drainage or undesirable water, gas, or other fluids, and prevent their entrance into the well.

Well development. The act of removing fine-grained sediment and drilling fluids from the sand pack and formation in the immediate vicinity of the well, thus increasing the porosity and permeability of the materials surrounding the intake portion of the well.

Well Screen. A perforated, wire-wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand and fine particulates.

2.0 Relevant Documents

Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-101, Water Quality Measurements
- SWE-FSOP-102, Groundwater and NAPL Measurements
- SWE-FSOP-801, Equipment Decontamination
- SWE-FSOP-802, IDW Management

Field Forms

- SWE-FFRM-004, Daily PFAS Sampling Checklist [PFAS Projects]
- SWE-FFRM-402, Well Development
- SWE-FFRM-501, Water Level/NAPL Measurements
- SWE-FFRM-801, Equipment Calibration

3.0 Equipment List

The list below identifies equipment expected to be used by staff while supervising well development activities.

- A bound, waterproof field logbook (e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation

  [PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink

  [PFAS Project]: Ball-point pens: do not use markers, felt pens, or pens with water resistant ink

- Digital camera/video, cell phone, or other devices capable of digital imagery

For monitoring well development, the following materials are usually required. Review project-specific work plans for specific or unique materials or installation procedures:

- Surge block on a cable or line (commonly on a development rig)
- Submersible pump, peristaltic pump, and bailer (Note: bladder and gear pumps are not recommended because of pump damage from fine sediments)
- Groundwater purge container, tank, or drum of known volume for flow estimation
- Water quality monitoring instrument(s) (e.g., YSI Water Quality Meter) capable of measuring parameters such as dissolved oxygen (DO), oxidation-reduction potential (ORP), conductivity, pH, turbidity, and temperature
- Clear glass jars (at least 2)

  [PFAS Project]: Two clear PFAS-free containers

- Water level indicator
- Measuring tape/sounder
- Decontamination equipment including soap (i.e., Liquinox™), de-ionized and tap water
- Plastic sheeting to protect decontaminated tools

  [PFAS Project]: Clean, dry development equipment should be stored within a protective medium (e.g., HDPE sheeting) or staged in a clean area for future use.

4.0 Procedures

This section contains procedures for developing groundwater wells. Additional guidance can be found in SWE-FSOPs listed in Section 2.0 and references in Section 7.0.

Procedures are provided for:

- Preparation Tasks (Section 4.1)
- Mobilization and Setup (Section 4.2)
- Development Procedures (Section 4.3)
- Documentation (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

4.1 Pre-Field Tasks

Preparation and coordination tasks for sonic drilling generally include the activities described below.

4.1.1 Clearances

Before starting well development, confirm that groundwater well locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. Before raising the mast on any development rig, ensure appropriate clearances are maintained from nearby/overhead structures and power and communication lines.

4.1.2 Health and Safety

- Hold Tailgate Safety Meetings in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during well developmnet. Rotating or swinging components can snag or catch loose clothing or strike personnel and cause severe injury or death.

4.1.3 Rig Decontamination and Preparation

Decontaminate all downhole equipment, sounders, bailers, pumps, and other materials used during well development. Procedures should follow SWE-FSOP-801 (Equipment Decontamination).

[PFAS Project]: In general, all well development equipment will be washed with certified PFAS-free potable water and detergents such as Alconox, Liquinox or Citranox and should end with a triple rinsing with laboratory certified PFAS-free de-ionized water. If another source is used, a sample should be collected and tested for PFAS. If the concentrations are low enough to meet project Data Quality Objectives, the water is acceptable for use.

Wherever possible, development equipment should also be rinsed immediately before use.

4.1.4 Calibrations

Before mobilization, calibrate the safety-related sampling and monitoring equipment, water quality meters, and other measuring devices according to the instrument manufacturer's specifications.

4.1.5 Personal Protective Equipment (PPE)

Provide workers with and don the appropriate PPE specified by the project work plans.

4.2 Mobilization and Setup

The standard procedure for well development is described below. Project work plans may have additional specifications.

4.2.1 Site Preparation

Before mobilizing, the logistics of well development, fluid containment, and site management should be determined. The site should be prepared as per the project work plans.

- Appropriate barriers and markers should be in place prior to well development, as per the site health and safety plan
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig
- Appropriate IDW containment should be set onsite prior to the commencement of well development

4.2.2 Discussion of Site Conditions

Before development operations begin, the following must be completed:

- The FTL or designee should assess the well site with the driller. This assessment should identify potential hazards and determine how operations may impact the environment
- As per the project work plans, potential hazards should be evaluated and corrected
- Potential hazards should be evaluated and corrected
- If hazard(s) (e.g., free product, vapors) may exist, the driller should be informed of the potential hazard(s) before starting work

4.2.3 Mobilization

Once the site is prepared, the rig is mobilized and located over the groundwater well.

- Level the rig with a set of hydraulic pads attached to the front and rear of the rig
- Raise the mast slowly and carefully to prevent tipping or damaging the rig and avoid obstructions or hazards
- Appropriate barriers and markers should be in place before drilling, as per the site health and safety plan

4.3 Development Procedures

Perform well development as soon as practical after well installation, but in compliance with applicable state or local requirements for seal curing times, which may range from a minimum of 48 to 72 hours following well installation.

> [PFAS Project]: The cap and all internal components of the well casing above the water table shall be rinsed with PFAS-free water to remove all traces of soil, sediment, and cuttings, before and/or during well development. Dedicated materials shall be used for well development.

Record details of development activities in the Well Development form (SWE-FFRM-402.00).

1. Measure and record the water level and total depth of the well using a water level indicator per SWE-FSOP-102 (Groundwater and NAPL Measurements). Note any accumulated sediment thickness, and record information in the FLB and on form SWE-FFRM-402.00 (Well Development).
2. Begin well development by removing any accumulated sediment from the bottom of the well using the bailer. Repeat this process until as much accumulated sediment as possible has been removed from the bottom of the well.
3. Begin surging the entire well screen using a surge block. A general rule for well development is to start slowly and gently, and gradually increase agitation as the well is developed. After a minimum of fifteen minutes, remove the surge block and immediately begin to bail the sediment-laden water. The length of time required at this stage will depend on various conditions such as water

clarity, sediment levels, etc. Contain all development water for proper disposal, according to the site-specific work plan and SWE-FSOP-802 (Investigation Derived Waste Management).

4. Repeat surging and bailing for several cycles developing the well from the bottom of the screened interval upward by alternately using the surge block and the bailer. Record the surge interval and duration of surging and bailing.
5. During development, monitor the clarity of the water removed from the well. Measurements can be collected using a calibrated turbidity meter, with results recorded on the development log or FLB/notepad.

   [PFAS Project]: Fill a clear PFAS-free container with development water to observe turbidity if necessary.

6. Once it is determined that the well has been adequately developed using the bailer and surge block, use an appropriately sized pump to continue development, typically placed near the bottom of the screen interval. Wells with screen lengths greater than ten feet may be pumped from multiple depths during this process.
7. Pumping should begin at a rate to minimize drawdown. Monitor groundwater levels with a sounder and adjust accordingly. Ideally, the pump should be operated at the maximum discharge rate as long as groundwater levels remain above the pump intake. Collect water quality parameters to check for water quality stability, emphasizing turbidity until the well is determined to be fully developed. Generally, at least ten well volumes are removed or until turbidity reaches the desired level (DTSC, 2014). Typically, 5 NTUs is considered satisfactory. If turbidity stabilization cannot be achieved, contact the FTL for their recommendation.
8. If the well recovers naturally (i.e., drawdown can be controlled/eliminated during pumping), continue development with formation water only. However, if the well is purged dry at any point during development, the process to complete the well development should be determined by the FTL.
9. Variability in geologic, ambient water, and well construction characteristics create conditions where exact criteria for determining adequate completion of well development are not feasible. The purpose of the well, type of contaminant, and geologic conditions must be considered when deciding on the appropriate level of development. Therefore, determining what constitutes acceptable development is considered a professional judgment determined by the Project Geologist or PL.
10. Measure and record a final depth to water and total well depth after well development.
11. Manage development water generated during well development as IDW, in accordance with the designated work plan or site waste management plan, and SWE-FSOP-802 (Investigation Derived Waste Management).

4.4 Demobilization/Site Restoration

After well development is completed, the tools should be laid down, the mast lowered, and the rig moved off the location. The FTL or designee should supervise the demobilization/site restoration.

Any debris generated by the well development operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project

work plans. Any hazards remaining due to well developnment activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

Department of Toxic Substances Control (DTSC), California Environmental Protection Agency, 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites*. June.

Environmental Protection Agency (EPA), Region 4, Science and Ecosystem Support Division, Athens, Georgia, 2018. *Design and Installation of Monitoring Wells*. SESDGUID-101-R2. January 16. https://www.epa.gov/quality/design-and-installation-monitoring-wells

Izsraeli, et.al., 1992. Monitoring Well Development Guidelines for Superfund Project Managers. USEPA OSWER Groundwater Forum. April.

Groundwater Well Decommissioning

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Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

Improperly decommissioned wells pose a potential threat to groundwater quality because they may act as a conduit for surface pollutants and allow migration into the subsurface or allow mixing of groundwater through interconnecting isolated aquifers. Other terms commonly used for a decommissioned well include “destroyed” or “permanently sealed.”

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation during decommissioning of groundwater monitoring wells, extraction wells, temporary wells (hereafter referred to as “groundwater wells”), and piezometers.

1.2 Scope

The scope of this SOP applies to field staff conducting well decommissioning oversight. The SOP includes guidance for the performance, management, and completion of decommissioning groundwater wells using drilling and in-place methods and includes descriptions of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Potential hazards related to well decommissioning is addressed in project-specific Accident Prevention Plans (APP) and Site Safety and Health Plans.

Per- and polyfluoroalkyl substances (PFAS) friendly procedures are also provided in this SOP. When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Projects].

1.3 Responsibilities

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Field Geologist. A Field Geologist is responsible for overseeing drilling activities according to project specifications. The Field Geologist is a registered geologist or a person performing work under the supervision of a registered geologist.

Project Geologist. The registered Project Geologist is responsible for oversight of the drilling subcontractor, proper completion of work activities, and field documentation. When a Field Geologist performs the oversight, the Project Geologist is responsible for fieldwork variances/deficiencies, completeness, and accuracy of field documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of the current version of U.S. Army Corps of Engineers EM-385-1-1 Safety and Health Requirements. The Safety

Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Abandoned Well. In general, a well that has not been used for a prescribed duration identified in the applicable well standard (e.g., one year). This status may also be termed "permanently inactive." If the well may be used in the future, some level of maintenance may be required.

Annular Space. The space between any of the following:

- An inner drill pipe and outer drive casing
- Drill pipe or drive casing and the borehole wall
- Well screen or casing and the borehole wall

Borehole – Any hole drilled into the subsurface to identify lithology, collect soil samples, and install groundwater wells.

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

Filter Pack – Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

Grout – For this SOP, the term "grout" consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout acts as a surface seal and is emplaced as a slurry. When set and cured, it can restrict the movement of water.

Tremie – A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.

Well Decommissioning. The process of eliminating a well structure and borehole as a possible means for the preferential migration of poor-quality water, pollutants, and contaminants; and to prevent a possible hazard to humans and animals. This usually requires removing all well materials and grouting the remaining borehole or grouting the well in place.

Well Screen – A perforated, wire-wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand and fine particulates.

2.0 Relevant Documents

This SOP focuses on the decommissioning of groundwater monitoring wells and associated tasks and should be used in conjunction with other project documents applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001 Field Documentation
- SWE-FSOP-300 Series (various drilling methods)
- SWE-FSOP-801 Equipment Decontamination
- SWE-FSOP-802 Investigation-Derived Waste (IDW) Management

Field Forms

- SWE-FFRM-004, Daily PFAS Sampling Checklist [PFAS Projects]

Well construction details and a copy of the well construction diagram should be carefully reviewed to identify details regarding materials and dimensions of the casing, screen, seals, and filter packs.

3.0 Equipment List

The list below identifies equipment expected to be used by staff while supervising the decommissioning of monitoring wells.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation

  [PFAS Project]: Field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink

  [PFAS Project]: Use ball-point pens. Do not use markers, felt pens, or pens with water resistant ink.

- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate PPE

The following materials are commonly used during well decommissioning and may or may not involve using a drill rig depending on requirements; review project-specific work plans for specific or unique materials or decommissioning procedures.

- Measuring tape
- Plastic sheeting to protect decontaminated equipment

  [PFAS Project]: Clean, dry well materials should be stored within a protective medium (e.g., HDPE bag) or staged in a clean area for future use.

- Cement and pure bentonite powder (for grouting wells/boreholes; confirm the type of each and mixture specifications)
- Bentonite chips/pellets
- Tremie pipe
- Grout pump

4.0 Procedures

Procedures are provided for:

- Pre-Field Tasks (Section 4.1)
- Preparation (Section 4.2)
- Mobilization and Setup (Section 4.3)
- Well Decommissioning (Section 4.4)
- Demobilization/Site Restoration (Section 4.5)

In general, the preferred method to decommission a well is to remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. However, some circumstances and ordinances may allow in-place well decommissioning where appropriate and approved. General procedures are described here because of variability in well construction, materials, nature of aquifer materials associated with the well, and acceptable decommissioning methods. Therefore, it is strongly recommended to document in project-specific work plans the appropriate and allowable well decommissioning method(s), approved before starting work, and clearly understood by all field personnel. Additional guidance can be found in SWE-FSOPs in Section 2.0.

4.1 Pre-Field Tasks

Planning well-decommissioning methodologies depend on several factors including, but not limited to:

- Total depth of the well
- Depth to groundwater
- Casing material, diameter, and condition
- Original seal condition within the annulus
- Well plumbness
- Hydrogeologic conditions
- Level of contamination if present, and the zone(s) where the contamination occurs
- Access to the well and surrounding site conditions

4.2 Preparation

4.2.1 Confirm Clearances

Before mobilization of a rig to the well site, ensure that the well location has been appropriately cleared for underground utilities, buried objects, overhead hazards, and permits issued per the project work plans.

- Review all forms and diagrams documenting the location of the well site and the location of any identified underground utility lines or other buried objects, especially if decommissioning activities will affect areas outside the original borehole diameter.
- It may be necessary for military installations/government property to obtain dig permits from the Department/Directorate of Public Works (DPW) or similar office before proceeding with work.
- Contact State 811 call-before-you-dig services (e.g., USA North 811, Dig Alert, etc.) to request that the location of buried utilities be marked with paint or flags so that you do not unintentionally contact an underground utility line. Confirm responses from each utility and retain copies of the confirmations.
- Before raising the mast on any drilling rig, ensure appropriate clearances are maintained from overhead structures and power and communication lines.

4.2.2 Health and Safety

- Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications as per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating or swinging drilling components can snag or catch loose clothing or strike personnel and cause severe injury or death.
- Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.2.1 Personal Protective Equipment (PPE)

Don the appropriate PPE as specified in the project work plans and APP.

4.2.2 Decontamination

Decontaminate all downhole equipment, appropriate portions of the rig, and materials per SWE-FSOP-801 (Equipment Decontamination).

4.2.3 Calibrations

Calibrate health and safety monitoring equipment according to the instrument manufacturer's specifications.

4.3 Mobilization and Setup

4.3.1 Site Preparation

The logistics of well decommissioning should be determined before mobilizing. The site should be prepared as per the project work plans.

- Clear the work site of all brush and obstructions and then mobilize the rig to the well location.
- As per the site health and safety plan, appropriate barriers and markers should be in place before drilling.
- Plastic sheeting (e.g., Visqueen™) may be required beneath the rig.
- Appropriate cuttings and other IDW containment should be set onsite before the commencement of drilling.
- Provisions should ensure adequate containment if formation water is expected to be produced during decommissioning operations.

4.4 Well Decommissioning

4.4.1 Preliminary Work

Investigate the well before it is decommissioned to determine its condition and details of its construction.

- Remove all undesirable hardware and equipment, including dedicated pumps, wiring, conveyance piping, and well-related debris.
- Remove contaminants in the form of oil from oil-lubricated pumps or pollutants and contaminants that could interfere with well decommissioning. Remove and dispose of the contaminants appropriately as IDW (see SWE-FSOP-802, IDW Management).
- Run a video log of the well if the condition of the well casing is suspect or of concern.
- Calculate expected quantities of grout during any well decommissioning in advance.
- Be prepared to continuously track grout quantities in the FLB during the grouting process to verify that the volume of the grout placed equals or exceeds the volume to be filled and sealed.

4.4.2 Sealing in Place

Where state regulations and conditions permit, it may be permissible to grout a well casing in place. Decommissioning a well in place is allowed where it is agreed (usually by enforcing agency) that it cannot or should not be removed. The procedure consists of cementing the sand pack, well screen, and casing in place, usually with a cement bentonite grout. The type and composition of the grout mixture should be specified in the project work plans. The grout is commonly pumped through a tremie pipe inside the well.

- The well should be sounded in advance to ensure no obstructions exist that interfere with filling and sealing the entire well.
- If granular material (e.g., sand pack, formation sediment, etc.) is believed present inside the well based upon the sounding, a bailer may be run to the bottom to attempt to ascertain the type of debris. The granular well debris should then be removed from the well to the extent possible by bailing, pumping, or other appropriate techniques.
- The surface pad should be demolished and the area around the casing excavated if necessary to allow the casing to be cut off below ground surface.

Circumstances may require perforation of the casing across low permeability zones, at excess sand pack intervals (i.e., behind blank casing), and intervals of known or suspected poor cement seals. Perforation techniques may include using a perforation gun (with explosives) or a tool such as a Mills Knife Perforator. Well end caps may also be punctured based on specific requirements.

The grouting is commonly conducted in successive stages across the perforated intervals. In some instances, local ordinances or regulatory agencies may require pressure grouting techniques to complete in-place well decommissioning. Specific procedures and safety measures, especially when working with pressurized systems, need to be developed in advance and clearly understood by all field personnel before activities start.

- Calculate the expected quantities of grout in advance (Section 4.4.1). Calculated quantity should include the volume of the well casing and void space in the surrounding filter pack.
- If tremieing is required, pump the grout via a tremie pipe (or equivalent) placed near the bottom of the well, with the tremie pipe progressively removed as grouting progresses. Grout should be pumped under sufficient pressure (e.g., capping the well casing if necessary, for pressure grouting, especially for shallow wells) to permeate the well screen and sand pack.
- Contain well water displaced by the neat cement as IDW.
- Place excess neat cement in portable metal bins or equivalent and dispose of as solid IDW after it is allowed to set.
- Top off wells with fresh, neat cement to offset any settling that may have occurred overnight.
- Complete the final well surface according to project work plans, including covering the area with native soil, repaving the surface if the well was installed in a paved area, etc.

4.4.3 Removal of Well Materials

Several factors such as aquifer locations and characteristics, project requirements, local ordinances, and regulatory requirements may necessitate the removal of all materials associated with a groundwater well during decommissioning. Materials to be removed could include well casing, screens, filter pack, seals, surface monuments, and protective covers. Removal of all well materials is usually required if the following conditions exist:

- The well is located in an area of known or potential pollution or contamination, and
- The well's annular seal, casing, screen, filter pack, or other components were not constructed or maintained according to applicable standards so that well decommissioning by merely filling the well casing with sealing material (Sealing in Place: Section 4.4.2) would not prevent potential water-quality degradation caused by the movement of poor-quality water, pollutants, or contaminants through the decommissioned well structure.

Removal of well materials may be accomplished by drilling or over drilling, or if the well is shallow and permitted, by pulling the well casing from the ground followed by removing the seal and filter pack materials.

Temporary Well Decommissioning

Temporary well boreholes must be decommissioned after sampling and removing the screen and riser.

1. Backfilling the holes with cuttings for shallow holes in uniform materials with expected low contamination levels may be allowed but must be confirmed before proceeding.
2. If contaminated soil, groundwater, or waste materials were encountered or a confining layer was breached, soil cuttings should not be permitted.
3. If the borehole cannot be backfilled with the soil cuttings, then reference the project Site Waste Management Plan and SWE-FSOP-802 (IDW Management) regarding the disposal of the cuttings as IDW.
4. Calculate expected quantities of grout to be used in advance (Section 4.4.1).
5. Contain well water displaced by the neat cement as IDW.
6. Place excess neat cement in portable metal bins or equivalent and dispose of as solid IDW after it is allowed to set.
7. After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.

Casing Pulling

Casing pulling involves removing the well casing by lifting the well structure (if possible) from the borehole. Casing pulling may be an acceptable method to use when no contamination is present, or contamination is present, and the well does not penetrate a confining layer. Also, the well construction materials and well depth must be such that pulling will not break the aboveground portion of the well. Because of its brittleness, a PVC well casing may be more challenging than a metal casing to remove from the borehole. Wells with little or no grouted annular space and/or sound well casings are usually best suited for removal.

General procedures for well casing removal are as follows:

1. Calculate expected quantities of grout to be used in advance (Section 4.4.1).
2. Knock out the bottom of the screen with a steel drill rod/pipe, which will allow grout to flow out the bottom of the casing into the borehole as the casing is removed.
3. Ensure that sealing grouts, when used, are correctly mixed and prepared in accordance with the work plan and/or enforcing agency guidelines before placement. If bentonite chips are used instead of grout, they will require hydration after placement.
4. Do not add grout into the casing via free-fall placement. Add sealing grout to the well through the tremie pipe until the materials are near the ground surface.
5. Add sealing material as the casing is withdrawn to maintain a grout column inside the casing. Allowing the materials to vacate the well casing during removal may cause the borehole to slough and compromise the seal. Keeping the column close to full will help avoid this and also fill any borehole void space should the casing break while being pulled.
6. Contain well water displaced by the neat cement as IDW.
7. When the grout has reached the prescribed level (commonly 2 to 5 feet below ground surface), allow the grout to settle and cure.

8. Place excess neat cement in portable metal bins or equivalent and dispose of as solid IDW after it is allowed to set.
9. After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.
10. Complete by filling the remaining 2 to 5 feet with approved material (e.g., native soil, sand, or gravel) and restoring the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement).

Because the ability to decommission a well using this method depends on numerous factors related to its construction and the surrounding environment as well as local ordinances and agency acceptance, the decision of whether or not to use this method and the specific approach should be made on an individual well basis with appropriate approvals in place.

Removal by Overdrilling

Overdrilling to remove a well may be accomplished using a hollow stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials surrounding the well casing.

1. Calculate expected quantities of grout to be used in advance (Section 4.4.1).
2. Select the auger size so that the inside diameter of the augers is greater than the well casing and screen and the outside diameter of the augers is equal to or slightly larger than the original borehole.
3. Center the auger over the casing with the center plug and pilot bit removed or a small guide plug inserted in the casing. Then drill out the cement seal, bentonite seal, and sand pack with the augers as they are advanced or washed over the well casing and screen.
4. Once the cement seal, bentonite seal, and sand have been drilled out and circulated to the surface, pull the well casing and screen from inside the augers.
5. Tremie-grout the clean borehole from bottom to top through the inside of the augers as they are retracted.
6. Add grout while augers are removed to ensure that grout level does not fall below the bottom of the augers.
7. When the grout has reached the prescribed level (commonly 2 to 5 feet below ground surface), allow the grout to settle and cure.
8. Contain well water displaced by the neat cement as IDW.
9. Place excess neat cement in portable metal bins or equivalent and dispose of as solid IDW after it is allowed to set.
10. After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.
11. Complete by filling the remaining 2 to 5 feet with approved material (e.g., native soil, sand, or gravel) and restoring the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement).

Removal by Drilling Well Materials Out

When neither of the decommissioning methods described above can be successfully employed, it may be necessary to physically drill out the well casing in pieces and annular space materials. This can be an effective option when the well has been damaged, broken, filled, or plugged with soil or other extraneous media. The concern with re-drilling a monitoring well borehole is that augers or drill bits will not necessarily follow the original borehole to the completed well depth. Based on the condition of the well and approved procedures, an extension, pilot bit, or "stinger" may be used ahead of the cutting head or bit to align the drilling by using the well casing as the guide.

General procedures are as follows:

1. Calculate expected quantities of grout to be used in advance (Section 4.4.1).
2. Remove the wellhead and re-drill the well while attempting to keep the augers/drill head centered on the well casing, and drill to the bottom of the casing.
3. A "stinger" extending beyond the drill bit or end of the augers may be incorporated to keep the bit/augers centered over the casing.
4. Select the diameter of the augers/drill bit to match or exceed the diameter of the original borehole.
5. Retrieve as much of the well materials as possible, as cuttings, and place them in containers as IDW.
6. Tremie-grout the clean borehole from bottom to top through the inside of the augers or drill string as they are retracted.
7. Grout should be added while augers/drill string are removed to ensure that the grout level does not fall below the bottom opening of the tools.
8. When the grout has reached the prescribed level (commonly 2 to 5 feet below ground surface), allow the grout to settle and cure.
9. Contain well water displaced by the neat cement as IDW.
10. Place excess neat cement in portable metal bins or equivalent and dispose of as solid IDW after it is allowed to set.
11. After 24 hours, check the grout for settling, add additional grout if necessary. Grouting is complete when the neat cement has hardened and no settlement has occurred.
12. Complete by filling the remaining 2 to 5 feet with approved material (e.g., native soil, sand, or gravel) and restoring the final surface per the work plan and applicable specifications (e.g., repair asphalt/cement).

4.4.4 Documentation

Record all measurements and pertinent information in the FLB or other appropriate form(s) as specified in the project work plans and conformance with SWE-FSOP-001 (Field Documentation):

- Date
- Site
- Well or boring number
- Location
- Observed field conditions
- Weather conditions

- Any unusual circumstances
- During drilling, track and note changes in the drilling process (e.g., sounds, rotation speed, sudden drops, etc.)
- See SWE-FSOP-001 (Field Documentation) for additional procedures related to field documentation.

4.5 Demobilization/Site Restoration

After well installation decommissioning is completed, the casing, drill string, and tools should be laid down, the mast lowered, and the rig moved off the location. The FTL or designee supervises the demobilization/site restoration.

All debris generated by the drilling operation should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans. All abandoned borings should be topped off and completed per the project work plans. Any hazards remaining due to drilling activities should be identified, and appropriate barriers and markers should be put in place, as per the APP. All fluids and waste should be adequately contained, clearly labeled, and maintained to comply with the project work plans.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for drilling and field documentation review will be performed by the FTL or PL to check that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance was taken to the SOP, the PL should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs.

6.0 Documentation Review

The FTL is responsible for daily review of the activities performed at the site and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

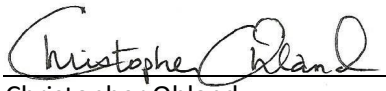
7.0 References

None cited.

Groundwater Well Rehabilitation

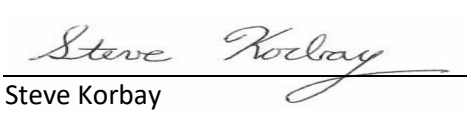
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Approvals



Christopher Ohland
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August 12, 2024
Date



Steve Korbay
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August 12, 2024
Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

This Standard Operating Procedure (SOP) describes the procedures that should be followed during the redevelopment and rehabilitation of groundwater monitoring, injection, and extraction wells. The goal is to recondition the well to its optimal performance.

Indicators of deterioration include:

- Chemical encrustation or biofouling of the well screen and filter pack materials
- Fine particles that plug formation and well screen
- Sand entering the well through corroded openings of the well screen
- Pipe conditions that affect the pumping and discharge of water

1.2 Scope

The SOP describes procedures for removing chemical encrustation and biofouling from the wells and fine-grained material that may be plugging the well, filter pack, and natural formation near the screened interval. The procedures outlined in this document are intended to redevelop wells fouled with slimes produced by microorganisms and precipitates of iron, manganese, and carbonate.

Well redevelopment involves both chemical and mechanical processes. Chemical processes involve the application of acids (biocides, e.g., sulfamic acid and glycolic acid) to remove/dissolve chemical encrustation and eliminate the organisms that produce biofouling. Mechanical processes involve surging, bailing, and pumping the well to remove fine-grained material from the well, screen, filter pack, and the natural formation near the screened interval.

For extraction wells, redevelopment aims to achieve flow rates like when the well was new and in use. The pre-and post-redevelopment well efficiency can be tested by determining the specific capacity.

1.3 Roles and Responsibilities

Field Team. A Field Team is one or more individuals working together. Each Field Team is responsible for maintaining a field log of their activities, as applicable.

Field Team Lead (FTL). The FTL provides direction and oversight of the fieldwork. The FTL is responsible for reviewing and confirming the adequacy of the field documentation during fieldwork as soon as possible and before releasing the daily quality control report. The FTL informs the Project (PM) of field variances or problems encountered.

Project Manager (PM). The PM is responsible for providing adequate resources to the field staff and ensuring that the field staff has sufficient experience and training to comply with this SOP successfully. The PM is responsible for approving and documenting techniques not described in this SOP but considered the best methods for the current project. The PM documents change as a variance to the plans and forward the variance to the Program Manager (PgM) for approval. The PM is also responsible for confirming the adequacy of the field documentation after fieldwork. An entry confirming which information was reviewed must be added to the post-event field documentation package (Section 5.0).

Program Manager (PgM). For each SWE Program, the PgM is responsible for providing written instruction to their Field Team, which complies with the requirements of this SOP and the client-contracted specifications.

Site Supervisor.[1] The Site Supervisor is responsible for maintaining a project-specific FLB/notepad and field forms of their activities, as applicable, and providing copies to the PM for review.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies, incidents, and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PM and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control. Method described in the project work plans. The QC Lead notifies the PM of quality deficiencies and actions to correct those. The PM approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

The SWE Quality Assurance Manager and SWE Field QC Manager report to the SWE Vice-President. When mentioned in this SOP, the “SWE” prefix is shown to distinguish it from the QC Lead assignment shown in the project organization chart.

1.4 Definitions

Bailer – A device used to withdraw water from a well. A bailer typically is a pipe attached to a wire with a check valve in the bottom.

Filter Pack – Uniform, clean sand or fine gravel placed in the well's annulus between the borehole wall and the well screen to stabilize the adjacent formation and prevent formation material from entering the well screen.

Flow Rate – The rate at which water is being pumped out of a well, usually measured in gallons per minute (gpm).

Investigation Derived Waste (IDW) – Waste generated while investigating or examining a contaminated site.

Specific Capacity – The specific capacity of a well is its yield per unit of drawdown, usually expressed as gpm per foot of drawdown (gpm/ft).

Surge Block – A device smaller than the well diameter used during development. Attached to the bottom of the surge block is a circular wire scrub brush slightly larger (tight fit) than the diameter of the well. When surging, the wire brush loosens debris and cleans the inside of the casing and screen. A rubber "squeegee" is also slightly larger (tight fit) than the well diameter in the middle of the surge block. The

[1] In this context, a Site Supervisor is a person assigned to oversee long-term operations or construction work; the roles and responsibilities are like that of the Field Team Leader.

squeegee acts like a plunger, pushing water through the screen and into the surrounding formation. The wire brush could be a separate device used in combination with a surge block.

Surging – A process in which a tool like a plunger or a piston (e.g., surge block with a squeegee) is lowered into a well and then raised and lowered a short distance (e.g., 10 feet). This action forces water to flow in and out of the well screen, loosening scaling and other built-up debris on the casing wall.

2.0 Relevant Documents

SWE file folder m:\\Environmental\Quality Control Procedures\SWE Field Forms\ has the current, approved form templates.

3.0 Equipment List

- Workplan or Operation and Maintenance (O&M) Plan
- Field forms
- Indelible ink pen
- Padlock keys for site wells
- Socket wrench or specialized tool for well cover removal
- Site map
- Electric water level indicator
- Field water quality meter (e.g., Horiba, YSI, or equivalent).

4.0 Procedures

4.1 Clearances

Before starting well development, confirm that groundwater well locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plans. Before raising the mast on any development rig, ensure appropriate clearances are maintained from nearby/overhead structures and power and communication lines.

4.2 Health and Safety Considerations

The health and safety of all contracted employees is the responsibility of the contractor or subcontractor. The contractor should provide all appropriate health and safety equipment (i.e., personal protective equipment, etc.). The contractor is responsible for having copies of the safety data sheets for all chemicals brought to the site and training contractor employees concerning hazard communication (29 CFR 1910.1200). All on-site personnel should attend a documented tailgate safety meeting daily. Specifically:

- Hold Tailgate Safety Meetings in the manner and frequency stated in the health and safety plan.
- All personnel at the site should have appropriate training and qualifications per the health and safety plan.
- All personnel within the exclusion zone should pay close attention to rig operations during well development. Rotating or swinging components can snag or catch loose clothing or strike personnel and cause severe injury or death.

Chemical Cautions. The main chemicals used in the redevelopment process include sulfamic and glycolic acid. Sulfamic acid is relatively safe to handle in its dry form; the dry material does not give off fumes and will not irritate dry skin. If spillage occurs, it may be cleaned up quickly and safely, thus providing safer shipping and handling. However, sulfamic acid should be handled like hydrochloric acid if mixed at the surface. During treatment, this slowly dissolving acid releases dangerous fumes at a relatively slow rate; nevertheless, proper ventilation should always be provided. Glycolic acid comes as a liquid with a pH of 1.1; proper handling is required.

4.3 Sequence of Activities for Performing Extraction Well Redevelopment

The general sequence of activities to be followed during well redevelopment are as follows:

1. Collect pre-redevelopment water quality parameter measurements.
2. Shut down the pumps, remove the discharge pipe and pumps from the wells, and
3. Refurbish/replace, as necessary.
4. Perform mechanical redevelopment of the individual wells.
5. Perform chemical treatment of the individual wells.
6. Perform additional mechanical redevelopment/chemical recovery of the individual wells.
7. Evaluate post-redevelopment water quality parameters.
8. Reinstall the dedicated pumps and discharge pipe and restart pumping.

Detailed procedures for well redevelopment are provided in the following sections of this SOP.

4.4 Field Documentation

Field details of well redevelopment should be recorded in a field logbook or on a designated field form. The following information should be documented during the well redevelopment process:

- Well identification number,
- Date and time of redevelopment,
- Periodic water quality parameter measurements during development,
- Purge water observations (i.e., nephelometric turbidity units [NTU] reading),
- Type of equipment used,
- Total volume of water removed,
- Amount and types of chemicals added, and
- Completion time for each task.

4.5 Investigation-Derived Waste

All IDW water evacuated from the wells during redevelopment must be handled and stored according to the project IDW Plan. At a minimum, the water will be stored onsite in a proper container, pending chemical analysis and disposal.

4.6 Decontamination

Every effort should be made to avoid outside contamination and the cross-contamination of wells. All downhole equipment should be steam cleaned using an approved water source before and after

redevelopment activities have been completed at each well. Fluids generated by the above decontamination procedures should be containerized and included in the IDW containment.

4.7 Mechanical Redevelopment

The well development contractor will begin the well development process by bailing the well to remove loose, settled solids and then using a surge block to loosen the scale and other debris in the wells. A circular wire scrub brush, slightly larger than the diameter of the well, should be attached to the bottom of the surge block (or as a separate device in combination with the surge block) to loosen debris and scrub the inside casing and screen. A rubber squeegee, also slightly larger than the well diameter, should be fixed to the middle of the surge block to plunge and push water through the screen and into the surrounding formation. The following well development procedure is used for mechanical treatment. Steps 1a and 1b are repeated, in any order, to remove large solids before continuing to Step 3.

1a. A bailer should be used to remove sediment and other debris introduced into the well casing by surging the well. The bailing will remove the settled fine sediment and debris.

1b. The surge block will be lowered to the bottom of the well. Starting at the bottom of the well and moving upward, the surging time shall be at least 15 minutes for every 10 feet of screen length. The surging shall be continued until the top of the screen is reached. (Note: Surging is the most essential part of the mechanical development process. Therefore, spend as much time as possible surging the well before moving on to the next step.)

2. A portable pump should be lowered into the well and slowly moved up and down the screened interval to remove additional fine sediments. The pumping will remove additional fine sediment and debris suspended within the water. This should be done until the water is visibly less cloudy and at least one borehole of purge volume is removed (see Appendix 1 for borehole volume calculation procedures).

3. Purge water will be stored in drums, tanks, or other containers, as appropriate, pending analytical profiling. All equipment (e.g., pumps, bailers, and surge blocks) will be decontaminated before being used in different wells.

4.8 Flocculants

Flocculants are concentrated liquid polymer dispersants that work to pull together and precipitate solids in well water. Using flocculants allows for better videoing of a well for condition appraisal. Any flocculant added early in the rehabilitation process is removed from the well during the ensuing processes.

4.9 Chemical Treatment

The chemical treatment process may include adding sulfamic acid (e.g., Baroid Aqua Clear™ Modified Granular Acid [MGA]), glycolic acid (e.g., Baroid Aqua-Clear™ Acid Enhancer/Antifoulant [AE]), or other acids to the wells according to manufacturer's specifications. The amount of chemicals required in the treatment process for each well is calculated based on the manufacturer's specifications.

The following procedures will then be performed:

1. Before introducing chemicals into the well, shut down the pumps at adjacent wells for the well rehabilitation activities.
2. Mix the sulfamic acid and water in a tank to dissolve the granular acid into the solution. Prepare the proper glycolic acid (AE) solution in a separate tank.
3. Measure the pH of the MGA solution before adding it to the extraction well (the pH should be less than 1.3).
4. Apply the MGA chemical solution to the well within the screened interval through a tremie pipe. Once the MGA chemical solution has been added, the AE chemical solution will be applied to the wells within the same screened interval through a tremie pipe. After both chemical solutions have been added to the well, the surge block with the squeegee affixed will be lowered into the well, and surging will begin for approximately 20 to 30 minutes to mix the chemical solution into the formation.
5. After surging is completed, allow the chemical solutions to sit for 2 hours, according to the manufacturer's specifications.
6. Repeat surging every 2 hours (or up to five times daily) while continuing to measure the pH of the solution in the well as part of the surge process. If the pH is greater than 2.0, additional acid should be added. The chemicals should be applied to the well within the screened interval through a tremie pipe, and the pH should be measured. Additional batches of acid should be added until the pH is less than 2.0. Surging will be repeated until the pH stays below 2.0 for two consecutive events or a maximum of five.
7. Upon completing the surging sequence, allow the chemicals to remain in the well for a total contact time of 24 hours (according to manufacturer specifications). After 24 hours, further redevelopment of the well will commence as described below.

4.10 Acid Recovery and Final Mechanical Redevelopment

The mechanical redevelopment process will begin after the chemicals have been in the well for 24 hours. This step serves multiple purposes including purging all remaining acid out of the well and removing any remaining material from the screens that the chemicals may have loosened. This process begins by purging the well via bailing or pumping following the criteria below:

1. Monitor groundwater quality parameters, including pH, specific conductivity, and turbidity. These parameters will be measured at the beginning of well redevelopment and after three borehole volumes are evacuated.
2. A minimum of three borehole volumes should be removed from the wells.
3. The final three consecutive water quality parameter measurements should satisfy the following criteria:
    a. pH: greater than the lowest pre-redevelopment measurement minus 0.5.
    b. Specific Conductivity: less than the highest pre-redevelopment measurement plus 10 percent (%) or until the readings are less than 2.0 millisiemens per centimeter and no longer decreasing (i.e., three measurements within 10% of each other).

c. Turbidity: less than 5 NTUs is preferable; up to 30 NTUs is acceptable. If this condition is not met following the removal of a minimum of three borehole volumes, purging shall continue until the turbidity stabilizes (i.e., three measurements within 10% of each other).

All purge water acquired during the acid recovery process must be disposed of at the IWTP following the procedures described in Section 4.5. All equipment used during this process must be steam cleaned between wells.

4.11 Pump Installation and System Restart

After redevelopment, the dedicated pumps and discharge pipe into the extraction wells will be reinstalled, and normal operations will resume.

1. Record the date and time of startup and pumping rates at the wells.
2. Return to the wells 72 hours after system startup and collect an operational water level and flow rate measurement from each extraction well.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and QC procedures for field documentation review will be performed by the FTL/Site Supervisor and checked by the PM to ensure the content and level of detail comply with this SOP. The FTL/Site Supervisor can approve variances and fieldwork problems in coordination with the PM. The FTL/Site Supervisor should try to resolve the issue so that work can continue; however, should the variance/incident/problem affect the contracted scope of work or a project decision made from the evaluation of date, the resolution must be coordinated with PgM and SWE Field QC Manager if corrective action is needed. The PgM should notify the SWE Quality Assurance Manager of all corrective actions.

6.0 Documentation Review

FTL is responsible for reviewing the fieldwork documentation daily for compliance with requirements (Section 4.0 “Procedures”) and legibility. Errors and omissions should be explained, and revisions to an entry should be signed and dated by the FTL.

The PM is responsible for reviewing and signing approved documents stored in the project file (Section 4.1).

7.0 References

U.S. Department of Defense, 2013. *DoD Environmental Field Sampling Handbook, Revision 1.0*. April.

Appendix

Appendix 1. Borehole Purge Volume Calculations

Borehole Purge Volume Calculations

Before the development process begins, the minimum number of gallons to be removed shall be calculated. The following information is needed to calculate purge volume:

1. Total depth of well.
2. Measured static water level.
3. Screen length.
4. Well casing inner diameter.
5. Borehole diameter.

The following procedure shall be used to determine one borehole purge volume. The number of borehole purge volumes required is at least one for Section 6.7 – Mechanical Redevelopment activities and at least three for Section 6.9 – Acid Recovery and Final Mechanical Development activities.

Borehole Purge Volume: Vt = (Vc + Van) x 7.48 gal/ft3

where:

V_t = Total Purge Volume (gals)

V_c = Volume of water in well casing (ft3)

V_a = Volume of water in well annulus (ft3)

n = Estimated porosity of sand pack (usually 30%)

Casing Volume: $V_c = \pi r_1^2 h_1$

where:

V_c = Casing Volume (ft3)

r_1 = Inside radius of monitoring well casing (ft)

h_1 = Height of water column (i.e., total well depth minus static water level depth) (ft)

Annular Volume: Va = π(r22 - r12) h2

where:

Va = Annular volume (ft3)

r_2 = Radius of borehole (ft)

r_1 = Outside radius of well casing (ft)

h_2 = Total vertical saturated thickness of sand pack (ft)

Note: If the standing water column is longer than the screen length, the length of the filter pack installed above the screen needs to be included in the total vertical saturated thickness of the sand pack.

Nested Soil Gas Probe Installation

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Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the standard operating procedure (SOP) is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

This standard operating procedure (SOP) directs field staff in the proper techniques and documentation requirements to install nested soil gas probes.

1.2 Scope

The scope of this SOP applies to field staff conducting nested soil gas probe installation oversight. The SOP includes guidance for the performance, management, and completion of installation activities, including a description of staff responsibilities, relevant documentation, equipment, procedures, and quality control. Project-specific accident prevention plans (APP) and Site Safety and Health Plans address potential hazards related to nested soil gas probe installation.

Per- and polyfluoroalkyl substances (PFAS)-friendly procedures are also provided in this SOP. When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP indicated by [PFAS Projects].

1.3 Responsibilities

Field Team. A field team is one or more individuals working together. The team is responsible for overseeing and/or collecting transect observations as specified in this SOP.

Field Team Lead (FTL). The FTL reviews project work plan to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL also reviews and confirms the adequacy of the fieldwork documentation.

Project Manager (PM). The PM or designated Assistant PM is responsible for providing adequate resources to the field staff and ensuring the field team has sufficient experience and training to comply with the SOP successfully. The PM is responsible for approving and documenting techniques not described in this SOP but considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2024). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies, incidents, and actions to correct those. If the circumstance warrants, the FTL approves those actions or notifies the PM and the project Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work is performed using the 3-Phases of Quality Control method described in the project work plan. The QC Lead notifies the PM of quality deficiencies and actions to correct them. The PM approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Borehole. Any hole drilled into the subsurface to identify lithology, collect soil samples, and install soil gas probes.

Cuttings. Pieces of soil, sediment, or rock cut by a bit while drilling boreholes.

Filter Pack. Granular filter material (sand, gravel, etc.) placed in the annular space between the soil gas probe's permeable tip and the borehole to increase the effective diameter of the probe and prevent fine-grained material from entering the probe.

Grout. For this SOP, the term "grout" consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry.

Hollow-Stem Auger Drilling. A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

Tremie. A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space. Material should be placed in the borehole with a tremie pipe at depths below 15 feet below ground surface.

2.0 Relevant Documents

This SOP focuses on the oversight and documentation of nested soil gas probe installation activities and should be used in conjunction with the Department of Defense (DoD) Vapor Intrusion Handbook (TSERAWG, 2009) and other applicable SOPs, including the following:

Standard Operating Procedures

- SWE-FSOP-001 Field Documentation
- SWE-FSOP-300 Series (various drilling methods)
- SWE-FSOP-801 Equipment Decontamination
- SWE-FSOP-802 Investigation-Derived Waste Management

Field Forms

- SWE-FFRM-401, Well Construction
- SWE-FFRM-004, Daily PFAS Sampling Checklist [PFAS Projects]

3.0 Equipment and Materials List

Equipment/Supplies

- Camera
- Field forms
- Field logbook
- Health and safety equipment, including safety glasses and nitrile/latex exam gloves as specified in the project Health and Safety Plan
- Measuring tape
- Waterproof, indelible pens/markers in black or blue ink

The list below identifies equipment expected to be used by staff while supervising nested soil gas probe installation activities.

- A bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation

[PFAS Project]: Field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink
  [PFAS Project]: Use ball-point pens. Do not use markers, felt pens, or pens with water resistant ink.
- Digital camera/video, cell phone, or other devices capable of digital imagery
- Appropriate personal protective equipment (PPE)

The following materials are usually required for nested soil gas probe installation. Review project-specific work plan for specific or unique materials or installation procedures.

- Steel protective locking cover or flush-mount well box and locking cap
- ⅛-inch or ¼-inch tubing (metal, Nylaflow®, polyetheretherketone [PEEK], Teflon®)
  [PFAS Project]: Do not use Teflon or polyethylene tubing
- Permeable probe tips
- Measuring tape
- Plastic sheeting to protect decontaminated materials
  [PFAS Project]: Clean, dry materials should be stored within a protective medium (e.g., HDPE bag) or staged in a clean area for future use.
- Downhole support rod (small diameter PVC or metal pipe, capped on both ends) for probes greater than 15 feet below ground surface
- Gas-tight caps
- Centralizers to keep the downhole rod centered in the borehole
- Silica sand (sized based on the formation material)
- Bentonite pellets or chips (for seal or borehole fill according to project requirements)
- Pure bentonite powder and cement (for grout; confirm the type of each and mixture specifications)
- Granular bentonite (for dry bentonite transition between filter pack and seal)
- Tremie pipe

4.0 Pre-Field Planning

It is essential to be thoroughly familiar and compliant with state, county, or local installation standards, codes, etc. They may contain requirements that must be used in conjunction with procedures presented in this SOP.

Site-specific factors must be considered in the selection of installation and completion materials, specification of designs, and drilling methods. The design and other specifications are incorporated into the project work plan or as the FTL/PM directs.

4.1 Clearances

Before breaking ground, confirm that drilling locations have been appropriately cleared of potential overhead, surface, and subsurface hazards per the project work plan. This should include a utility locating subcontractor to identify subsurface infrastructure and anomalies. The clearance process also includes completing public utility locating service calls (e.g., Dig Alert, USA North 811) and completing any coordination and permitting procedures with the onsite Department/Directorate of Public Works personnel required by the project contract.

Review available forms and diagrams that document the selected location of the drilling location relative to underground/overhead utility lines, surface structures, or buried objects.

Copies of the site clearance documents should be kept onsite.

4.2 Health and Safety

- Hold Tailgate Safety Meetings in the manner and frequency stated in the APP.
- Personnel at the site should have appropriate training and qualifications as per the APP.
- Personnel within the exclusion zone should pay close attention to rig operations during drilling. The rotating or swinging drilling components can snag or catch loose clothing or strike personnel and cause severe injury or death.
- Hearing protection is especially critical when sonic drilling, as the rig can generate high-frequency noise and considerable noise when drilling through gravel and cobbles.
- Establishing clear communication signals with the drilling crew is mandatory because verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the driller of any unforeseen hazard—or when anyone is approaching the exclusion zone.

4.3 Equipment Blank Testing

A representative section of tubing will be equipment blank tested by using the longest length of tubing expected and sampling without purging, collecting a volume that is less than the amount of air within the tubing.

A representative permeable probe tip will be equipment blank tested by running deionized water over and through the inside of the tip into a sample bottle.

4.4 Site Conditions and Drilling Logistics

Prepare the site per the project work plan. Before mobilizing, determine the logistics of drilling, logging, sampling, cuttings containment, and construction. The FTL or the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (i.e., slip/trip/fall, overhead power lines) and determine how drilling operations may impact the environment (i.e., dust, debris, noise). As per the project work plan, potential hazards should be evaluated and corrected, or the borehole location changed or shifted.

- Drill site space requirements commonly include an area for the rig and swing-out clearances, access for a support truck, and forklift and/or debris bin.
- The FTL or the Field Geologist should inform the driller of the appropriate equipment (e.g., cookie-cutter) to penetrate the surface cover (e.g., asphalt, concrete, cement).
- Lubricating compounds used on drill pipe and drive casing threads must be approved in advance and must not contain compounds incompatible with project objectives.
- The drilling method will be hand auger, direct push, or hollow-stem auger. Air rotary and rotosonic drilling methods disrupt the soil gas equilibrium and should not be used unless there is a longer equilibrium time prior to sampling. Mud rotary drilling is not an appropriate method for installing soil gas probes.

4.5 Mobilization

- The drill rig is mobilized to the site and located over the borehole location
- The drill rig is leveled with a set of hydraulic pads attached to the front and rear of the drill rig

- The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig and avoid obstructions or hazards

5.0 Nested Soil Gas Probe Installation Procedures

5.1 Drilling

The following procedures assume that the drilling of the borehole occurred per the project work plan and appropriate SOPs (see SWE-FSOP-300 Series [various drilling methods]).

During fieldwork, the Field Geologist will generally:

- Observe and monitor rig operations
- Conduct health and safety monitoring and sampling, and supervise health and safety compliance

5.2 Borehole Preparation

At total depth, remove soil cuttings through circulation or rapidly spin the augers before constructing the nested soil gas probes. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect nested soil gas probe installation. Condition the hole or take other actions mutually agreed upon by the Field Team (FTL, PM, Field/Project Geologist, driller) to aid in soil gas probe installation.

Remove the drill pipe and bit if using rotary techniques, or remove the center bit if using the hollow-stem auger technique. Install the soil gas probe construction materials inside the open borehole or through the drive casing or auger center, using a tremie pipe as needed.

Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not heaved to fill the borehole. If heaving has taken place, discuss cleaning, re-drilling, or installation options in the open section of the boring with the Field Team (FTL, PM, Field/Project Geologist, or driller).

5.3 Backfilling Over-Drilled Boreholes

If the hole was over-drilled to a depth greater than needed for soil gas probe installation, backfill material such as grout, filter pack, bentonite pellets, or bentonite chips (as specified in the project work plan) may be added to the bottom of the boring to raise the bottom of the hole to the desired depth.

- Before placing materials, confirm the borehole dimensions and calculate the estimated volume of material required, including allowances for hydration of dry materials.
- Closely monitor the progress of borehole backfilling by frequently tagging the level in the borehole and comparing against estimated fill quantities. This is especially important if irregularities in the borehole are suspected (e.g., voids, sloughing).
- Pump grout through a tremie pipe and fill the borehole from the bottom of the boring upward. During grouting, submerge the tremie pipe below the top of the grout column in the borehole to prevent free fall and bridging.
- Add gradually to prevent bridging if filter pack or bentonite solids (chips/pellets) are used.
- Obtain approval of the final depth of the borehole in advance from the FTL or PM. Stop grout, filter pack, or bentonite addition when the general level has reached approximately one foot below the desired base

of the nested soil gas probes. Hydrate the bentonite plug for at least one hour before installing a filter pack.

5.4 Assembling and Installing Nested Soil Gas Probes

Installation of nested soil gas probes involves constructing multiple probes in one boring so that multiple depths can be sampled at one location to obtain vertical profile soil gas data within the vadose zone. Nested soil gas probes must be sealed between sampling intervals to ensure that the sample collected is from the targeted depth in the vadose zone (Figure 1).

Before installation, inspect the tubing, permeable probe tip, and any other soil gas probe construction materials to confirm that no damage has occurred during shipment and decontamination activities. During the inspection, confirm that materials, dimensions, and quantities are accurate before proceeding. If there are any foreign materials or moisture in the tubing, clean and dry or replace the tubing. Attach the permeable probe tip to the tubing and attach the tubing to the outside of the downhole support rod.

Assemble and carefully lower the downhole support rod with soil gas probes through the open borehole, drive casing, or inside the augers with tremie pipe as needed until the desired depth is reached. Suspend the downhole support rod by the installation rig, so it does not rest on the bottom of the boring. If the downhole support rod was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the downhole support rod and attached soil gas probes should be removed from the boring and inspected.

In certain instances, the downhole support rod and attached soil gas probes may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment (drill pipe, hammers, etc.) to prevent the downhole support rod from rising. The Field Geologist notes the amount of rise and consults with Project Geologist for an appropriate course of action.

Use centralizers on the downhole support rod to keep it centered in the borehole.

Record the following information in the FLB/notepad:

- Diameter of the boring
- Total depth of boring
- Total length of each probe's tubing
- Depth of each probe's permeable tip

5.5 Installing Filter Pack and Transition Bentonite

Based on borehole and soil gas probe dimensions, calculate volumes of filter pack, dry bentonite, and bentonite pellets or grout required. Place a layer of filter pack (one to two feet, unless otherwise specified in the project work plan) at the bottom of the borehole.

When constructing nested soil gas probes within a cased hole or through hollow-stem augers, install the filter pack by pouring and allowing it to free-fall through the center of the drive casing/augers or tremie according to the project work plan. Add filter pack slowly while withdrawing the drive casing/augers. Withdraw the drive casing/augers slowly during filter pack installation in increments no greater than one foot. Take care to minimize the height of the filter pack inside the auger/drive casing during pouring to avoid potentially "sand locking" the downhole support rod and soil gas probe tubing and pulling it up with the auger/drive casing.

Monitor filter pack settlement by initially measuring the sand level (before beginning to withdraw the drive casing/augers). Repeatedly take depth soundings using a weighted tape to continually monitor the level of the sand in the auger/drive casing as it is removed. Monitor the top of the downhole support rod and soil gas probe tubing to detect any movement due to settlement or from drive casing/auger removal. If the top of the downhole support rod and/or soil gas probe tubing moves upwards at any time during the installation process, the driller should not be allowed to force the top of the downhole support rod or tubing from further movement, which could cause the tubing to bend or break in the borehole.

Place the probe midway in the filter pack with approximately six inches of sand below and six inches above the probe. Once approximately one foot thick (or as specified in the project work plan) filter pack placement is complete, measure and record the depth to the top of the pack in the FLB/notepad.

Place an approximately one-foot thick (or as specified in the project work plan) layer of dry granular bentonite between the filter pack and the seal.

5.6 Installing Seals

Above the dry granular bentonite layer, install a seal (hydrated bentonite for temporary probes expected to be in place for less than a year or neat cement-grout for permanent probes) up to the bottom of the next soil gas probe filter pack (or just below ground surface for the shallowest probe). If pellets or chips are used, add them gradually to avoid bridging. Take repeated depth soundings using a weighted tape to ascertain the top of the bentonite seal. Allow the seal to hydrate for at least 30 minutes before proceeding.

- Unless otherwise specified, cement grout should be mixed using approximately 6 to 7 gallons of water per 94-pound bag of Type I/II Portland cement to a density of approximately 15 pounds/gallon.
- If needed, add bentonite (5 to 10 percent) to the cement grout to strengthen the mix and delay the setting time.
- Specific mixtures and other types of cement and grout proposed should be evaluated on a case-by-case basis by the Field Geologist and communicated to the drillers.

During grout installation, maintain the bottom of the tremie pipe below the top of the grout to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, raise the drive casing/augers in short increments during grout pouring, keeping the bottom of the drive casing/augers below the top of the grout. It is essential to calculate the approximate volume of grout required; note reduced/excessive volumes, which may indicate irregularities in the annulus or grout flow into a formation. Cease grouting when the grout level has risen to approximately one to two feet of the ground surface, depending on the surface completion type (flush-mount versus aboveground). Monitor grout levels to ensure that grout taken into the formation is replaced by additional grout. If settling occurs, additional topping off of the grout may be necessary.

5.7 Surface Completion

Make sure the top of the tubing of each soil gas probe extends enough out of the borehole to allow for ease of sampling. Each tubing should be labeled with the appropriate probe depth identification and capped/secured to prevent foreign materials, moisture, and ambient air from entering the tubing opening with a gas-tight cap.

Before installing any well box or vault over the soil gas probes, confirm clearances between the tubing and inside vault lid and the final height of the vault top above ground surface. Where installations are in parking lots, roads, concrete slabs, etc., consider the final height of the surrounding surface.

Set and cement into position a well box or vault, usually one inch to a few inches above ground surface, depending on design requirements. Raise the top of the well box or vault slightly above grade and slope the cement collar to grade to promote surface drainage away from the well box or vault.

Place the soil gas probe tubing in the vault in a way to reduce the chance of creasing or breaking the tubing, which would compromise the air-tight seal when sampling the probe.

6.0 Demobilization/Site Restoration

Debris generated by the drilling operation/soil gas probe construction should be disposed of appropriately. The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plan. Any hazards remaining due to drilling activities should be identified and appropriate barriers and markers should be put in place per the APP. Soil cuttings and fluids should be adequately contained, clearly labeled, and maintained to comply with the project work plan.

7.0 Document Control

Field forms should be completed in their entirety. If an entry is not applicable, indicate “n/a” or line out the entry.

After a task or project, field documentation, including the field logbook and field forms, will be scanned and placed on the server in the appropriate folder, along with photographs and GPS data. Original documents will be submitted to the PM/Assistant PM and kept in the project file. See FSOP-001 (Field Documentation).

8.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plan.

Quality Assurance (QA) and Quality Control (QC) procedures for soil gas probe installation field documentation review will be performed by the FTL or PM to confirm that procedures and documentation content and level of detail comply with this SOP. If a deficiency or a variance is identified, the PM should document the deficiency/variance and determine the need for corrective action in coordination with the QA Manager.

If a non-registered geologist performs the oversight, a registered Project Geologist is responsible for reviewing the fieldwork documentation for the accurate and complete representation of the drilling and approval of final logs/forms.

9.0 Documentation Review

The FTL is responsible for the daily review of the fieldwork documentation for legibility and compliance with requirements identified in Section 4.0 “Pre-Field Planning” and Section 5.0 “Nested Soil Gas Probe Installation Procedures.” Errors and omissions should be explained, and revisions to an entry should be signed and dated by the FTL.

The PM is responsible for the review and signoff of final approved documents stored in the project file.

10.0 References

California Environmental Protection Agency (CalEPA), 2015. *Advisory – Active Soil Gas Investigations*. July. Available from: https://dtsc.ca.gov/wp-content/uploads/sites/31/2021/11/VI_ActiveSoilGasAdvisory_FINAL_a.pdf

Tri-Service Environmental Risk Assessment Workgroup (TSERAWG), 2009. *DoD Vapor Intrusion Handbook*. January. Available from: https://www.denix.osd.mil/irp/vaporintrusion/

U.S. Army Corps of Engineers (USACE), 2024. *Safety and Health Requirements. EM 385-1-1*. March.

Investigation Derived Waste Management

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April 1, 2022
Date



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April 1, 2022
Date

Project-Specific Modification[1]

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques, and documentation for handling, labeling, tracking, and disposing of investigation derived waste (IDW) encountered or generated during environmental field activities. This SOP gives descriptions of equipment, field development procedures, field data collection, and personnel responsibilities.

1.2 Scope

The scope of this SOP is to describe procedures for projects that generate IDW.

Materials that may become IDW include but are not limited to:

- Personal protective equipment (PPE) includes disposable coveralls, gloves, booties, respirator canisters, splash suits, and other non-soil, solid wastes
- Disposable equipment and items include plastic ground and equipment covers, aluminum foil, conduit pipe, disposal samplers (e.g., bailers), tubing, and others
- Soil cuttings/spoils from boreholes/trenches and other soil wastes generated during sampling
- Drilling mud or water used or generated during drilling
- Groundwater obtained through well development or well purging
- Cleaning fluids such as spent solvents and wash water
- Packing and shipping materials
- Sediment from surface water bodies (rivers, lakes, ponds)
- Wash and rinse waste from decontamination activities

These types of IDW may require classification as non-hazardous or hazardous waste and should be containerized, stored, profiled, transported, and disposed of appropriately according to regulatory and client-specific requirements. Review project-specific work plans and waste management plans to confirm appropriate procedures for each site.

1.3 Responsibilities

Field Team. A Field Team is one or more individuals working together. The Field Team is responsible for the oversight of IDW as specified in this SOP.

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the

FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

Investigation Derived Waste (IDW). Waste that is generated in the process of investigating or examining a contaminated site.

Personal Protective Equipment (PPE). Personal health and safety equipment is used to protect the individual from contaminant exposure and physical injury.

2.0 Relevant Documents

This SOP focuses on the IDW management task and applications and should be used in conjunction with other applicable SOPs and forms, including the following:

2.1.1 Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-801, Equipment Decontamination

3.0 Equipment List

The following materials and equipment may be needed for IDW management:

- Bound field logbook (FLB) with consecutive page numbers and waterproof, indelible pens/markers
- PPE as outlined in site-specific Accident Prevention Plans (APPs)
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, Liquinox™, plastic sheeting, paper towels, sponges, garden-type water sprayers, large plastic bags (minimum 0.85 mil), potable water, distilled water, and deionized water)
- Department of Transportation (DOT)-rated 55-gallon drums or other approved containers for containing soil cuttings, decontamination water, and formation water
- Drum/bung wrench and drum funnel

- Heavy equipment forklift or vehicle with drum grappler (as necessary)
- Photoionization detector (PID)
- Vendor-supplied roll-off bin(s), with liners if applicable
- Laboratory-supplied sample containers
- Wood pallets (as necessary)
- Non-porous (e.g., stainless steel) trowels
- Field notebook/notepad and waterproof permanent marking pens
- Waste manifests
- Secondary containment materials (i.e., spill containment platform/pallet with drain, absorbent pads)

4.0 Procedures

The procedures below are provided for managing non-liquid and liquid IDW generated during field activities.

4.1 IDW Staging Area

Identify an onsite area for staging drums, bins, and other storage containers. The area should be large enough to allow temporary storage and safe access to the drums and bins of IDW. If IDW is left onsite without supervision, then the area must be secured from unauthorized access and containers labeled appropriately. Hazardous IDW may not be accumulated for more than 90 days.

4.2 Soil IDW

Place IDW (soil cuttings/spoils generated during drilling, trenching, soil sampling, or other) into DOT-rated 55-gallon drums, appropriately-sized containers/bins, or stockpiles at the point of generation. In most cases, mixing the cuttings from several borings or sampling locations is permissible to fill the containers or entire stockpiles but must be confirmed in advance by the PL/FTL. Ask the FTL whether potentially hazardous solids should be segregated from non-hazardous.

When drums or containers are full or daily activities are completed, the drum lids and rings will be fastened. Full drums or containers will be transported to the designated IDW accumulation area regularly to avoid the accumulation of drums or containers at investigation sites for extended periods.

Waste profiling analyses will be performed before disposal (Section 4.5). Each project may have unique waste profiling, storage, and disposal—review project-specific work plans and coordinate activities between the PL and client.

Unless approved, hazardous soil cuttings and excavation spoils must not be used to fill boreholes, test pits, or excavations. Place soil cuttings/spoils on plastic sheets or containerize them when generated; dispose of the plastic sheets with the used PPE or soil cuttings.

4.3 Liquid IDW

Contain liquids in DOT-rated drums or appropriately-sized watertight containers at the point of generation. Mixing the water from several sampling locations, decontamination water, process water,

and other IDW sources may be permissible to fill the drums but should be confirmed in advance with the PL or FTL. Ask the FTL whether potentially hazardous liquids should be segregated from non-hazardous.

When drums or containers are full or daily activities are completed, the drum lids and rings will be fastened. Full drums or containers will be transported to the designated IDW accumulation area regularly to avoid accumulating drums or containers at investigation sites for extended periods. All drums or containers will be labeled appropriately at the end of each day's activities. Perform waste profiling before disposal (Section 4.5). Each project may have unique requirements for waste profiling, storage, and disposal—review project-specific plans and coordinate activities with the PL or FTL.

4.4 PPE and Other Consumable Supplies

Inspect equipment and PPE (e.g., plastic sheets, screens, coveralls, boot covers, or other) to determine proper disposal procedures. If there is no evidence of contamination, materials can be disposed of with regular trash.

Decontaminate and discard PPE and other used supplies in plastic bags and sealed in metal barrels for final storage, transport, and disposal. Decontamination procedures consist of brushing off or using small amounts of water to scrub off potential gross contamination (see SWE-FSOP-801, Equipment Decontamination).

4.5 Waste Profiling

Waste profiling requirements will be coordinated by the PL with the client and disposal facility. At a minimum, a representative sample of the solid and aqueous IDW will be collected and analyzed for all chemicals of potential concern. When approved by the PL, generator knowledge is an acceptable alternative to laboratory testing. The PL will also coordinate with the client, disposal facility, and waste transporter to manage the completion of the waste manifest and ensure that an adequate number of manifests are available for the amounts and types of material to be disposed of. An example manifest is provided in Attachment 1.

Waste manifests are signed by the client or client's representative (usually identified on the manifest as the "owner" and/or "generator"). Field personnel are not allowed to sign manifests under any circumstances.

4.6 Labeling

Apply a label immediately after adding soil or groundwater to drums or soil to bins. If the waste generated has not been profiled, apply a "Pending Analysis" label (Figure 1). Add the contents, date(s) of generation, the origin of materials, address of generation, and contact information to the label. Because drum and container labels may be exposed to the elements, it is essential to use waterproof markers to fill in the information on labels and possibly clear packaging tape over the labels to preserve the information.

Once the material has been profiled, remove the "Pending Analysis" label and add the appropriate "Non-Hazardous" (Figure 2) or "Hazardous" label (Figure 3). Add the shipper, address, date(s) of generation, contents, and contact information to the label.



Figure 1 – Label: Pending Analysis



Figure 2– Label: Non-Hazardous



Figure 3– Label: Hazardous

4.7 Disposal of IDW

Soil and groundwater IDW will be placed in drums or appropriately configured bins and stored in a designated hazardous/non-hazardous waste storage area, the location and use of which will be coordinated with the client. Manifesting and disposal of IDW during field activities will be coordinated with the client before the initiation of field activities. As applicable, field activities that generate IDW will be conducted consistent with sustainable practices (e.g., reducing the volume of routine waste or IDW generated by decreasing materials consumption).

4.8 Document Control

The FTL is responsible for documenting or reviewing field team documentation of IDW management, including collection, sampling, labeling (if applicable), staging, and ultimate disposition of IDW. Disposition may include manifesting the waste and transportation offsite or releasing the waste to the client for ultimate disposal. The information entered in field documentation concerning IDW should include the following:

- Project Name
- Names of personnel
- Site location
- Type of activities
- Date waste generated
- Boring, well, or site number(s)
- Matrix
- Type of container(s)
- Estimated volume
- Disposition of contents
- Comments (field evidence of contamination [e.g., PID reading, odors])
- Any variance to procedures described in this SOP

After completing a task or project, all field documentation, including the field logbook, field datasheets, and electronic data, shall be scanned and placed on the server in the appropriate folder. All original documents shall be submitted to the PL and kept in the project file. See FSOP-001 (Field Documentation).

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for IDW field documentation review will be performed by the PL and QC Manager to confirm that content and level of detail comply with the applicable planning documents. Identification of errors and corrections made during QA/QC reviews will follow documentation requirements described in SWE-FSOP-001 (Fieldwork Documentation).

6.0 Documentation Review

The FTL is responsible for reviewing hazardous waste characteristics, ensuring the disposal facility is licensed to receive the IDW, and reviewing waste manifests and bills of lading.

The FTL is responsible for the daily review of fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited.

Attachments

Attachment 1.
Uniform Hazardous Waste Manifest

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) **A7 2002939203-001** **SC PPW 12/9/2008** Form Approved. OMB No.2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of 1	3. Emergency Response Phone	4. Manifest Tracking Number

5. Generator's Name and Mailing Address — Generator's Site Address(if different than mailing address)

Generator's Phone:

6. Transporter 1 Company Name — U.S.EPA ID Number

7. Transporter 2 Company Name — U.S.EPA ID Number

8. Designed Facility Name and Site Address — U.S.EPA ID Number

Facility's Phone:

9a. HM	9b. U.S. DOT Description (Including Proper Shipping Name, Hazard Class, ID Number, and Packing Group(If any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		

14.Special Handling Instructions and Additional Information

Contract retained by generator confers agency authority on initial transporter to add or substitute additional transporters on generator's behalf for purposes of transportation efficiency, convenience, or safety

15. GENERATION'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I Certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name — Signature — Month Day Year

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit :

Transporter Signature (for exports only): Date leaving U.S. :

17. Transporter Acknowledgement of Receipt of Materials

Transporter 1 Printed/Typed Name — Signature — Month Day Year

Transporter 2 Printer/Typed Name — Signature — Month Day Year

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator) — U.S. EPA ID Number

Facility's Phone:

18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1.	2.	3.	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a.

Printed/Typed Name — Signature — Month Day Year

EPA Form 8700-22v (Rev. 3-05) Prevolus editions are obsolete.

Figure 1

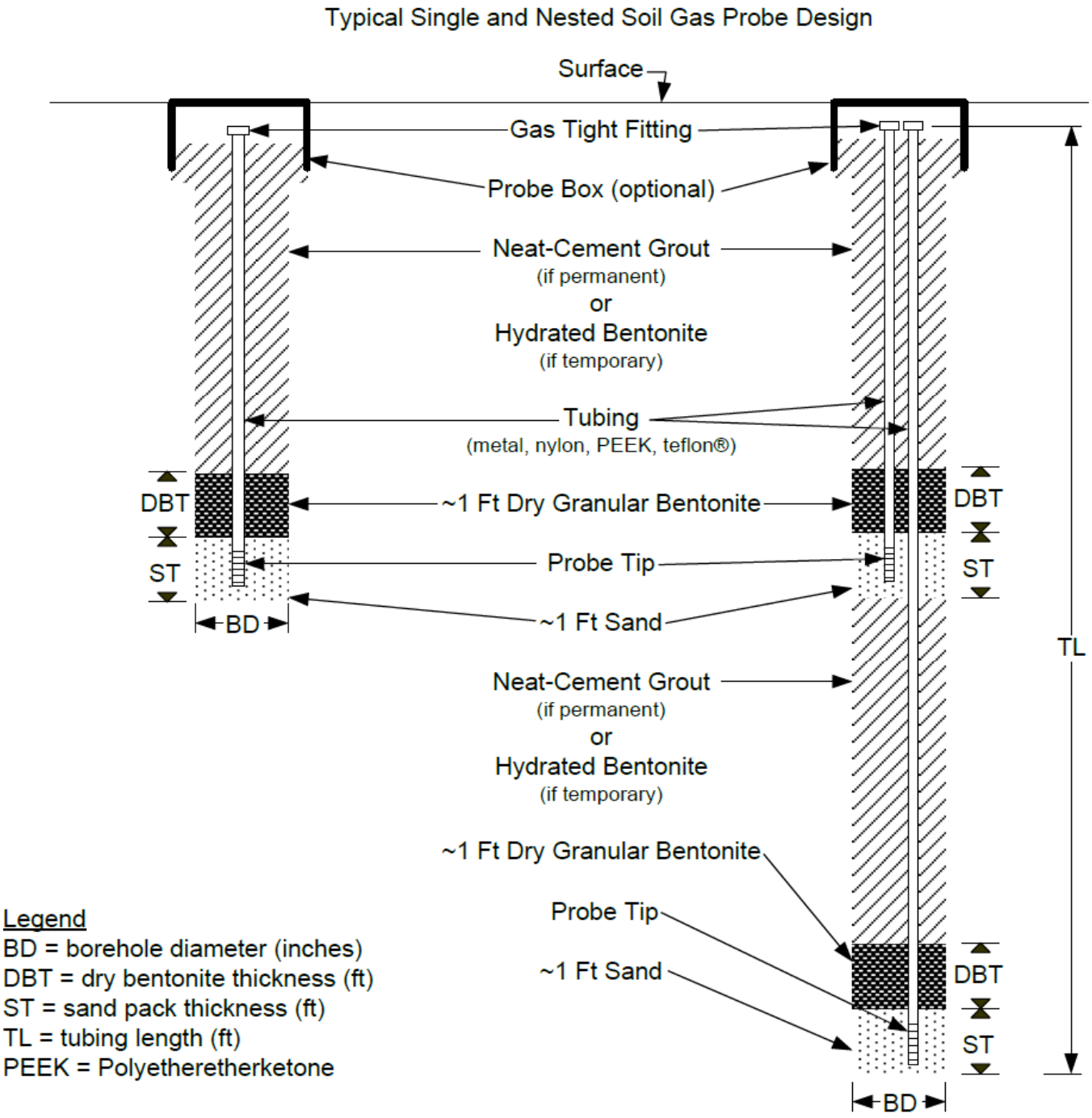


Figure 1 Source: *Advisory – Active Soil Gas Investigations* (CalEPA, 2015)

Field Standard Operating Procedure (FSOP)-A1
Supply Well Sampling Protocol

1.0 Sample Collection

Samples are collected from three former Fort Ord supply wells (Well 29(A), 30 (B), and 31 (C)[1]) operated by the Marina Coast Water District (MCWD). Samples from these wells are analyzed for VOCs by EPA Test Method 8260 SIM (selected ion monitoring) OUCTP A-Aquifer COC list on a quarterly basis[2]. Samples are collected in three 40 milliliter (mL) VOA vials pre-preserved with hydrochloric acid (HCl). The water from these wells is collected prior to treatment or chlorination; therefore, the addition of sodium thiosulfate as a preservative is not needed.

2.0 Sample Techniques

Upon arriving at the supply well, the MCWD field technician will inform the sampler if the well is on (pumping) or off. If the pump is on, the MCWD field technician will inform the sampler how long the well has been pumping. If the pump is off, the sampler should remain outside the building until the MCWD field technician has started the pump due to noise associated with the pump's initial start-up. Once the pump is running for a minimum of twenty (20) minutes, the sampler must open the sampling port, a small Teflon or copper tube coming from the main water flow pipe. The MCWD field technician can help locate the sampling port if the sampler is unable to identify it. Let the spigot run approximately one minute at high flow to flush the sampling port tube. A drain located on the floor near the spigot collects the discharged water. Adjust the flow rate downward until you can fill the 40mL VOA vials with no splashing or bubbling, letting the water flow down the inside of the VOA. Do not overfill or rinse the container or the preservative will be lost. The 40m: VOA vials should be completely filled to the point where the water's meniscus forms a convex shape above the lip of the container. Replace the container's cap and secure snugly making sure not to over tighten and check for headspace or bubbles. VOA vials are zero headspace and therefore if a bubble appears inside the bottle after capping, a new sample must be collected. The sample bottles are to be labeled, placed in a bubble wrap bag, stored in a Ziploc bag, and placed on ice in a sample cooler immediately. The chain of custody (COC), the IPAD, and daily field logbook shall be filled out completely prior to moving on to the next well.

[1] These wells are identified as FO-29, FO-30, and FO-31, respectively.
[2] Unless a well is inoperable and should be noted in the Log Book as such.

Field Standard Operating Procedure A2

OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements

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1.0 Sample Types

Project samples may be extraction well groundwater samples, Groundwater Treatment Plant (GWTP) process water samples, or quality control/quality assurance samples. Standard operating procedures for the collection of these water samples are described in this document.

1.1 Extraction Well Samples

Extraction well samples (standard field samples) will be generated to evaluate the effectiveness of the remedial action in containing the groundwater contamination plume, removing contaminant mass from the groundwater, and achieving remedial action objectives. Data generated will be applied to decision rules identified in the QAPP to determine operational status and sampling frequency for individual extraction wells.

1.2 GWTP Process Samples

GWTP process samples (standard field samples) will be generated to evaluate the effectiveness and efficiency of GWTP components in removing chemicals of concern (COCs) from extracted groundwater, determining the timing for replacing granular activated carbon (GAC) in the GAC vessels, and maintaining discharge limits for COCs in treated water.

1.3 Quality Control (QC)

Field QC samples will be generated to evaluate the precision, accuracy, and integrity of field sampling and laboratory analytical procedures. Quality control samples are introduced into the sample analysis stream along with environmental samples. The frequency of field QC sample generation is based on project Data Quality Objectives (DQOs), as well as the total number of samples submitted and the nature and intensity of the investigative process that is being monitored or evaluated. The following QC samples will be employed during the field program.

1.3.1 Trip Blanks

Trip blanks are prepared by the laboratory using contaminant-free water (e.g., nitrogen purged deionized water) which is poured into Volatile Organic Analysis (VOA) vials and shipped to Ahtna Environmental Inc. (Ahtna) by the laboratory. The laboratory also provides pre-cleaned and hydrochloric acid (HCl) acid-preserved sample containers for collecting water samples for Volatile Organic Compound (VOC) analysis. Trip blanks will accompany sample containers into the field and will be shipped back to the laboratory with every cooler that contains samples for VOC analyses. Trip blanks will be analyzed for all VOC analytes specified for environmental samples in the corresponding cooler.

1.3.2 Field Duplicate Samples

Duplicate samples are submitted to the contract laboratory for the purpose of assessing the effect of the sample matrix on analytical measurement precision.

The laboratory will not be informed as to the identity of duplicate samples and no special sample handling protocol will be employed during collection, shipment, or analysis of these samples. These “blind” duplicate samples will be submitted and analyzed on a frequency of one in ten of the total

environmental sampling effort for each matrix sampled. Areas of known contamination or critical sampling points may be preferentially selected for submittal as blind duplicates. Duplicate samples will be analyzed for the same parameters as the corresponding primary sample.

2.0 Field Documentation

Field activities and sample collection will be documented using the following forms and information as appropriate: sample label, chain of custody form, groundwater sampling form, well completion details, well development form, cooler receipt form, waste management label, and hazardous waste label. The purpose of standardized field documentation and sampling procedures is to maintain integrity of field documentation and field samples throughout the remediation process. Each field sample will be labeled and sealed immediately after collection. Sample identification documents will be carefully prepared to maintain control of sample disposition. Field sample custody procedures are described in Section 4.1. Standard procedures for documentation of field activities are presented below.

2.1 Field Logbooks

Field procedures relevant to sample collection and field activities will be recorded daily in permanently bound notebooks. Each individual in the field will maintain a bound field logbook with serially numbered pages. The logbook is signed and dated prior to daily initiation of field work. If logbook duties are transferred, the individuals relinquishing and receiving will both sign and date the logbook and record the transfer time. Logbook corrections are made by a single line strikeout of the incorrect entry and entering the correct information that is initialed by the person making the entry. If the correction is made at a later time or date, the correction date is also entered. Unused partial or whole logbook pages are crossed out and unused pages signed and dated at the end of each workday. All entries must be legible, in ink, and primarily factual in content. Hypothetical information can be entered but should be noted accordingly. Logbook entries may include the following information as necessary:

- Project name and number.
- Site name and location.
- Arrival and departure date/time.
- Name and affiliation of personnel onsite (including site visitors), and personnel contacted.
- Author name and date.
- Field instrument calibration methods and identification number.
- Chronology and location of activities.
- Sampling locations.
- Sample identification numbers, amount collected, sampling method and container (size/type) for each sample collected, including QC samples. Sample processing techniques such as filtration, compositing, and preservation techniques should be noted. Alternatively, this information may be contained on the COC form, groundwater sampling form, or other field form. The logbook will then contain a unique identifier linking the field log book entry to the field form.
- Date and time of sample collection, name of sampler.
- Field observations including weather conditions and applicable comments.

- Number of shipping coolers packaged and sent.
- Name and address of all receiving laboratories.
- Any modifications or deviations from quality assurance project plan.

Written reports of all significant non-routine events for field and laboratory work will be sent to the USACE Contracting Officer within 48 hours of occurrence. These reports will identify the problem, corrective action, and verbal written instructions from the USACE Project Manager (PM) to Ahtna regarding corrective action. Significant non-routine events are occurrences that impact cost of work, work schedule, work quality, and analytical data quality.

2.2 Sample Identification and Labels

2.2.1 Sample Identification

Two sample identifiers, the sample number and the station number, will be used to designate samples and sampling locations. Sample numbers will be used for coding, tracking, and reporting chemical data. Station numbers will encode sample type, site identification, and boring number or monitoring well sequence. Conventions for generating sample and station numbers are presented below.

The sample number is a coded identification designed to satisfy project and database criteria. Each sample number:

- Will contain up to 12 characters.
- Will be unique.
- Will be traceable to a specific sampling event.
- Will be traceable to a specific sampler.
- Will incorporate a specific site designation.
- Will not obviously indicate to the laboratory the sample depth, station number, or type of sample (i.e., original sample and duplicate).

All chemical data produced by the contract laboratory will be reported using the sample number. Samples will be numbered as follows (no spaces in actual sample numbers):

YR WK X SSS 000 Z

Where:

YR = Calendar year

WK = Week of the year

X = One-letter ID code assigned to each field sampler

SSS = Three-character site identification code: “OU2” or “212”

000 = Three-digit sequence number for each sample

Z = Assigned QC sample code

Assigned sample QC codes are as follows:

- A = Trip blank

- B = Not used for groundwater treatment system (GWTS) sampling
- C = Not used for GWTS sampling
- D = Field duplicate
- E = Not used for GWTS sampling
- F = Standard field sample

For example, sample number 1704M212015A represents the fifteenth sample collected by sampler "M" and is a trip blank (QC code A) collected at Sites 2/12 during Week 4 of 2017. Each sample collector will start with sequence number 001 and continue consecutively through 999. Field personnel are responsible for keeping track of their own sequence in the field logbook. Field audits will include checks of this sample numbering system to ensure that correct procedures are being followed.

Week numbers are assigned to week-long periods ending on Friday. For example, Week 4 of 2017 is the week ending January 27, 2017. Week numbers below 9 must contain a zero (i.e., 01 through 08). For aqueous samples, multiple sample containers for each discrete sample may be required to fulfill analytical requirements. In these instances, the same sample number will be used on all sample containers.

The station description is a sequence of characters designed to identify site-specific samples. Station descriptions will not be included on the laboratory copy of the chain of custody form. The station description field on the chain of custody form will be used to record the site, sample type, sequence number, and other relevant sample characteristics.

The convention for station description naming is as follows:

ST-SSS-000-XXX

Where:

ST = Sample type

SSS = Three-character site identification code (same as for sample numbering scheme)

000 = Station number unique to each station

XXX = Sample depth or aquifer

Station description names will not include spaces. Example sample type codes are as follows:

- EW = Extraction well
- MP = Multi-port well
- MW = Monitoring well
- SG = Soil gas
- SL = Sludge
- PZ = Piezometer
- TS = Treatment system
- WW = Wastewater
- VE = Vapor extraction

Sample depth may indicate the actual depth the sample was collected relative to ground surface or top of well casing (e.g. the pump intake depth), the port the sample was collected from in a multi-port well, or the aquifer the sample was collected from. Example sample depth codes for aquifers at the former Fort Ord are as follows:

- A = A-Aquifer
- 180 = Upper or Lower 180-Foot Aquifer

For example, station name EW-OU2-13-A represents an extraction well station 13 at the OU2 site with a sample depth in the A-Aquifer.

2.2.2 Sample Label

All samples will be properly labeled to prevent misidentification of samples. Preprinted sample labels will be provided. The label will be affixed to the sample container prior to transportation to the laboratory and will contain the following information:

- Project name, number, and location
- Site name
- Name of collector
- Date and time of collection
- Sample identification number
- Preservative, if any
- Requested test methods or analyses

2.3 Chain of Custody Record

A chain of custody (COC) record will be filled out for and will accompany every sample to the analytical laboratory for documentation of sample possession from the time of collection to sample receipt. A carbonless copy of the chain of custody form will be retained in the investigation files according to project number. The primary laboratory will upload copies of the cooler receipt forms and associated chain of custody forms to its LabLink website for review by the Project Chemist within 24 hours of sample receipt. The forms will contain the following information:

- Sample number or identification
- Name and signature of collector, sampler, or recorder
- Name, number, and location of project
- Project manager's name
- Date of collection
- Place of collection (station description)
- Sample type
- Analyses requested
- Dates and times of possession changes

- Signature of persons relinquishing and receiving sample
- Laboratory sample number, where applicable
- Date and time of laboratory sample receipt

2.4 Transfer and Review of Field Documentation

During site-specific field operations, copies of each field logbook page will be telefaxed or hand delivered to the Task Manager on a daily basis. In the absence of a facsimile, field staff will be in contact with the Task Manager, via mobile telephones.

At the end of each week of field operations, all field documentation will be copied, and originals sent to the Task Manager or Project Manager for review and verification. Original field documents will be kept in the project files. Verification and review of field documentation will include at a minimum, the following checks:

- Consistency of dates and times of activities; among the various field records and forms
- Consistency of sample location and identification documentation among the various field records and forms
- Accuracy and correctness of well completion details
- Correctness of sample preservation techniques

Errors or inconsistencies identified during the review process will trigger a nonconformance investigation to be conducted by the Project Chemist or Quality Control System Manager (QCSM). Appropriate corrective action will be implemented and documented if systemic errors are identified.

3.0 Groundwater Sampling

This section describes groundwater sampling procedures to be followed prior to, during, and after groundwater sample collection from monitoring wells. Procedures for collecting grab groundwater samples are described at the end of this section.

3.1 Sampling Preparation

Prior to sampling, the well vault or GWTS process sampling port will be examined for signs of tampering or deterioration and observations noted. After a well vault is opened, the Activity Hazard Analysis (AHA) may call for the air in the wellhead vicinity to be tested for organic vapors with the Photo Ionization Detector (PID) or Flame Ionization Detector (FID) and/or for explosive atmospheres with an oxygen/combustible gas indicator (see Appendix E of the Site Safety and Health Plan). Results will be recorded in the field notebook. (Note: well vault air testing is not required for routine groundwater sampling as long as previous results indicate that organic vapors or explosive atmosphere are not present). All measuring and sampling equipment will be decontaminated prior to use in any well (see Section 3.5).

Extraction wells that are not normally operated will be run to purge a minimum of three well volumes prior to sample collection. Pumped purge volumes will be estimated using the flow meter in the well vault. The volume of water purged and the withdrawal rates will be recorded. Purge rates will be sustainable and executed at a rate that minimizes drawdown to prevent water from cascading into the

well. Prior to sample collection, ports for extraction well and process sampling will be purged with the port valve completely open for a minimum of 1 minute to ensure stagnant water and any foreign matter or debris are discharged so a representative sample may be collected.

If a well is purged dry before three casing volumes have been removed, VOC samples will be collected immediately. Other samples will be taken after the well has recovered to within 80 percent of the static water level prior to purging, or after 4 hours, or when sufficient water volume is available to meet analytical requirements, whichever occurs first.

Pre-cleaned sample containers will be provided by the laboratory. The containers for each sample will be labeled in advance of the sampling event with the date, sample number, project name, sampler's name or initials, parameters for analysis (method numbers where possible), and preservation.

3.2 Sampling Procedures

After purging, samples will be collected using designated sampling ports in extraction well vaults or designated GWTS process sampling ports. Water samples will be collected carefully by discharging directly from the sample port to the appropriate sample containers.

Water samples for VOC analysis will be collected in VOA vials, which will be filled by inserting the sample port spout to the bottom of the VOA vial and keeping the spout beneath the surface of the liquid as it fills the vial until there is a convex meniscus over the neck of the bottle. The Teflon side of the septum (in the cap) will be positioned against the meniscus, and the cap screwed on tightly; the sample will be inverted, and the vial tapped lightly. The absence of an air bubble indicates a successful seal; if a bubble is evident, the sample will be discarded and the process repeated.

All sample bottles and equipment will be kept away from fuels and solvents. Gasoline (used in generators) will be transported in a different vehicle from the vehicle containing sampling equipment, sample bottles, etc. If possible, one person should be designated to handle samples and another person should operate the generators and refuel equipment, if required. Disposable gloves will be worn for each separate activity and then properly disposed. Care will be taken to avoid fuel spillage.

All samples will be packaged and transported appropriately, as described in Section 4.3.

3.3 Water-Level Measurement

The methods presented below are intended to produce water-level measurements that are consistent over multiple measurement events. Calibration and precision requirements for water-level measurements are summarized in Section 3.4.

Groundwater levels may be measured using an electrical sounder, a steel tape, or a pressure transducer. All water-level measurements will be taken from an obvious survey mark at the top edge of the well casing. Water levels will be measured using the following procedures.

Electrical Sounder

The standard equipment for making individual water-level measurements will be a battery-powered sounder. The sounder must have firmly affixed or permanent marks on the sounder line at regular intervals (minimum interval of 0.01 foot).

Calibration checks on the electrical sounder will be made periodically. The sounder markings will first be checked for the proper spacing by physically comparing the spacing with a graduated steel tape. Accuracy rechecks will be made after any incident that might alter the measuring capability of the instrument, such as cable stretching, entanglement, or sensor tip replacement.

Portions of the cable that are inserted in wells will be decontaminated after use according to the procedure described in Section 3.5. Sounders will be maintained in a clean and functional condition.

Steel Tape

A graduated steel tape (with 0.01-foot graduations) can be used for water-level measurements in conjunction with other methods and, when required, for a quality control check of other methods. The steel tape will be periodically checked for kinks, and if kinked tapes are found, the tape will be labeled as unusable and taken out of service. Portions of the tape that are inserted in wells will be cleaned after use according to the procedure described in Section 3.5. Tapes will be maintained in a clean and functional condition.

3.4 Sampling Equipment Calibration Procedures

Included is a description of the procedure or a reference to an applicable standard operating procedure, the calibration frequency, and the calibration standards used. All instruments and manufacturers' instructions and specifications are maintained in the project files. All instruments are calibrated prior to being sent to the field. Field calibration procedures will be documented in the Field Logbook.

Water-Level Measurement Instruments

Electrical sounder: Checked against steel surveyor's tape prior to initial use. Battery and sensitivity checked daily.

Graduated steel tape: Referred to new steel tape; manufacturer-supplied temperature correction is applied if appropriate for field conditions.

Pressure transducer: Factory calibrated once, in-house calibration checked with water columns prior to aquifer tests, and weekly field checks made against steel tape or electrical sounder.

3.5 Decontamination Procedures

All reusable equipment that may come in contact with potentially contaminated soil, sediment, or water will be decontaminated prior to use to reduce the potential for cross-contamination during field activities. Decontamination will consist of steam cleaning (high pressure, hot water washing); non-phosphate detergent wash; solvent rinse; distilled, deionized (DI), or clean water rinse; pesticide-grade methanol rinse; and final rinse with DI water, as appropriate.

The procedures for decontaminating sampling equipment are described below:

- Wash steel tapes, well sounders, transducers, and water quality probes in a non-phosphate detergent solution, and rinse in distilled or DI water, or wipe clean after each use, depending upon site conditions. Clean the portion of these devices inserted into wells with a mild non-phosphate detergent solution.

4.0 Sample Handling Procedures

Appropriate sample handling techniques are necessary to protect the samples and maintain sample custody protocol requirements following collection. Sample handling includes custody, container/preservative type, transfer, storage, and disposal.

4.1 Field Sample Custody

Standardized sample custody procedures will be followed through sample collection, transfer, storage, analysis, and ultimate disposal. Sample custody begins with shipment of the empty sample container sent to the office or site. All sample containers are shipped from the laboratory in sealed containers or cartons with appropriate seals and custody information. Sample quantities, types, and locations will be specified before the actual field work commences.

A sample is considered under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession
- The sample is in the sampler's view
- The sample is in a designated secure area after being in the sampler's possession

4.2 Sample Containers and Preservation

Samples should be collected and containerized in order of the analyte volatilization sensitivity. A preferred collection order is listed below:

- Volatile organic compounds
- Sulfate and chloride

Methods of sample preservation are intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light.

All sample containers will be properly labeled (see Section 2.2) and monitored for temperature control in the field and during laboratory transport and storage. Temperature blanks will be used in all coolers containing samples requiring preservation at reduced temperature (4°C).

4.3 Sample Transfer and Shipment

Samples will always be accompanied by a chain of custody record. When transferring samples, both the individuals relinquishing and receiving the samples will sign, date, and note the transference time on the chain of custody record. Samples will be packaged properly for shipment, including isolation of samples suspected of high chemical concentrations, and dispatched to the appropriate laboratory for analysis. Custody seals will be used when samples are shipped via courier service, and must be placed on the container so that the seals have to be broken before the container can be opened. The seal must be signed and dated by the field personnel. Custody seals are not deemed necessary when the samples will be in the continuous possession of project, field, or laboratory personnel. The chain of custody record(s) will accompany each sample shipment. Samples will be packaged for shipment as follows:

- Print the following information clearly in waterproof ink on the label; the test methods requested, the

preservative(s) used (if any), the sample number, the project number, the initials of the sample collector, and the date and time the sample was collected.

- Fill out field sample log and chain of custody record as described in Sections 1.2.1 and 1.2.3, respectively.
- Place each sample bottle or set of VOA vials in a separate plastic bag and seal the bag. Squeeze air from the bag before sealing.
- If using a plastic cooler as a shipping container, tape shut the drain plug from the inside and outside, and line the cooler with a large plastic bag. If sample containers are glass, place approximately 3 inches of inert packing material, such as asbestos-free vermiculite, perlite, or Styrofoam beads in the bottom of the container or wrap the sample containers in other appropriate protective packing material (e.g., bubble wrap. Other commercial shipping containers (cardboard or fiber boxes complete with separators and preservatives) may be used but should be preapproved by the USACE.
- Place the bottles upright in the lined plastic cooler and position to avoid contact during shipment. Cardboard separators may be placed between the bottles at the discretion of the shipper.
- Transport all samples to the laboratory on ice chilled to 4°C ± 2°C.
- Place additional inert packing material in the cooler to partially cover the sample bottles (more than halfway). If samples are required to be shipped to the laboratory with ice, place ice in double bags around, among, and on top of the sample bottles, fill the cooler with inert packing material, and tape the liner shut.
- Place paperwork going to the lab inside a plastic bag. Seal the bag and tape to the inside of the cooler lid. Include the original of the COC form in the paperwork sent to the laboratory. The last block on the COC form should indicate the over-night carrier and air bill number, if applicable. Fill out the air bill before the samples are handed over to the carrier. Notify the laboratory if the shipper suspects that the sample contains any other substance that would require laboratory personnel to take additional safety precautions.
- Close the cooler and tape it securely shut.
- Place at least two signed custody seals on the cooler, one on the front and one on the side. Additional seals may be used if the sampler or shipper deems necessary. Affix "fragile" and "this end up" labels on coolers, as appropriate.
- Samples may be hand delivered to the laboratory, transported by commercial or laboratory couriers, or shipped to the laboratory using an overnight shipper.

4.4 Laboratory Custody

A designated laboratory sample custodian will accept custody of the samples and verify that the information on the sample label matches that on the chain of custody form(s). Pertinent information as to sample condition, shipment, pickup, and courier will also be checked on the chain of custody form(s). In addition, a Cooler Receipt Form (e.g., cooler receipt form) will also be completed by the custodian and copies will be sent to the project chemist within 24 hours of sample receipt. On receiving samples at the laboratory, the temperature inside the cooler and of the temperature blank will be measured immediately after opening the cooler and the results recorded on the cooler receipt form. Information on

the date and time of receipt, method of shipment, and sample condition also will be recorded on this form. The custodian will then enter the appropriate data into the laboratory sample tracking system. The laboratory custodian will use the sample number on the sample label as well as assign a unique laboratory number to each sample. The custodian will then transfer the sample(s) to the proper analyst(s) or store the sample(s) in the appropriate secure area.

Laboratory personnel are responsible for the care and custody of samples from the time they are received through sample disposal. Data sheets and laboratory records will be retained by the laboratory as part of the permanent documentation for a period of at least 3 years.

Field Standard Operating Procedure A3
Low Flow Groundwater Quality Parameter Collection

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures for calibrating and operating the field equipment necessary for collecting groundwater stabilization parameters by low flow. Groundwater stabilization parameters are obtained by using electronic equipment and are required to meet calibration standards.

2.0 Equipment List

- Decontamination equipment including soap, de-ionized and tap water
- Health and safety equipment including safety glasses and nitrile/latex exam gloves
- Field logbook, indelible ink pens and field forms
- Tools to open wells
- Horiba U-50 Series multi-meter or equivalent
- Electronic water level meter such as the Solinst Model 101 or equivalent
- Rinse water receptacle and disposal area
- Horiba pH4 multi-calibration solution or equivalent
- Horiba oxygen-reduction potential (ORP) standard powder No. 160-22 or No. 160-51 or equivalent.
- Flow-through-cell/chamber for Horiba
- Dedicated or non-dedicated submersible low flow 12 volt Geosquirt pump or equivalent
- Vehicle battery to power pump with pump controller
- Sample tubing (dedicated or non-dedicated) 3/8 inch (”) or ½” inner diameter (ID) Polyethylene

3.0 Procedures

3.1 Multi-Meter Calibration

Water parameters are primarily recorded with the **Horiba U-50 Series** (Horiba) multi-meter (or equivalent). A wide variety of measurements can be obtained, but for groundwater stabilization parameter purposes only temperature, specific conductivity, dissolved oxygen (DO), pH, ORP, and turbidity are needed. All these parameters require calibration with the exception of temperature. According to the Horiba manual utilize approximately 200 milliliters (mL) of calibration fluid in the calibration cup. While calibrating turbidity, the lower fill line in the calibration cup is used. Remember to remove any protective caps from the sensors prior to calibration and use of the meter.

The Horiba instrument utilizes simultaneous Auto Calibration of **DO, pH, conductivity, and turbidity** with the standard pH 4 calibration solution. At a standard temperature of 25 degrees Celsius (°C); pH is

calibrated to 4.01, conductivity is calibrated to 4.49 milliSiemens per centimeter (mS/cm), DO is calibrated to 8.92 milligrams per liter (mg/L), and turbidity calibrated to 0 nephelometric turbidity units (NTU). Be sure the calibration solution is approximately the same temperature as the ambient air, if this cannot be confirmed, allow a one hour equilibration time. To perform auto calibration of the parameters listed above, follow the steps below:

1. Turn the Horiba unit on and let it warm up for approximately 20 minutes.
2. Remove the sensor guard and wash the sensor probe two to three times with deionized (DI) water.
3. Remove the transparent calibration cup.
4. Fill the transparent calibration cup to the "With TURB" labeled lower line with pH 4 standard solution.
5. Press the Horiba's "CAL" key or navigate to the Calibration menu to set the calibration mode.
6. Select "Auto Calibration".
7. Immerse the sensor probe in the transparent calibration cup.
8. Check that there are no air bubbles and the appropriate sensors are submerged.
9. Place the transparent cup with probe into the black calibration cup.
10. When all the sensor values have stabilized, press the "ENTER" key to start calibration.
11. Calibration is finished when the message "Cal complete. MEAS to measure" appears.
12. Press "MEAS" to begin reading parameters.
13. Finally, remove the calibration cup and rinse sensors and cup with DI water.

ORP is calibrated with another set of steps and materials as described below. ORP standard solution is not stable for more than an hour and therefore cannot be stored. For measuring low concentrations measurements may not be repeatable, start the measurement immediately after submersion.

1. Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51.
2. Add 250 mL of DI water and agitate the solution thoroughly (there will be some excess quinhydrone [a black powder] that floats on the surface when agitating the solution).
3. Fill the transparent calibration cup to the reference line (the upper line "Without TURB") with this ORP solution.
4. Wash the sensor probe two to three times with DI water then submerge probe into the transparent calibration cup.
5. Press the Horiba's "CAL" key or navigate to the Calibration menu to set the calibration mode.
6. Select "Manual Calibration".
7. Select "ORP".
8. Set the millivolts (mV) value of the ORP standard solution appropriate for specific temperature conditions as specified in the table below.

Temperature (°C)	ORP Powder 160-22	ORP Powder 160-51
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

9. Once the value has stabilized, press “ENTER” to start calibration.
10. Calibration is finished when the message “Cal complete. ENT to manual cal menu” appears.
11. Press “ENT” and then “MEAS” to begin reading parameters.
12. Finally, remove the calibration cup and rinse sensors and cup with DI water.

The auto multi-calibration and the ORP calibration of the Horiba should be performed daily. Record the auto multi-calibration and ORP calibrations were performed in the daily field logbook and other paperwork as necessary. Remember to replace any protective caps on the sensors following calibration or use of the meter and decontamination.

3.2 Site Control

- Upon arrival at groundwater monitoring well or sample station, position field vehicle in location convenient to access well as necessary for use of pump and field equipment while collecting parameters. Consider using the field vehicle to provide safety from traffic or shade from the sun.
- Establish a work area as needed. Lay out equipment in an orderly manner so as to avoid creating trip hazards. This is an important consideration in regards to cords and tubing. If necessary, use traffic cones or caution tape to define a work area and do not allow the public or subcontractors to enter your work area. Control activities in the sample collection work area so as to preserve the quality and integrity of the parameters being collected.

3.3 Water Level Measurement

Water level indicators (sounders) need to be calibrated and checked for accuracy. If more than one instrument is to be used, they should be checked by measuring a single well using both instruments to assure that measurements are consistent. A single water level meter can be checked against another tape (i.e. 100 foot reel measuring tape). Turn on unit and test the audible detector by depressing button on the site of unit before use.

Prior to leaving field office or before beginning water level measurements, decontaminate the probe and cable. Inspect well casing and locking cap for tampering, damage, maintenance needs or rust and make note of the conditions on the appropriate *Well Maintenance Form* and in the field logbook.

Use care when removing the well cap or J-plug and observe if there is a pressure difference between the closed well and atmospheric pressure. If project groundwater wells tend to build pressure attach a lanyard to well cap to eliminate the potential for injury from rapid pressure release. Never place body, face or head directly over a well while opening the well cap. Each well shall be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed. In the event a marking is not visible or well is not yet surveyed, take the water level reading from the north-side top of casing.

Don disposable silicone or nitrile exam gloves before lowering well sounder probe and measuring tape into the well. After decontaminating the sounder following water level measurement, properly dispose of exam gloves. A fresh pair of exam gloves should be used for each well or monitoring station.

Slowly lower probe into the monitoring well until contact with the water surface. An audible alarm on the water level meter will occur when the probe touches the water. Gently lift and lower the probe until an accurate measurement can be determined. Adjust well sounder sensitivity as necessary to get a good reading. Obtain the reading from the established mark on the well casing and measure to the nearest 0.01 foot. Record water level on the appropriate field forms.

After a water level measurement is collected at a groundwater monitoring well, decontaminate the measuring tape and reel. After decontamination is completed, properly secure the sounder in the sampling vehicle before moving on to the next location.

3.4 Equipment Setup

- Lie out and connect electric cords to vehicle battery from the pump. Lie out and connect pump discharge tubing from pump to flow-through-cell and from flow-through-cell to purge water storage tank. Keep tubing and equipment in shade whenever possible.
- Check the specifications for the well and place the pump at the specified depth after collecting a depth to water measurement, collecting any necessary analytical samples, and removing any hardware in the well. Make sure the pump is decontaminated accordingly with deionized water and soap between locations. Discharge tubing should be securely attached to the pump head and decontaminated or replaced between locations. Secure the pump electrical line and discharge tubing to the top of the well in a manner to avoid kinking once the desired depth has been reached. Record depth to water and depth to pump in the field log.
- Attach the end of the discharge tubing to the flow through cell that has been setup with the calibrated Horiba multi-meter. Attach the discharge of the flow through cell to a bucket for collecting purge water.
- Attach the end of the pump's electrical connector to the controller and connect the controller to the battery. The pump should start running once the controller is on and hooked up but it may

take a few minutes for water to come up to the surface. Adjust the flow accordingly if no water is being produced. Allow the flow through cell to fill before taking the first reading.

- Measure and monitor the flow rate with a graduated cylinder and record it as milliliters per minute (mL/min). Also record the cumulative volume purged as liters (L) and the water quality parameters temperature, pH, conductivity, dissolved oxygen, oxidation reduction potential, and turbidity.

Low-flow dedicated pump purging and sampling will consist of low flow 12 volt Geosquirt, or equivalent, low flow type pump to purge wells. This pump type is meant to pull water from approximately 120 feet below ground surface or shallower. If the well is too deep to pump adequately, lift the pump in the water column and record the pump depth on the field log.

The pumping rate will be maintained within the range of 0.25 to 1.0 liters per minute, limited to minimize the drawdown of the water table. Water level measurements will be collected before purging and after purging to ensure that drawdown in the well is not causing the well to go “dry”. Any well that should go “dry” during the course of sampling will be noted in the field notebook as well as on the appropriate field monitoring data sheet. After recharge time is allowed purging may be reattempted at a slower rate.

3.5 Groundwater Quality Parameter Collection

Parameters are measured from the wells by low-flow dedicated or non-dedicated pumping with a Horiba multi-meter or equivalent. Begin well documentation by filling out the top half of the water sampling log as needed.

The Horiba will be connected to a flow through cell. Parameter measurements are recorded on the sample log as follows:

- Time of measurement
- Pump intake depth (feet below top of casing)
- Flow rate (mL/min)
- Cumulative volume (L)
- Temperature (°C)
- Conductivity (mS/cm)
- DO (mg/L)
- pH (unitless)
- ORP (mV)
- Turbidity (NTU)
- Additional comments, if any

Each successive measurement will be recorded within 3-5 minutes. At least three measurements will be taken but there must be three successive readings stabilized according to the requirements below:

- pH: ± 0.1 units
- Electrical conductivity: ± 3% mS/cm

- ORP: ± 10 mV
- Dissolved oxygen: ± 10 percent mg/L
- Temperature: ± 1.0 °C
- Turbidity: ± 10% or less than 10.0 NTU

Well purging will be continued until the field parameters meet the criteria above, or until a maximum of three well volumes have been purged. An additional water level measurement should also be taken after monitoring is completed to assure the drop in water level is not excessive. Complete paperwork as needed.

3.6 Demobilization and Equipment Decontamination

- Stop purging the well, remove pump if non-dedicated and tubing and electrical line from the well. Re-install hardware and deploy passive diffusion bag (PDB) for next sampling event as necessary.
- Install the well cap or J-plug. Store dedicated discharge tubing in well or contain on vehicle as applicable. Decontaminate non-dedicated pump and tubing with water and soap, purging tubing by operating the pump.
- If possible, purge wells in order of lowest to highest contaminant of concern (COC) concentrations to reduce the chance of carryover from non-dedicated equipment.
- For wells located in a busy street, once all sampling equipment is packed, travel to the next scheduled location before decontaminating field equipment.
- Pumps should not be stored in an area where volatile sources (e.g., household cleaning chemicals, fuels, oils) are present; pumps shall not be stored without appropriate decontamination. Prior to use, the outside of the pump and tubing should be thoroughly rinsed with reagent grade water. Decontaminate all other equipment that contacted the well discharge water, including the water level sounder and the field meter flow-through-cell and probes.
- Collect all cords, tubing, tools and equipment and store in field vehicle in an orderly manner. Police site for trash and investigative derived waste and place in a trash bag.
- Collect any traffic control equipment while paying attention to potential traffic hazards. Never turn your back to oncoming traffic while on the street or when de-mobilizing traffic control from your work area.

3.7 Waste Management

Purged groundwater will be collected in temporary storage tanks, buckets or drums and transferred to proper storage tank for disposal at the Sites 2 and 12 groundwater treatment plant (2/12 GWTP). Non-hazardous solid wastes such as latex and nitrile gloves, plastic bags and paper towels will be collected and discarded to an approved municipal solid waste collection container.

Field Standard Operating Procedure A4
Downhole Meter Groundwater Quality Parameter Collection

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures for calibrating and operating the field equipment necessary for collecting groundwater quality parameters by downhole meter.

2.0 Equipment List

- Decontamination equipment including soap, de-ionized and tap water
- Health and safety equipment including safety glasses and nitrile/latex exam gloves
- Field logbook, indelible ink pens and field forms
- Rinse water receptacle and disposal area
- Water level meter
- Tools to open wells
- YSI 6-Series (6920) Multi-parameter Water Quality Sonde or equivalent downhole multi-parameter probe
- Calibration cup
- Probe guard
- Battery if required
- Ruler
- Barometer recommended
- Calibration solutions:
    - Conductivity: 10 milliSiemen per centimeter (mS/cm) YSI 3163 or 1 mS/cm YSI 3165 or equivalent
    - pH: pH 7 and pH 10 buffer solutions or pH 4 and pH 7 buffer solutions
    - Oxygen-reduction potential (ORP): Zobell standard recommended
    - Turbidity: two standards 0 nephelometric turbidity unit (NTU) and 100 NTU of formazin prepared by YSI, Hach, or other approved vendor.
    - Water for dissolved oxygen (DO)
- Ring stand recommended
- YSI 200 foot Sonde cable (for deeper wells)
- YSI 100 foot Sonde cable (for shallower wells)

3.0 Procedures

3.1 Downhole Meter Calibration

If the Sonde did not come with the sensors installed, install and activate the appropriate sensors per manufacturer's instructions. Remove protective caps on the sensors before calibration or use of the meter. If the meter is rented, calibration has already been performed by the vendor and field calibration is not

necessary during field events lasting less than 1 month. If the meter is rented, it is assumed that, unless warranted by erroneous field data, the meter will not require any maintenance.

To perform calibration of the Sonde, follow the general procedures below or specific manufacturer directions.

1. If installed, remove the Sonde probe guard.
2. Use the calibration cup supplied with the Sonde for all calibrations.
3. Rinse the Sonde probe and calibration cup with water and shake off excess.
4. Rinse the Sonde probe and calibration cup with a small amount of calibration solution if there is sufficient volume.
5. While calibrating the Sonde can be upright or inverted, but the sensors should be fully submerged.
6. Turn on the YSI meter and select Calibrate on the menu.

The following approximate volumes of calibration solution are to be used (check calibration solution and meter directions).

- Conductivity: 320 milliliters (mL) upright (150 mL inverted)
- Dissolved Oxygen: 1/8 inch (”) water vented to air
- pH/ORP: 200 mL upright (150 mL inverted)
- Optical sensors (turbidity): 225 mL upright (do not calibrate inverted)

7. Fill the calibration cup with the appropriate amount and type of calibration standard.
    a. For conductivity, be sure the probe is dry prior to immersing and no salt deposits. Make sure the sensor is completely immersed past the vent hole. Rotate the Sonde to remove air bubbles from sensor. Allow the temperature to equilibrate for approximately one minute after submersion.
    b. When calibrating dissolved oxygen, place 3 millimeters (mm) or 1/8” of water in the calibration cup. Engage only one or two threads of the calibration cup to vent to air. Loosen the bottom cap if the probe is inverted. Do not immerse DO or temperature sensors in the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for temperature equilibration.
    c. For pH, allow approximately one minute for temperature stabilization.
8. Screw the cup onto the probe. It is recommended to use a ring stand to prevent the probe from falling over.
9. In the Sonde Menu select “Calibrate”.
10. Input the calibration type you are performing (i.e., conductivity, Dissolved Oxygen, pH, ORP, Turbidity).
    a. Select Specific Conductivity for Conductivity calibration.
    b. Calibrating for percent (%) DO will also calibrate for milligrams per liter (mg/L) DO.
    c. For pH, enter 2-point calibration for two buffer solutions.
    d. For turbidity, enter 2-point calibration.

11. Once a parameter is selected, some will have a number that appears in parenthesis, which is the default value to be used for calibration.
12. Check the number is correct on the calibration standard being used, and press Enter or change the calibration value accordingly.
    a. For pH you must enter the calibration value, which is usually temperature dependent.
    b. For DO, you must enter the current barometric pressure. If you do not have a barometer, check the local weather station and calculate according to actual elevation. Barometric pressure must be entered in mm Hg. If given in in Hg, multiply by 25.4. To calculate for elevation take the barometric pressure at sea level in your area and subtract the following; divide your location's altitude in feet above sea level by 100 and multiply by 2.5.
    c. For turbidity, the 0 NTU standard must be calibrated first.
13. A real time value will display, with all enabled sensors reading values, not just the sensor currently being calibrated.
    a. For turbidity activate the wiper function to remove any bubbles if necessary.
14. Observe the stabilization of the sensor value being calibrated. When the reading stabilizes for approximately 30 seconds, press Enter to accept calibration.
15. Press Enter to return to the Calibration menu, and proceed to the next calibration. Repeat steps 3-13 for each calibration standard. For pH and turbidity 2-point calibrations, the Sonde will prompt you for the second calibration solution. Dry the Sonde between readings.
16. Once completed rinse and dry the Sonde.

The Sonde is now ready to be used for readings throughout the day. Recalibrate as necessary if field conditions present erroneous data or the Sonde experiences mechanical issues. Record the calibrations were performed in the daily field logbook and other paperwork as necessary. Remember to replace any protective caps on the sensors following calibration or use of the meter and decontamination.

3.2 Site Control

- Upon arrival at groundwater monitoring well or sample station, position field vehicle in location convenient to access well as necessary for use of pump and field equipment while collecting parameters. Consider using the field vehicle to provide safety from traffic or shade from the sun.
- Establish a work area as needed. Lay out equipment in an orderly manner so as to avoid creating trip hazards. This is an important consideration in regards to cords and tubing. If necessary, use traffic cones or caution tape to define a work area and do not allow the public or subcontractors to enter your work area. Control activities in the sample collection work area so as to preserve the quality and integrity of the parameters being collected.

3.3 Water Level Measurement

Water level indicators (sounders) need to be calibrated and checked for accuracy. If more than one instrument is to be used, they should be checked by measuring a single well using both instruments to assure that measurements are consistent. A single water level meter can be checked against another tape

(i.e. 100 foot reel measuring tape). Turn on unit and test the audible detector by depressing button on the site of unit before use.

Prior to leaving field office or before beginning water level measurements, decontaminate the probe and cable. Inspect well casing and locking cap for tampering, damage, maintenance needs or rust and make note of the conditions on the appropriate *Well Maintenance Form* and in the field logbook.

Use care when removing the well cap or J-plug and observe if there is a pressure difference between the closed well and atmospheric pressure. If project groundwater wells tend to build pressure attach a lanyard to well cap to eliminate the potential for injury from rapid pressure release. Never place body, face or head directly over a well while opening the well cap. Each well shall be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed. In the event a marking is not visible or well is not yet surveyed, take the water level reading from the north-side top of casing.

Don disposable silicone or nitrile exam gloves before lowering well sounder probe and measuring tape into the well. After decontaminating the sounder following water level measurement, properly dispose of exam gloves. A fresh pair of exam gloves should be used for each well or monitoring station.

Slowly lower probe into the monitoring well until contact with the water surface. An audible alarm on the water level meter will occur when the probe touches the water. Gently lift and lower the probe until an accurate measurement can be determined. Adjust well sounder sensitivity as necessary to get a good reading. Obtain the reading from the established mark on the well casing and measure to the nearest 0.01 foot. Record water level on the appropriate field forms.

After a water level measurement is collected at a groundwater monitoring well, decontaminate the measuring tape and reel. After decontamination is completed, properly secure the sounder in the sampling vehicle before moving on to the next location.

3.4 Equipment Setup

Remove any sample or hardware from the well and allow settling time before deployment of the downhole meter, approximately five minutes. Remove hardware and take water level readings in a manner to minimize disturbance of the water column in the monitoring well, lower and remove equipment slowly.

Be sure the Sonde and cables have been decontaminated prior to deployment in the monitoring well. Connect the Sonde to the power source if needed and connect communication cable from the Sonde to the probe.

Remove the probe guard and any protective sensor caps before using the Sonde. After calibration of the meter, confirm the sensors and parameters that are needed (turbidity, temperature, DO, ORP, and conductivity) are all reading on the instrument display. Replace the probe guard and keep in place during deployment. Check the pump intake depth for the current monitoring well and attach the correct length of Sonde cable to the meter (100 foot or 200 foot cable available).

Deploy the meter into the monitoring well and secure at the top of the well once the appropriate depth has been reached as to avoid kinking. Attempt to not disturb the water column too much while deploying by lowering the meter slowly. Allow settling time before collecting parameters, approximately two minutes.

3.5 Groundwater Quality Parameter Collection

On the YSI meter menu, Select Run. Choose Discrete Sampling on the meter's menu. Discrete sampling is used for spot sampling and short term sampling. In the Discrete Sampling Menu, set the appropriate sample interval sample time length. The default sample interval is four seconds and is appropriate for most discrete sampling. Optionally, identify the location by entering a filename and site name. Then select Start Sampling. Once the sample interval time has passed (4 seconds), the data will be displayed and it can be saved by selecting Log Last Sample.

When using the downhole meter, place the meter at the specified pump depth and record one measurement on the field paperwork once stabilized. If no other readings are required, remove the Sonde and cable from the monitoring well. Replace the hardware and deploy a passive diffusion bag (PDB) as necessary for the next sampling event. Replace the well cap and secure well.

3.6 Equipment Decontamination and Waste Disposal

Decontaminate the Sonde, meter cables, and all sensor probes with deionized water and a mild detergent. A small brush may be used on the sensors if necessary. The cable connector port must always be covered to prevent moisture from entering. If the cable is not connected cover the port with the pressure cap.

For short term storage place approximately 0.5 inches of water in the calibration or storage cup and place it on the Sonde. The use of a moist sponge is also acceptable instead of water. Do not immerse the sensors. The purpose is to keep the air in the cup at 100% humidity. Any type of water may be used such as tap water, distilled water, or deionized water. Make sure the cup is on tight to prevent evaporation. Check periodically to make sure there is still water/moisture present. For Sondes with level sensors, keep the tube sealed and dry.

Containerize any decontaminate water and dispose at the Sites 2 and 12 groundwater treatment plant (2/12 GWTP). Bag up any non-hazardous solid wastes, such as disposable gloves and paper towels, for disposal in a garbage receptacle.

Source Test Protocol

Former Fort Ord

Monterey, CA

Thermal Treatment Unit (TTU)

Prepared For:

Ahtna Global, LLC
9699 Blue Larkspur Lane, Suite 203
Monterey, California, 93940
Attn: Eric Schmidt

Prepared By:

BEST ENVIRONMENTAL
339 Stealth Court
Livermore, CA 94551
Phone (925) 455-9474
Fax (925) 455-9479
Email: bestair@best-enviro.com

Date Issued: April 1, 2025

Source Test Information

General Information

Source Owner:	US Army
Source Location:	Former Fort Ord Operable Unit 2 (OU2) Landfill Monterey Bay, CA
Contact:	Eric Schmidt, Ahtna Environmental, Inc.
Phone:	(831) 582-1348
Source Description:	Thermal Treatment Unit
Test Parameters & Limits:	NOx: 0.06 lbs/MMBtu CO: 0.4 lbs/MMBtu THC: 0.03 lbs/MMBtu NMOC: 98% DRE SOx: 2000 ppm Fuel Sulfur: 50 grs/100 scf
Source Testing Firm:	**BEST ENVIRONMENTAL** 339 Stealth Court Livermore, CA 94551
Phone:	(925) 455-9474
Email:	bestair@best-enviro.com
Contact:	Bobby Asfour
Proposed Testing Date(s):	April 29 2025
Test Start Time:	~10:00 A.M.
Analytical Laboratories:	**Eurofins/Air Toxics Ltd. (VOC's, Fixed Gases & Sulfur)** 180 Blue Ravine Road Suite B Folsom, CA 95630 Phone: (800) 985-5955 x 1039

1.0 Introduction:

Annual source testing of the TTU is conducted to demonstrate that the TTU operates efficiently and meets air quality regulations for emissions. The TTU remedy is being performed under CERCLA (42 USC 9601 et seq.) as amended by SARA. As such, the MBARD does not have jurisdiction and a permit for operating the TTU and exhaust stack is not required; however MBUAPCD Rule 207 and Rule 1000 are identified as applicable or relevant and appropriate requirements in the OU2 Landfills ROD (Army, 1994) and the substantive permit requirements were met during the reporting period. Meeting these objectives will require NOx, CO and THC/NMOC emission testing to be performed at the exhaust outlet of the TTU. The TTU fuel testing is required for NMOC, speciated VOCs, Total Sulfur as H_2S & composition (including fixed gases & BTU/HHV).

2.0 Emission Source Information:

Ahtna Environmental (Ahtna) operates one TTU at the former Fort Ord Landfill. The TTU is used as a control device for removing the landfill gas created by the underground solid waste. The TTU stack will be equipped with proper sampling ports that meet and/or exceed the minimum location criteria of 2 stack diameters downstream from the burners and 0.5 diameters upstream from the stack exit. The sample ports will be accessed using a 40-foot boom-lift.

The TTU inlet gases will be accessed with a sample tap located downstream of the flame arrestor.

The flare will be operated at a flow rate of ~95 SCFM and an operating set point of ~1,650 deg-F during the testing. The quality of the landfill gas is ~36% (by volume) methane.

Description	Limits
Thermal Treatment Unit	NOx 0.06 lbs/MMBtu CO 0.4 lbs/MMBtu SO_2 2000 ppmv Inlet total sulfur 50 grains/100scf THC 0.03 lbs/MMBtu & DRE ≥ 98%

3.0 Source Testing Program Description:

Triplicate 40-minute test runs will be performed at the TTU outlet for O_2, NOx, CO, THC, CH_4 & NMOC. Two samples of the TTU inlet gas (landfill gas) will be collected and analyzed for fixed gases (O_2, CO_2, N_2 & C_1-C_6+), BTU/HHV, speciated VOC and Sulfur compounds (AP-42 Table 2.4-1). A single outlet sample will be collected and analyzed for speciated VOC. For each test run the stack volumetric flow rate will be calculated from the corrected meter fuel flow, BTU/HHV and stack oxygen concentration. During each test run all relevant operating data (gas flow and operating temperature) will be monitored and recorded.

A mass balance calculation will be used to determine the outlet SO_2 emission rate according to EPA Method 19.

Overview of Sampling-Flare

Parameter	Location	Methods	Duration	# of Runs
NOx, CO and O_2	Exhaust	EPA 7E, 10 & 3A	40 mins	3
THC, CH_4 & NMOC	Exhaust	EPA 25A	40 mins	3
Speciated VOCs	Exhaust	EPA Method TO-15	grab	1
Flow Rate	Exhaust	EPA 19	40 mins	3
Speciated VOCs	Inlet	EPA Method TO-15	grab	2
Speciated Sulfurs	Inlet	ASTM D-5504-98	grab	2
Fuel analysis (BTU, O_2, CO_2, N_2, C_1-C_6+ & NMOC*)	Inlet	ASTM D-1945-96	grab	2
Fuel Flow Rate	Inlet	Metering System	40 mins	3

All laboratory gas samples will be collected into silco lined summa canisters and shipped by Ahtna personnel.

4.0 Source Testing Procedures:

This section is intended to provide an overview of the sampling strategy and does not attempt to summarize the sampling procedures, which are described in detail in the reference methods.

EPA Method 1 (Traverse points), EPA Method 3A, 7E and 10 (O_2, NOx, and CO), EPA Method 25A (THC/NMOC), and EPA Method 19 will be used to determine outlet emission rates. A single sample of the exhaust will be collected and analyzed using EPA Method TO-15 (speciated organic compounds). Two LFG samples will be collected and analyzed using ASTM D-1945 (O_2, CO_2, N_2, C_1-C_6+ & BTU/HHV), EPA Method TO-15 (speciated organic compounds) and ASTM D-5504 (speciated inorganic compounds).

Outlet VOC analysis may consist of continuously analyzing total hydrocarbons (THC) at the exhaust with a FID analyzer. If applicable an integrated outlet sample will be collected at the exhaust and will be sent to a lab for methane and ethane analysis. The appropriate calibration checks will be performed prior and throughout the sampling. VOC will be assumed equal to THC or total non-methane/non-ethane hydrocarbons.

Exhaust SOx emissions will be calculated using mass balance calculations based on the measured inlet total sulfur content as allowed by EPA Method 19.

EPA Method 1. This method is used to determine the duct or stack area and appropriate traverse points that represent equal areas of the duct for sampling and velocity measurements. The point selection is made based on the type of test (particulate or velocity), the stack diameter and port location distance from flow disturbance.

For the Continuous Emission Monitoring procedures (EPA Methods 7E, 3A, & 10), a sample is extracted from the exhaust stack conditioned and analyzed by continuous monitoring gas analyzers in a test van. The sampling system consists of a stainless steel sample probe, heated Teflon sample line, glass-fiber particulate filter, glass moisture-condensation knockouts, Teflon sample transfer tubing, diaphragm pump and a stainless steel/Teflon manifold and flow control system. A constant sample and calibration gas supply pressure of 5 PSI is provided to each analyzer to avoid pressure variable response errors. The entire sampling system is leak checked before and after the sampling program. The BE sampling and analytical system is checked for linearity with zero, mid and high span calibrations, and is checked for system bias at the beginning and end of each test run. System bias is determined by pulling calibration gas through the entire sampling system. Individual test run calibrations will use the calibration gas that most closely matches the stack gas effluent. The calibration gases will be selected to fall approximately within the following instrument ranges; 80 to 90 percent for the high calibration, 40 to 60 percent for the mid range and zero. An additional low NOx calibration gas in the 20 to 30 percent range may also be used. Zero and calibration drift values and system bias will be determined for each test run.

The reference method system and test results will meet the following criteria:

Parameter	Limits
System Criteria	
Instrument Linearity	± 2% Calibration Span
System Bias	± 5% Calibration Span
Calibration Gas	± 2% Value
NO_x converter efficiency	> 90%
Test Criteria	
Instrument Zero Drift	± 3% Calibration Span
Instrument Span Drift	± 3% Calibration Span

A 12-point traverse will be performed through the two available sample ports according to EPA Method 7E.

EPA 25A (THC by FID) is an accepted method for the determination of THC. A flame ionization detector (FID) total hydrocarbon continuous monitor is used for the sampling. The sampling and calibrations are performed through an all heated sample line connected directly to the THC analyzer without the removal of moisture. The FID in the analyzer is heated to 185 ºC. The calibration gases are selected to fall within the following instrument ranges; 80 to 90 percent for the high calibration, 45 to 55 percent for the mid range calibration, 25 to 35 percent for the low range calibration and zero. Zero and mid calibration drift values are determined for each test run. A methane cut can be performed by passing stack gas through activated charcoal to determine stack methane concentration. Bag samples will be collected through activated charcoal during each run and analyzed at the end of each run with the THC analyzer.

EPA Method 25A will meet the following QA/QC method requirements:

System Criteria

Instrument Linearity ≤ 5% Calibration Gas Conc.

Test Criteria

Instrument Zero Drift ≤ 3% Span Range
Instrument Span Drift ≤ 3% Span Range

The following continuous monitoring analyzers or equivalents will be used:

Parameter	Make Model	Principle
NO_x	CAI 600CLD	Chemiluminescence
O_2	CAI 100P	Paramagnetic
CO	TECO 48i	GFC/NDIR
THC/CH_4	CAI 300M	Flame Ionization Detector

The following expected concentrations and calibration ranges are proposed. Certain gases and instrument ranges may be changed depending on availability and stack concentrations at the time of testing.

Anticipated Emissions & Test Van Measurement Ranges

	Expected	
NO_x	15 ppm	Range 0-50 ppm
O_2	12.5%	Range 0-25%
CO	<10 ppm	Range 0-50 ppm
THC/CH_4	<10 ppm	Range 0-100 ppm (as methane)

Anticipated Calibration Gas Concentrations

	Low Range	Mid Range	High Range
NO_x	N.A.	22.5 ppm	45 ppm
O_2	N.A.	12.5%	21.0%
CO	N.A.	25 ppm	45 ppm
THC/CH_4	25.0	45	85

All calibration gases are EPA Protocol #1 rated or are traceable to the National Institute of Standards and Technology. Calibration gas certificates will be included in the final test report. The analyzer data recording system consists of a digital strip chart and a computer Data Acquisition System (DAS).

EPA Method 19 is used to determine stack gas volumetric flow rates using oxygen-based F-factors. F-factors are ratios of combustion gas volumes generated from heat input. The heating value of the fuel in BTU per cubic foot is determined from lab analysis of the fuel gas samples using ASTM D-1945/3588 gas chromatography analytical procedures. Total fuel consumption for the flare is monitored on the systems control panel. During each test run gas readings and samples were taken and used for determining the stack flow rate. The total cubic feet per hour of fuel multiplied times the BTU/cf provides million BTU per hour (MMBtu/hr) heat input. The heat input in MMBtu/hr is multiplied by the F-factor (DSCF/MMBtu) and adjusted for the measured oxygen content of the source to determine volumetric flow rate. The flow rates are used to determine stack emission rates.

EPA Method TO-15 & D-5504 analysis is used to determine concentrations of Organic and inorganic compounds including Non-methane Organic Compounds (NMOC) and sulfurs compounds. Inlet gases are filled into tedlar bags in triplicate corresponding to the test program. The bags are labeled respectively then sent to a laboratory and analyzed for NMOC and speciated compounds using GC/MS (gas chromatography/mass specrometer) within 72 hours and GC/SCD (gas chromatography/Sulfur Chemiluminescence Detector) within 24 hours for sulfur.

EPA Method ASTM D-1945 & D-3588 analysis is used to determine the composition of gaseous fuels (e.g. Methane, fixed gases & BTU Content). Inlet gases are filled into a tedlar bag, the bag is labeled respectively then sent to a laboratory and analyzed for fixed gases, methane and C_1-C_6 using GC/FID (gas chromatography/flame ionization detector). Each compound has calorific values that are used to calculate the combustion factors.

5.0 Project organization/key personnel:

The table below lists the positions and responsibilities of the personnel potentially assigned to this project.

Project Organization

Name	Position	Responsibilities
Bobby Asfour	Project Manager	Project Overview, Collection of all field data and operational data, Data reduction and Report Writing
Edward hernandez	Source Test Technician	Sample collection, Chain of Custody
Eurofins-Air Toxics Inc.	Lab Supervisor	Receipt of Samples, Sample analysis, Lab report production

The Project Manager is the primary person responsible for the outcome of this project. He leads the sampling team in the field, interacts with the client during testing and is responsible for gathering all data necessary for completing the report. Upon the completion of the fieldwork, he completes any Chain of Custody documentation and submits samples to the laboratory for analysis. He then reduces the data and prepares the report.

The Source Test Technicians are responsible for performing the actual field emissions tests. They are responsible for performing the emissions tests as per the approved test methods.

The Laboratory Supervisor is responsible for receipt, analysis and disposition of samples. He is also responsible for all laboratory method specific QA/QC procedures.

BE is an approved independent contractor for the California Air Resources Board (CARB), which is a national leader in the development and implementation of progressive emissions monitoring and documentation programs. BE is also affiliated with the Air and Waste Management Association (AWMA), Professional Environmental Marketing Association (PEMA), Source Evaluation Society (SES) and Air Pollution Training Institute (APTI).

6.0 QA & QC Procedures:

QA/QC Program: All quality assurance and quality control procedures will be followed as prescribed in the appropriate methods and Ahtna Quality Assurance Project Plan Former Fort Ord, California, Volume 1 Appendix D, Draft Final Revision 1 Operable Unit 2 Landfills.

Adherence to QA/QC procedures during field test preparation and field sampling will be the responsibility of the QA/QC Officer and/or Project Manager. This test program would include all QA/QC procedures specified in the test methods (equipment calibration, field data recording, contamination control and record keeping). Analytical QA/QC protocol will be the responsibility of the Analytical Liaison (Ahtna), and the laboratory manager and QA/QC coordinator assigned to this program by the laboratory Ahtna has subcontracted. Any deviations from stated protocols not mentioned herein would be discussed with the appropriate individuals prior to implementation.

Chain of Custody: A sample is considered to be under a person's custody if (1) if in a person's physical possession, (2) in view of the person after he has taken possession, (3) secured by that person that no one can tamper with the sample, or (4) secured by that person in an area which is restricted to authorized personnel. The following steps are taken to ensure sample identification and integrity:

1) Sample labels (identity, #, date, time)

2) C.O.C. seals (with sample #)

3) Field sample log book and field notes

4) C.O.C. record and analysis request sheet

5) Shipping papers (Courier, Fed. Ex.)

6) Receiving/Log-in (signed receipt of samples and their condition)

Once the sample has been received in the laboratory and the status of the sample integrity has been determined, the lab QA/QC supervisor is responsible for care and custody. The lab should be prepared to testify to the possession and security of the sample until analysis is complete.

In addition to the QA/QC procedures mentioned, BE uses EPA Protocol or 1% NIST Traceable calibration gases.

7.0 Source Test Report:

Data reduction/reporting procedures: All data reduction is performed using Excel spreadsheet programs developed by BE. The report will be written by a senior project manager and will be reviewed by his peers. All supporting documentation, field data sheets, lab reports, lab and field QA/QC reports, emission calculations, etc., will be included in the final report. Calculations are contained in the referenced methods and in the APCD/AQMD source Test Procedure Guidelines where applicable. The expected date for a final report is approximately two weeks after the analytical work is completed. The analytical turn around time is approximately two to three weeks.

Tabular results summary will be presented showing the following:

- NOx, ppmvd, lbs/hr, lbs/MMBtu
- CO, ppmvd, lbs/hr, lbs/MMBtu
- VOC, ppmvd, ppmvd @ 3% O_2, lbs/hr, lbs/MMBtu, DRE
- THC & CH_4, ppmvd, lbs/hr, lbs/MMBtu
- SOx, ppmvd, lbs/hr (Calculated from Fuel Sulfur)
- Fuel Total Sulfur, ppmvd, grains/100scf
- LFG Flow Rate, scfm, MMBtu/hr
- Stack Flow Rate, DSCFM

All ancillary information will be included with the report; process information, field data sheets, strip charts, calculations, equipment calibrations, chain of custody information, laboratory analytical results.

Submitted by,



Bobby Asfour
Principal/QSTI

Field Standard Operating Procedure (FSOP) A6

SVE Treatment System Sampling

Since Site 12 is located in a public retail location, the likelihood of sampling site visitors is high. Visitors to the sampling site may include shareholders such as project personnel, clients, regulators, property owners or managers, property employees, property customers, other temporary site workers (e.g., construction workers, delivery drivers, painters, landscapers, etc.), or members of the public. If there are visitors to the site during sampling who ask questions, direct them to the BRAC Office Community Relations department or fortordcleanup.com. Unauthorized visitors may not enter a safety exclusion zone. Notify project manager of any visitor encounters.

I. Equipment List

- Personal protective equipment including safety vest, sun/wind protection (if necessary), steel-toe boots and nitrile gloves
- 1-Liter SUMMA® canisters, vacuum gauges, and fittings. Order extra equipment and materials in the event of failure during checkout and use.
- 1/4" Nylaflow® tubing and PTFE tape
- Clamps and tools
- Field logbook, indelible ink pen, field forms and camera.

II. Procedure

1) Wear new disposable gloves to prevent contamination during leak testing, and dispose of gloves after each test, in a trash bag for proper disposal. Wear new gloves for each VOC sampling event and location.
2) Confirm the valve on the SUMMA® canister is closed (knob should be tightened clockwise).
3) Remove the brass cap and attach the closed-loop vacuum gauge with the appropriate size wrenches.
4) Open the SUMMA valve to verify there is sufficient vacuum greater than -25 inches mercury (inHg) and that the vacuum does not decrease within 15 minutes, which would indicate a leak in the sampling train of the SUMMA® canister. If a leak is detected at any time, resample using all new sampling equipment; re-used canisters may have been contaminated (use professional judgement). Record the results of this shut-in test on the field logbook and sampling forms.
5) Record the SUMMA® canister vacuum after a passed shut-in test is completed as "Initial Vacuum" on the Chain of Custody form, field forms, and in the field logbook.
6) Close the SUMMA® valve and remove the brass cap on the manifold.
7) Attach an approximately 1-foot long piece of 1/4" Nylaflow® tubing with the compression fitting and Swagelok®. Use wrenches to assure a tight seal, but do not over-tighten.

8) Wrap the Swagelok®- Nylaflow® tubing union with PTFE tape.
9) Insert the tubing into the sample port at the SVE wellhead with the sample valve off.
10) Open the SUMMA® canister valve to make sure there are no leaks in the system. A leak will be identified by any vacuum drop on the canister gauge, whereas a leak free system will exhibit a stable vacuum reading for a period of 2 minutes.
11) If a leak is detected, close the SUMMA® canister valve. Re-tighten all fittings then repeat the above step with a new SUMMA® canister.
12) If no leak is noted, open the sample port valve and allow at least 3 minutes for the SUMMA® canister to fill.
13) Verify the final vacuum of the SUMMA® canister (repeat steps 2 through 4 above). For grab samples, the ending vacuum may be close to ambient pressure (0 inHg).
14) Record the SUMMA® canister final vacuum after sampling is completed as “Final Vacuum” on the Chain of Custody form, field forms, and in the field logbook.
15) Only perform VOC monitoring on the SVE wells and SVE system influent and effluent monitoring points while the SVE System is in operation to ensure proper purging.
16) Tubing associated with VOC sampling may be designated to one location or disposed of and new tubing used at the next VOC sampling event based upon event conditions.

Field Standard Operating Procedure A7

Treatment System Flow Meter Use

I. Equipment List

- Personal protective equipment including safety vest, sun/wind protection (if necessary), steel-toe boots and nitrile gloves
- Anemometer
- PTFE tape
- Tools
- Field logbook, indelible ink pens, field forms and camera

II. Procedure

1) The SVE System must be running prior to taking anemometer readings.
2) A monitoring port is located at the SVTU influent. The monitoring point will be located at least five pipe diameters away from any bend in the conveyance piping or any valve.
3) PTFE tape is wrapped around the anemometer to ensure a good seal is made when inserted in to the monitoring port.
4) The anemometer is powered on using the “On/Off” button and the probe is inserted into the port with the probe perpendicular to air flow.
5) Use the “Temp/Velocity” button to switch between measuring the temperature and velocity and use the “Range” button to switch ranges in the velocity reading if the reading is out of range. Use the “Units” button to switch between fpm (feet per minute) and mps (meters per second) and F (Fahrenheit) and C (Celsius).
6) Record the readings in the field logbook and field data sheet.
7) Power down the anemometer
8) Replace the cap on the monitoring port.

Field Sampling Procedure Using Canisters with Quick-Connect (QC) Fittings: Grab Sample Collection



Equipment provided by the laboratory:

- Evacuated Canister
- Vacuum gauge with a built-in particulate filter
- Chain-of-Custody (COC)

Equipment to be supplied by field technician:

- 9/16" wrench
- ½" wrench

Preparing the canister for sample collection:

1) Place the canister in the desired sample location. Confirm valve is closed (turned clockwise).



Figure 1. Male QC fitting check

2) Check the male QC on the canister and verify the stem tip is tight. If loose, screw tip clockwise to tighten (Fig 1.)

3) To install the vacuum gauge on the canister, pull back on the sleeve of the female QC fitting (Fig 2.)



Figure 2. Female QC installation

4) Place the female QC fitting over the male QT fitting located on top of the canister, then release the sleeve once fully seated. Gently pull up on the gauge to make sure it is securely connected to the canister. Once installed the vacuum gauge will read zero.

5) Verify initial canister vacuum and vacuum gauge/filter assembly connection.

   a. With the brass cap securely installed, open and close the valve quickly to register the vacuum of the canister.

   b. The vacuum on the gauge should read steady at ***25 to 30 in Hg*** (Fig. 3)

   c. Record initial vacuum level ("Hg) on the Chain of Custody (COC) in the "Initial (in Hg)" field.



Figure 3. Pre-sample Vacuum check

Collecting the sample:



Figure 4. Removing brass cap

6) To begin sampling, ensure the valve is ***CLOSED***, remove the brass nut on the vacuum gauge using a 1/2" wrench to stabilize and 9/16" wrench to turn cap, as pictured in Fig 4.

7) Open the canister valve counter clockwise **no more than 1/2 turn** to begin sampling. Attempts to open the valve further can lead to valve damage and sample loss. Note the start date/time on the COC.

8) ***At the start of sampling, the vacuum gauge will read approximately 16 to 17 in Hg*** and remain at this reading for approximately 2 minutes for a 6L canister and 15 seconds for a 1L canister before the vacuum can be observed dropping toward zero. (Fig 5.)



Figure 5. Sample Start Vacuum

9) When the vacuum gauge nears 5 in Hg, close the valve by hand-tightening clockwise. (Fig 6.) At the point of closing the valve, note the vacuum and record on the COC in the "Final (in Hg)" field. (Once the valve is closed, the vacuum gauge will read zero.) Do not use tools to tighten the valve.

Record the stop date/time. Approximate canister fill times to 5 in Hg are shown in Table 1.

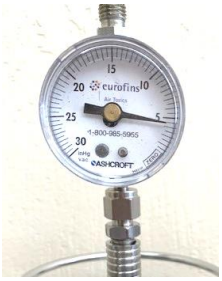


Figure 6. Sample End Vacuum

Table 1. Approximate Fill Times for Grab Samples with filter assembly

Canister Size	Fill time to 5 in Hg
1 Liter	~1 minute
6 Liter	~7 minutes

Note: Unless specified by your sampling and analysis plan, it is not critical to end the sample at 5 in Hg when collecting grab samples. However, leaving residual vacuum in the canister provides a check that the canister did not leak during transport to the laboratory.

Preparing the canister sample for return shipment to lab:

10) Detach the gauge by pulling back the sleeve of the female QC fitting and lifting it upwards off of the canister. Replace the brass nut on the vacuum gauge assembly by hand tightening.

11) Finish filling out the COC. In the Can # field, write the serial # or barcode circled below from the base of the canister. This number must be entered exactly as shown onto the COC to ensure no canister discrepancies upon receipt by the lab.



12) Make sure all canister tags are filled out and match the COC. If cans are unused, please check the "unused" box on the canister tag. Return canisters and vacuum gauge filter assemblies in boxes provided by the laboratory using the packaging provided. Place the completed COC in each sample box, making sure the samples have been relinquished properly by signing and dating the "Relinquished by:" field. *Note: You may keep a carbon copy of the COC for your records.*

13) Securely tape box shut and ship to the laboratory via USPS, FedEx, or UPS. Canisters should be delivered within 10 days of sample collection to ensure laboratory has sufficient time to process samples within the 30 day sample hold time.

Note: A replacement fee will be applied if the vacuum gauge filter assembly is not returned intact.

Laboratory Return Address: Eurofins Air Toxics, 180 Blue Ravine Rd. Suite B, Folsom, CA 95630

For questions, please call 800-985-5995

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Guide to Whole Air Sampling – Canisters and Bags

Revision 6/27/14

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Section 1.0 Introduction

Eurofins Air Toxics Inc. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the equipment and media used. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot sufficiently address the multitude of field conditions. Note that this guide is intended for projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar® bags. Eurofins Air Toxics provides the "Guide to Sorbent-Based Sampling - Volatiles and Semi-Volatiles" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are three general ways to collect compounds in a gas phase sample. A sampler may collect the gas sample in a container, actively pump the vapor through a sorbent tube, solution or filter, or rely on passive sample collection onto a sorbent bed. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and bags. The sample may be collected in the container either passively, relying on an evacuated canister to drive the sample collection, or actively using a pump to fill the container. The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix inside the container.

As a general rule, whole air sampling is appropriate when target compounds are chemically stable and have vapor pressures greater than 0.1 torr at 25°C and 760mm Hg (EPA standard ambient conditions). Performance of a given compound in a whole air sample is dependent upon its chemical properties, the matrix of the sample, and the degree of inertness of the sample container.

1.2 Choosing Between Canisters and Bags

Table 1.2 compares the features and performance of Summa canisters and bags. Summa canisters or similarly treated canisters are rugged containers designed to provide superior inertness and extended sample storage times. Evacuated canisters also do not require a sampling pump for sample collection. By contrast, bags require a sample pump, but can be purchased inexpensively in bulk, require little preparation or cleaning, and take up little space prior to use. Unlike canisters, bags are typically not appropriate for ppbv-level VOC measurements due to their background artifacts and short hold-times. Over time, low molecular weight gases can diffuse through the bag material while chemicals with lower vapor pressures can condense on the bag surface thereby compromising analyte recoveries. Call your Project Manager at 800-985-5955 if you have questions regarding the appropriate sampling media.

Table 1.2 Comparison of Canisters to Bags

	Canisters	Bags
Type of Sampling	Passive (vacuum)	Active (pump required)
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	Up to 30 days	Up to 3 days
Surface Inertness	Excellent	Fair
Cleanliness	Batch or 100% certified to ppbv/pptv levels	Some VOCs present in the ppbv range
Sampling Application	Ambient air, soil/landfill gas	Soil/landfill gas, stationary sources, SVE systems
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

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Section 2.0 Canisters and Associated Media

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting grab and integrated samples. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters



An air sampling canister is a container for collecting a whole air sample. A canister may be spherical or cylindrical and is constructed of specially treated stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. Flow controllers can be utilized to restrict the flow and allow for collection at a desired flow rate or over a desired range. When the sample has been collected, the valve is closed and the canister is returned to the laboratory. Canisters range in volume from less than 1 liter (L) to 6 L. In general, 6 L canisters are used to collect ambient air samples and samples requiring time integration greater than 2 hours. One liter canisters are typically used for taking high concentration (i.e., greater than 5 ppbv) samples not requiring time integration such as soil vapor.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Eurofins Air Toxics maintains a large inventory of Summa canisters in 1 and 6 L volumes.

2.1.2 Canister Certification

Eurofins Air Toxics provides two types of canister cleaning certification, batch and 100%, depending upon the requirements of the project. The batch certification process is most appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The batch certification process begins by cleaning a set of canisters using a combination of dilution, heat and high vacuum. The cleaning batch is certified by analyzing a percentage of canisters for approximately 60 VOCs using GC/MS. The batch meets cleaning requirements if the target compound concentrations are below 0.2 ppbv. Alternatively, the 100% certification (i.e., individual certification) process is typically required for ambient and indoor air applications driven by risk assessment or litigation requiring pptv (parts per trillion by volume) sensitivity. If 100% certification is required, canisters are individually certified for a client-specific list of target compounds using GC/MS. When the 100% certified canisters are shipped, the analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits is emailed to the client. When sampling with certified media, it is important to note that all media is certified as a train and must be sampled as such (i.e., a particular flow controller goes with a particular canister and is labeled as such).

Specify whether your project requires batch or 100% canister certification.

2.1.3 Canister Hold Time

Media Hold Time: Unlike water and soil environmental samples, which are collected in single-use, disposable vials and jars, air samples are collected in reusable summa canisters. Eurofins Air Toxics requires that canisters be returned within 15 days of receipt to effectively manage our inventory and to insure canisters meet performance requirements in the field. Evacuated canisters have a finite timeframe before the canisters naturally lose

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vacuum during storage. Using canisters beyond 15 days increases the risk of having unacceptable initial vacuum at the start of sampling.

Sample Hold Time: EPA Method TO-15 cites a sample hold time of up to 30 days for most VOCs. Several non-routine compounds, such as bis(chloromethyl)ether, degrade quickly and demonstrate low recovery even after 7 days. Reactive sulfur compounds such as hydrogen disulfide and methyl, ethyl, and butyl mercaptan are not amenable to storage in stainless steel summa canister, and either fused silica lined (FSL) canisters or Tedlar bags are required for sample collection.

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter and vacuum gauge. (Flow controllers are covered in detail in section 3.2.)

2.2.1 Valve

An industry standard 1/4" stainless steel bellows valve is mounted at the top of the canister. The valve maintains the vacuum in the canister prior to sampling and seals the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak, possibly compromising the sample. Some canisters have a metal cage near the top to protect the valve.

To protect the valve and provide secure connections in the field, a replaceable fitting is attached to all canisters. As threads wear and require replacement, new fittings can be installed at the laboratory prior to shipping to the field. You will need a 1/2" wrench to secure the fitting while connecting or removing the required equipment to the canister.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4" plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or a valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from damaging the valve. The cap is removed prior to sampling and replaced following sample collection.

Always replace the brass cap following canister sampling.

2.2.3 Particulate Filter

Particulate filters should always be used when sampling with a canister. Separate filters are provided to clients taking a grab sample, and filters are built into the flow controllers for clients taking integrated samples. The 2 micron filter is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter. This device has a relatively high pressure drop across the fritted disk and restricts the flow into the canister even when sampling without a flow controller. Table 2.2.3 lists the typical fill time for a grab sample using a 2 micron particulate filter.



Table 2.2.3 Grab Sample Fill Times for Canisters

CANISTER VOLUME	2 micron filter
6 L	<5 minutes
1 L	<1 minute

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2.2.4 Fittings

All fittings on the sampling hardware are 1/4” Swagelok, and a 9/16” wrench is used to assemble the hardware. A 1/2” wrench is also required to tighten fittings onto a union connector. Compression fittings should be used for all connections. Never use tube-in-tube connections. It is critical to avoid leaks in the sampling train. Leaks of ambient air through fittings between pieces of the sampling train will dilute the sample and cause the canister to fill at a faster rate than desired. Eurofins Air Toxics can provide the necessary fittings and ferrules if requested.

2.2.5 Vacuum Gauge

A vacuum gauge is used to measure the initial vacuum of the canister before sampling, and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Eurofins Air Toxics provides 2 types of gauges. For grab sampling, a test gauge checks initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and may be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. Both gauges are considered to be rough gauges, intended to obtain a relative measure of vacuum change. Accuracy of these field gauges are generally on the order of +/- 5 in Hg. Individuals with work plans that outline specific gauge reading requirements are strongly encouraged to purchase and maintain their own gauges in the field. In special cases, a laboratory-grade, NIST-traceable vacuum gauge can be provided upon request.



The vacuum gauges that are routinely provided are intended as a rough gauge measurement device (+/-5 in Hg accuracy).

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Section 3.0 Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) to provide a point-in-time sample concentration, while an integrated sample is taken over a specified duration or utilizing a specified flow rate. In both modes the canister vacuum is used to draw the sample into the canister. This is commonly referred to as passive canister sampling. Sections 3.1 and 3.2 detail procedures for grab and integrated sampling, and section 3.3 provides procedures specific to soil vapor collection.

Regardless of the type of canister samples collected, the following rules apply:

- DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.
- ALWAYS use a filter when sampling. NEVER allow liquids (including water) or corrosive vapors to enter canister.
- DO NOT attach labels to the surface of the canister or write on the canister; you will be liable for cleaning charges.
- DO NOT over tighten the valve, and remember to replace the brass cap.
- IF the canister is returned in unsatisfactory condition, you will be liable for damages.
- DO NOT make modifications to the equipment connections and/or use Teflon tape unless approved by the laboratory.
- AND, if you have any questions or need any support, our experienced project management team is just a phone call away at 800-985-5955.

Use a 9/16” and 1/2” wrench to tighten Swagelok connections on the canister sampling train.

3.1 Grab Sampling Using Canisters



The most common hardware configuration used to take a grab sample is to simply attach a particulate filter to the canister inlet. A particulate filter is shown in section 2.2.3 and is used to prevent particulate matter from fouling the valve and entering the canister.

3.1.1 Step-By-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested).
2. Make sure you include a 9/16” and 1/2” wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister as described in the following section:

- **Verify Initial Vacuum of the Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use. Eurofins Air Toxics recommends doing this before going to the field if possible. The initial vacuum of the canister should be greater than 25 in Hg. If the canister vacuum is less than 25 in Hg, ambient air may have leaked into the canister during storage or transport and the sample may be compromised. Contact your Project Manager if you have any questions on whether to proceed with sample collection. If

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sampling at altitude, there are special considerations for gauge readings and sampling (see Section 5.2). The procedure to verify the initial vacuum of a canister is simple but unforgiving.

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove the brass cap.
3. Attach gauge.
4. Attach brass cap to side of gauge tee fitting to ensure a closed train.
5. Open and close valve quickly (a few seconds).
6. Read vacuum on the gauge.
7. Record gauge reading on “Initial Vacuum” column of chain-of-custody.
8. Verify that canister valve is closed and remove gauge.
9. Replace the brass cap.



When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap.
3. Attach particulate filter to canister.
4. Open valve 1/2 turn (6 L canister normally takes less than 5 minutes to fill).
5. Close valve by hand tightening knob clockwise.
6. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum). For grab samples, the ending vacuum is typically close to ambient pressure (0 in Hg).
7. Replace brass cap.
8. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
9. Return canister in box provided.
10. Return sample media in packaging provided.
11. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
12. Place chain-of-custody in box and retain pink copy.
13. Tape box shut and affix custody seal (if applicable) across flap.
14. Ship accordingly to meet method holding times.

Return all equipment used or unused to the laboratory. Unreturned canisters and associated hardware will result in additional charges as outlined in the media agreement.

3.2 Integrated Sampling with Canisters and Flow Controllers

As an alternative to an “instantaneous” grab sample, an air sample collected at a controlled rate is referred to as an integrated sample. Flow controllers or flow restrictors are devices which provide sample collection at a desired flow rate and/or sampling interval. By using a flow controller at a specified flow rate, air samples can provide information on average compound concentrations over a defined period. For example, an 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample may be collected to determine residential exposure to indoor or outdoor air sources. In addition to using a flow controller for time-integrated sample collection, a flow controller may be required for soil gas collection to restrict the vacuum applied to the soil and pore water and to collect a representative sample with minimal intrusion of ambient air.

Eurofins Air Toxics provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.

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3.2.1 Mass Flow Controller



A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate over the desired time period. As the differential pressure decreases, the flow rate decreases and the diaphragm responds by opening up to allow more air to pass through to maintain a stable flow rate. Mass flow controllers are calibrated in the laboratory to provide flow rates suitable for durations up to 24 hours. Durations greater than 24 hours are possible, however, performance of the flow controller is less reliable due to the low flow rates required.

3.2.2 Critical Orifice Devices



Eurofins Air Toxics has two types of critical orifice controllers – "capillary column" and "frit pressed". Both types restrict the flow rate and the canister fill rate decreases as the canister fills to ambient pressure. These controllers are suitable for applications not requiring constant flow rate over the sampling period such as soil vapor collection or at sites in which temporal variability of VOCs is not expected. Critical orifice devices can cover intervals from 0.5 to 12 hours and flow rate from 10 to 250 ml/min. The "capillary column" device (also known as the Blue Body Flow Controller) restricts air flow by forcing the sample to enter a capillary column of minute radius. The flow rate is a function of the length of inert capillary column. The frit pressed device has a critical orifice machined to meet a set flow rate.



3.2.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Eurofins Air Toxics, you will be asked for the flow rate (soil vapor) or sampling interval (ambient air), and the flow controllers will be pre-set prior to shipment. The flow rate is set at standard atmospheric conditions (approximately sea level and 25°C). If samples will be collected at elevation or at ambient temperatures significantly different than 25°C, the canister will fill faster or slower depending on sample conditions. If you specify unusual sample conditions at the time of project set-up, we can set the flow controller accordingly. (See Section 5.2 for a discussion of collecting a sample at elevation.) Mass flow controllers should not be utilized for source or process samples in which the collection point is under vacuum or pressure. Please discuss these specific non-standard field conditions with your Project Manager at the time of project set-up.

Table 3.2.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	4 min.	0.5	1	2	4	8	12	24
6 L Canister	NA	167	83.3	41.7	20.8	11.5	7.6	3.8
1 L Canister	167	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

3.2.4 Final Canister Vacuum and Flow Controller Performance

For time-integrated sample collection using a mass flow controller, the final vacuum of a canister should ideally be approximately 5 in Hg or greater. The flow rate will remain constant as the canister fills and will start to decrease as the canister vacuum approaches

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5 in Hg. At this point, the differential pressure between the canister and ambient air is not sufficient to maintain the set flow rate. Because of normal fluctuations in the flow rate due to changes in field temperature and pressure, the final vacuum typically ranges between 3 and 10 in Hg.

- **If the residual canister vacuum is greater than 10 in Hg** (i.e., more vacuum), the actual flow rate is lower than the set point and less sample volume is collected. When the canister is pressurized prior to analysis, the pressurization dilution will be greater than normal. This will result in elevated reporting limits.
- **If the residual canister vacuum is near ambient pressure** for a time-integrated sample, the canister filled faster than calibrated. Once the vacuum decreases below 5 in Hg, the flow rate begins to decrease from its set point. This scenario indicates that the sample is weighted toward the first portion of the sampling interval. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. Although the actual sampling interval is uncertain, the canister still contains a sample from the site.

Table 3.2.4 Relationship between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (in Hg)	0	2.5	5	7.5	10	12.5	15	17.5	20
Volume Sampled (L)	6	5.5	5.4	5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

*Canister pressurized to 5 psig for analysis

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$$\text{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Analysis)}$$

$$\text{Dilution Factor (Canister Pressurization)} = \frac{\text{Final Pressure}}{\text{Receipt Pressure}} = \frac{14.7 \text{ psig} + \text{Final Pressure (psig)}}{14.7 \text{ psig} \left[\frac{\text{1-Receipt Vacuum (in Hg)}}{29.9 \text{ in Hg}} \right]}$$

3.2.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the sampling train is properly configured, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train**: A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. (Follow the leak check step #4 in 3.2.6).
- **Verify Initial Vacuum of Canister:** See Section 3.1.1 for instructions on verifying initial canister vacuum. A separate gauge is not necessary as both the mass flow controllers and critical orifice flow controllers have built-in rough gauges.
- **Monitor Integrated Sampling Progress**: When feasible, it is a good practice to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of the canister vacuum. For example, when using a 24-hour mass flow controller, at a quarter of the way (6 hours) into a 24-hour sampling interval, the canister should be a quarter filled (1.25 L) and the gauge should read approximately 6 in Hg lower than



the starting vacuum (~22 in Hg). More vacuum indicates that the canister is filling too slowly; less vacuum means the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 3.2.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample; the time interval need not be continuous.

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is done by returning them to the laboratory.
- **Caution When Sampling in Extreme Temperatures**: Field temperatures can affect the performance of the mass flow controllers. Laboratory studies have shown that flow rates can increase slightly with decreasing temperatures. A flow rate increase of approximately 10% is expected when sampling at field temperatures of 5 to 10°C.

3.2.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, and flow controller)
2. Make sure you include a 9/16" and 1/2" wrench in your field tool kit.
3. Verify the gauge is working properly
4. Verify the initial vacuum of canister (section 3.1.1)

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister. The flow controller is securely attached if the flow controller body does not rotate.
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and open the canister valve a ½ turn.
6. Monitor integrated sampling progress periodically.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When sampling is complete, close valve by hand tightening knob clockwise.
9. Detach flow controller and replace brass cap on canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy.
14. Tape box shut and affix custody seal at each opening (if applicable).
15. Ship accordingly to meet method holding times.

3.3 Soil Gas Sample Collection

Canisters can be used for the collection of soil vapor by attaching the sampling train to the soil gas probe. Typically, a critical orifice flow controller is used to minimize the applied vacuum in order to minimize partitioning of VOCs from the soil or pore water to the soil vapor. Additionally, lower flow rates help to minimize the intrusion of ambient air into the soil vapor probe. In general, time-integration is not required for soil gas samples; however, there may be exceptions to this rule of thumb. For example, some regulatory guidance documents recommend concurrent indoor air and sub-slab soil vapor collection over a

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24-hour period. This means that a mass flow controller calibrated for a 24-hour sample would be required for the sub-slab as well as the indoor air sample.

3.3.1 Canister to probe connection – Tubing

Collection of a soil gas sample requires the use of tubing to connect the soil gas probe to the sample train. Teflon FEP tubing is recommended based on its low background and its inertness. Alternative tubing can be used if shown to meet data quality objectives. Please note that Low Density Polyethylene or flexible Tygon tubing is not recommended due to VOC adsorption during sample collection. Teflon tubing is provided by the laboratory upon request at the time of order. A charge based on the length will be assessed. It is important to store the tubing away from VOC sources during storage and transport to the site to minimize contamination.

3.3.2 Canister to probe connection –Fittings

To connect the tubing to the canister sampling train, a Swagelok fitting and a pink ferrule are used. The position of the ferrule is key to ensure the fitting is securely connected to the canister. See the figure below for the correct positioning and connection. The pink ferrule is flexible and cannot be over-tightened.



3.3.3 Leak Check Compounds Considerations

To determine whether ambient air is introduced into soil gas sample, a leak check may be used. Leak check compounds may be liquid or gaseous tracers. Liquid compounds are challenging to use effectively in the field and can be introduced into the sample due to improper handling in the field, erroneously indicating a leak in the sampling train. Liquid tracers such as isopropanol should never be directly applied to connections in the sampling train. Rather, the liquid is carefully applied to a cloth and placed near the connection or on the ground next to the probe. Great care must be used in the field to insure the liquid tracer is not handled during sampling train assembly or disassembly. Even a trace amount of a liquid tracer on a glove used to replace a canister brass cap can contaminate the sample. Liquid leak check compounds can interfere with the analytical runs, and even small leaks may result in analytical dilution and raised reporting limits when measuring ppbv target compound levels.

Gaseous tracers such as helium are typically used with shroud placed over the sampling equipment and/or borehole. To quantify the leak, the concentration of the tracer gas in the shroud should be measured.

Specify the leak check compound planned for your soil gas sampling event and record on the COC.

3.3.4 Step-by-Step Procedures for Soil Vapor Sampling

These procedures are for a typical soil vapor sampling application; actual field conditions and procedures may vary. Please consult your specific regulatory guidance for details.

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Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, tubing, fittings, and flow controller).
2. Make sure you include a 9/16" and 1/2" wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister.

Prior to vapor collection:

- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing. A standard rule of thumb is to utilize 3 purge volumes prior to sample collection. However, under certain circumstances, purge volumes of 1 to 10 may be appropriate. Please review your regulatory guidance and your site specific conditions in determining the appropriate purge volumes.
- **Don't sample water**. If moisture is visible in the sample tubing, the soil gas sample may be compromised. Soil gas probes should be at an appropriate depth to avoid reaching the water table. Additionally, subsurface vapor should not be collected immediately after measurable precipitation.

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister if needed. The flow controller is securely attached if the flow controller body does not rotate. (Note: The frit-press flow controller and 1 L canister may be pre-assembled by the laboratory.)
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and attach the probe tubing to the flow controller using the pink ferrule and Swagelok nut. (See 3.3.2 for proper positioning of the ferrule.)
6. Once the probe line has been purged and appropriate leak check measures have been implemented, open the canister valve a ½ turn.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When canister fills to the desired end vacuum, close valve by hand tightening knob clockwise.

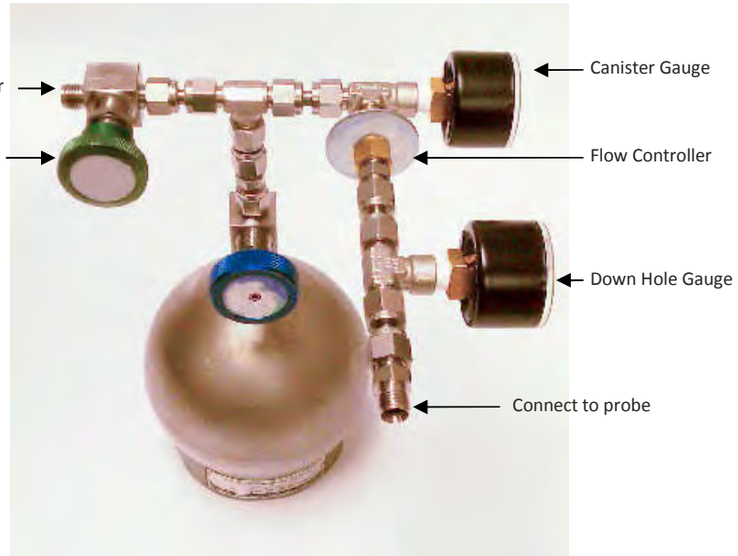
   Please note: Some projects require residual vacuum of approximately 5 in Hg at the end of sample collection even if time-integrated samples are not required. The residual vacuum serves to provide a check of the integrity of the canister during transport to the laboratory to insure no leaks occurred during shipment. A field vacuum reading similar to the lab receipt vacuum reading demonstrated that no leak occurred.

9. Detach tubing and flow controller and replace brass cap on the canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal at each opening (if applicable)
15. Ship accordingly to meet method holding times

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3.4.4 Collecting Soil Gas Samples with Sampling Manifolds

If required, Eurofins Air Toxics can provide a sampling manifold to assist with leak checking the sampling train, purging the sampling line, and monitoring the vacuum applied to the soil gas bore hole during sample collection. The manifold is shown below:



The 'Down Hole Gauge', located prior to the flow restrictor, is a vacuum gauge that monitors the vacuum applied to the soil gas probe. Because this is not a flow meter but a measure of pressure/vacuum, the gauge should read at zero if there is sufficient flow from the soil. If the gauge begins to read a vacuum, then the flow is being restricted. Low flow, high vacuum conditions can be encountered when sampling in low permeability soil. The 'Canister Gauge', in line after the flow controller and prior to the purge canister, is a vacuum gauge that indicates to the sampler whether or not the canister is filling properly at the expected rate. This setup enables the sampler to evaluate the lithologic conditions at the site and determine if a valid soil gas sample is being taken. Finally, when duplicate samples are required, the manifold can be used as a duplicate sampling "T" by simply replacing the purge canister with another sample canister.

There are several options to use as a purge vacuum source to attach to the purge valve connection – a Summa canister, sampling pump or sampling syringe. The below instructions assume a Summa canister will be used as a purge volume source since other sources are generally provided by the client.

When ready to sample:

Leak Check Test

1. Confirm that canister valves are closed (knob should already be tightened clockwise).
2. Remove brass caps from both the sample canister and the purge canister. (Unless using certified media, there is no difference between the two).
3. Attach manifold center fitting to sample canister.
4. Attach purge canister to the Purge Valve end of the manifold by attaching provided Teflon tubing and compression fittings.
5. Confirm that there is a brass cap secured at the inlet of the manifold creating an air tight train, make sure the manifold valve above the purge canister is open, and quickly open and close the purge canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.

Purging

6. Once the sample train is airtight remove the brass cap from the manifold inlet, connect the tubing from the sample port using a compression fitting and open the purge canister valve, 1/2 turn.
7. Monitor integrated sampling progress periodically. *Please note, because the purge canister is inline after the flow restrictor the line will not purge faster than at a rate of 167 ml/min.

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8. Once the desired purge volume is met close both the manifold valve and the purge canister valve by hand tightening the knobs clockwise.

9. If sampling at multiple locations, the purge canister can be disconnected from the manifold and used to begin purging the next sample location without compromising the sample train.

Sampling

10. The line is now ready to be sampled. Open the sample canister valve and monitor sampling progress periodically.

11. When the sampling is complete close the valve and replace the brass cap on the canister; record final vacuum of canister (simply read built-in gauge).

12. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).

13. Return canisters in boxes provided and all parts of the soil gas manifold. **Unreturned media will result in a replacement charged assessed as described in the media agreement**.

14. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).

15. Place chain-of-custody in box and retain pink copy.

16. Ship accordingly to meet method holding times.

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Section 4.0 Sampling with Bags

This section provides a description of the types of air sampling bags, selecting the right bag for your application, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.

4.1 Introduction to Bags

Air sampling bags are containers used to collect whole air samples for landfill gas, soil gas and stationary source applications. Bags can be constructed from various materials which can differ in terms of stability characteristics and cleanliness. In general, air sampling bags are best suited for projects involving analysis of compounds in the ppmv range. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon®, or Nylon).

Air sampling bags are equipped with a valve that allows for filling. Sample collection requires a pressurized sampling port, a low flow rate pump or a lung sampler. The bag expands as the vapor sample is pulled in. When the target volume of the sample is collected, the valve is closed and the bag is returned to the laboratory. Bag materials should be selected based on the specific application. Common air sampling bags include Tedlar film and FlexFoil. Eurofins Air Toxics maintains a limited inventory of air sampling bags in 1 L, 3 L and 5 L volumes.

4.1.1 Tedlar® Film

Tedlar® is a trade name for a polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels and aircraft interiors. Tedlar® film is tough yet flexible and retains its impressive mechanical properties over a wide range of temperatures (from well below freezing to over 200°F). Tedlar® exhibits low permeability to gases, good chemical inertness, good weathering resistance and low off-gassing.



Tedlar® bags may be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, atmospheric and biogenic gases and many other classes of compounds. Compounds with low vapor pressures such as Naphthalene are not appropriate for Tedlar bags as recovery is very low even under short sample storage times. Low molecular compounds such as Helium and Hydrogen can diffuse through the Tedlar bag material resulting in poor storage stability.

4.1.2 Tedlar® Bag Suppliers and Re-use

Compounds commonly detected from analyzing new Tedlar® bags include methylene chloride, toluene, acetone, ethanol, 2-propanol, phenol, and dimethylacetamide. While levels of these common artifacts are typically in the ppbv range, the cleanliness of bags can vary significantly between vendors, and purchasing bags directly from an unknown vendor should be avoided. Once the Tedlar® bag is used for sample collection, the surface has been exposed to moisture and possible VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas may not remove the VOCs from the surface. Consider your data quality objectives to determine whether re-using Tedlar® bags is appropriate.

4.1.3 Hold Time for a Tedlar® Bag

The media hold time for a Tedlar® bag is indefinite if stored out of sunlight in a cool, dry location.

The sample hold time to analysis varies by method and compound. See Table 4.1.3 for recommended sample storage times for commonly requested parameters.

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Table 4.1.3 Recommended Maximum Sample Storage Times for Tedlar® Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Suite of sulfur compounds including Reactive Sulfur compounds (Hydrogen sulfide, Methyl mercaptan)	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases: CO, CO2, CH4, C2-C5 hydrocarbons (He and H_2 not recommended)	Up to 3 days
Modified TO-14A, TO-15, TO-3, TO-12	Volatile Organic Compounds (VOCs)	Up to 3 days

4.1.4 FlexFoil Bags

FlexFoil bags are made from an opaque and flexible material with 4-ply construction resulting in high physical strength to minimize rupture and leakage and low permeability to provide good stability for low molecular weight compounds. FlexFoil bags are ideal for target compounds such as Hydrogen and Helium and can be used for the suite of atmospheric and natural gas components. While the reactive sulfur compounds, Hydrogen Sulfide and Methyl Mercaptan, show good stability over 24 hours in FlexFoil bags, other sulfur compounds demonstrate low recovery. Table 4.1.4 summarizes the compounds and the hold times amenable to FlexFoil bags.

Table 4.1.4 Recommended Maximum Sample Storage Times for FlexFoil Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Hydrogen sulfide, Methyl mercaptan only Not recommended for full sulfur list.	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases Full List	Up to 3 days

4.2 Air Bag Sampling

Using a bag to collect an air sample normally involves “active” sampling, unlike an evacuated canister that can be filled “passively” by simply opening the valve. There are two methods commonly used to fill a bag: a pump or a lung sampler.

- **Sampling with a Pump**: The most common method for filling a bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Eurofins Air Toxics, Inc. does not provide pumps but pumps may be rented from equipment providers or purchased from manufacturers such as SKC or Gilian.
- **Sampling with a Lung Sampler**: A “lung sampler” may be used to fill a bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler to fill a bag is that it avoids potential pump contamination.



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A bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated via a pump, causing the bag to expand and draw the sample into the bag through the protruding tube. The sample air never touches the wetted surfaces of the pump. Eurofins Air Toxics does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

4.2.1 Considerations for Bag Sampling

Some considerations for collecting a bag sample:

- **Fill the bag no more than 2/3 full**: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane)
- **Keep the Tedlar® bag out of sunlight**: Tedlar® film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions
- **Protect the bag**: Store and ship the bag samples in a protective box at room temperature. An ice chest may be used, but DO NOT CHILL
- **Fill out the bag label**: It is much easier to write the sample information on the label before the bag is inflated. Make sure to use a ball-point pen, never a Sharpee or other marker which can emit VOCs.
- **Provide a "back-up" bag**: Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis. The "hold" sample does not need to be documented on the Chain-of-Custody and should have an identical sample ID to the original sample indicating that it is the "hold" sample
- **Avoid Contamination**: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use the shortest length possible of Teflon® tubing or other inert tubing. DO NOT REUSE TUBING. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar® bag (see Section 1.2)
- **Don't Sample Dangerous Compounds in a Bag**: Do not ship any explosive substances, radiological or biological agents, corrosives or extremely hazardous materials to Eurofins Air Toxics. Bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

4.2.2 Step-by-Step Procedures for Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, bag, and tubing/fittings – if requested).
2. Verify pump cleanliness and operation (Eurofins Air Toxics does not provide pumps).

When ready to sample:

3. Purge sample port.
4. Attach new Teflon® tubing from sample port or probe to low flow rate pump.
5. Purge tubing.
6. Fill out bag sample tag.
7. Attach additional new Teflon® tubing from the pump outlet to the bag valve.
8. Open bag valve.
9. Collect sample (FILL NO MORE THAN 2/3 FULL).
10. Close bag valve by hand tightening valve clockwise.
11. Return filled bags in a rigid shipping container (DO NOT CHILL).
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy.

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14. Tape box shut and affix custody seal (if applicable) across flap.
15. Ship first overnight or priority overnight to meet method holding times.



Expedite delivery of air sampling bags to the laboratory for analysis.

Section 5.0 Special Sampling Considerations

This section provides recommendations for the collection of field QC samples such as field duplicates. Considerations for sampling at altitude, sampling SVE ports and using sample cylinders are presented.

5.1 Field QC

To measure accuracy and precision of the field activities, project plans often include field duplicates, field blanks, ambient blanks, trip blanks and/or equipment blanks.

5.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample may be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon® tubing connected to a Swagelok "T". If integrated samples are being collected and the sample duration is to be maintained, the sample train should be assembled as follows: each canister should have a flow controller attached, then the duplicate sampling T should be attached to the flow controllers. If the collection flow rate from the sample port is to be maintained then the duplicate sampling T should be connected to the canisters; then the flow controller is connected to the inlet of the sampling T.

Alternatively, if the project objective is to assess spatial or temporal variability, then field duplicates may be deployed in close proximity (ambient air sampling) or samples may be collected in succession (soil vapor).

5.1.2 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon® tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

5.1.3 Ambient Blank

An ambient blank is an ambient air sample collected in the field. It is usually used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is recommended that an individually certified canister be used to collect an ambient blank.

5.1.4 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

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When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. The trip blank VOC concentrations essentially provide information regarding the cleanliness and performance of the trip blank canister. Results cannot necessarily be applied to the associated field sample canisters accompanying the trip blank. **Eurofins Air Toxics does not recommend collecting a trip blank for air sampling.**

5.2 Considerations for Sampling at Altitude

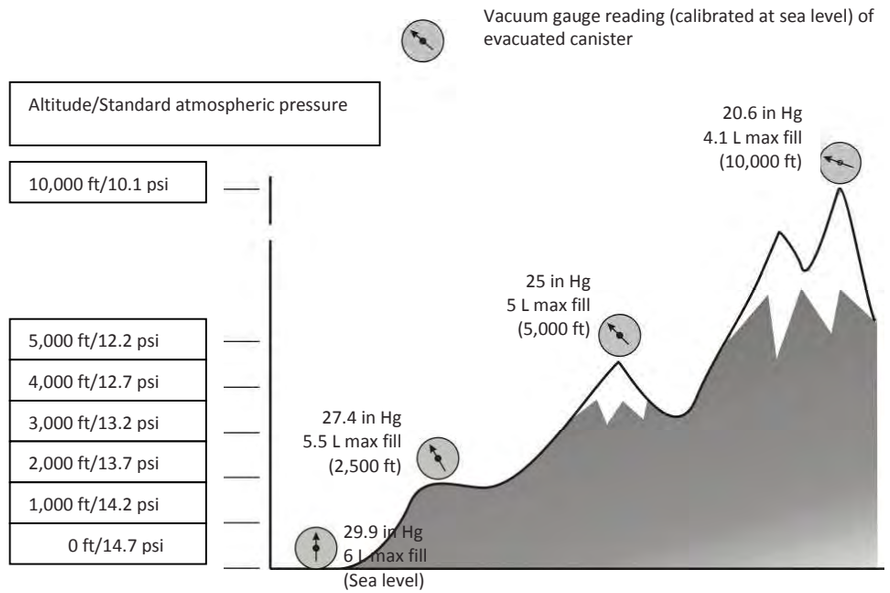
Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum in that target fill volumes may be difficult to achieve. The figure to the right illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient conditions in Denver at 5,000 ft altitude are quite different from ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister.

There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Eurofins Air Toxics, Inc. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in Hg and the fill volume will be reduced by 1/5 L.

If you have questions about sampling at altitude, please call your Project Manager at 800-985-5955.



5.3 Considerations for SVE/LFG Collection System Sampling

There are some additional sampling considerations for collecting grab samples (canister or bag) from a Soil Vapor Extraction (SVE) system or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ a length of tubing to direct the landfill gas or process air to the canister or bag. Tubing introduces the potential for contamination and diluting the sample.

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- **Use inert tubing**. Teflon® tubing is recommended. Tubing with an outer diameter of ¼" works best with the fittings on the particulate filter. (See Section 3.3.1).
- **Do not reuse tubing**.
- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train**. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.
- Always use compression fittings for all connections; never use tube in tube connections.
- **Purge the sample port**. A sample port on an SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.
- **Consider the effects of sampling a process under vacuum or pressure**. When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump may be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 5.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 5.4). Under no circumstances should a Summa canister be pressurized more than 15 psig. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

5.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of BTU by ASTM D-3588. Eurofins Air Toxics assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4" Swagelok fitting to attach to the sample cylinder. Eurofins Air Toxics has a limited inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.



Inform the lab during project set up if hazardous samples (e.g. high Hydrogen Sulfide concentrations) will be collected to verify the lab can safely handle the samples.

Step-by-Step Procedures for Sample Cylinder Sampling

These procedures are for a typical stationary source sampling application and actual field conditions; procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder. Follow required DOT guidelines for packaging and shipping.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter).
2. Verify that gauge on sample port is working properly.
3. Purge sample port.

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4. Remove brass caps on either end of cylinder.
5. Attach particulate filter to upstream valve.
6. Attach filter/cylinder assembly directly to the sample port.
7. Open both valves 1/2 turn.
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder).
9. Close downstream valve of sample cylinder by hand tightening knob clockwise.
10. Allow sample cylinder to pressurize to process pressure (max 100 psig).
11. Close upstream valve of sample cylinder and sample port.
12. Detach filter/cylinder assembly from sample port and remove particulate filter.
13. Replace brass caps.
14. Fill out sample cylinder sample tag.
15. Fill out chain-of-custody and relinquish samples properly.
16. Include the chain-of-custody with the samples and retain pink copy.
17. Pack, label, and ship according to DOT regulations.



Follow DOT regulations for packaging and shipping hazardous samples.

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Eurofins Air Toxics Helium Shroud Spec Sheet

Items included:

- Two hand, zipper lock closure inflatable glove box bag. Dimensions: 32 in. × 42 in. average inflated height 12 in. Zippered opening diameter is 19.5 in.
- Port to cover soil vapor well 12 cm diameter at ground level.
- 2 additional ports allow for ¼"tubing to be inserted for charging the shroud with helium and purging with an external canister or pump.
- Zip ties to hold tubing in place

Instructions for use:

1. Open the zippered end of the shroud bag and place port 1 over the soil vapor point. Seal to the ground as needed.
2. Reach into bag and Push port 2 outwards, and snip a hole in the end. Place the tubing from your Helium tank or canister into this port, and zip tie securely.
3. Push port 3 outwards, and snip a hole in the end. Place the purge line through port 2, and zip tie securely.
4. Place your sample canister and manifold into the shroud through the zippered opening. Attach the purge tubing to the purge valve on the manifold. Attach the sample tubing to the manifold inlet.
5. Proceed with purging the lines according to your workplan.
6. Seal the shroud zipper. Charge the shroud with Helium.*
7. If necessary, Helium concentration can be confirmed by portable meter or additional summa canister sample collected inside the shroud.
8. Place your hands into the shroud gloves, and open the sample canister valve to begin sampling.
9. Close the canister valve when sampling is complete.
10. Open the shroud to remove the canister. Shroud can be moved to the next sampling point.
11. Return all shroud components to the laboratory with the samples. Full replacement cost will be charged for any unreturned items.

* The shroud can be charged using a 6L summa filled with helium to 15 psi (resulting shroud atmosphere is 10-15% Helium). Alternately the shroud can be charged with a pressurized cylinder fitted with a regulator set to 20 psi (resulting shroud atmosphere is 70-75% Helium).

Special features:

1. Inflatable shroud can be reused at multiple points, the sample does not come into contact with shroud components
2. Minimizes Helium use, easily remains inflated for 10 minutes without recharging.

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3. Canister and flow controller are inside the shroud; consistent with the California DTSC Advisory.
4. "Glove Box" design allows for sampling to be carried out without disturbing the shroud environment, consistent with California DTSC Advisory.



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OIL-LESS DIAPHRAGM VACUUM PUMPS & COMPRESSORS

OPERATION & MAINTENANCE MANUAL



Model DOA Shown



Model DAA Shown

Thank you for purchasing this Gast product. It is manufactured to the highest standards using quality materials. Please follow all recommended maintenance, operational and safety instructions and you will receive years of trouble free service.

⚠ WARNING



PLEASE READ THIS MANUAL COMPLETELY BEFORE INSTALLING AND USING THIS PRODUCT. SAVE THIS MANUAL FOR FUTURE REFERENCE AND KEEP IN THE VICINITY OF THE PRODUCT

Product Use Criteria:

- Pump only clean, dry air.
- Operate at 32ºF - 104ºF (0ºC - 40ºC).
- Protect unit from dirt & moisture.
- Do not pump flammable or explosive gases or use in an atmosphere that contains such gases.
- Protect all surrounding items from exhaust air. This exhaust air can become very hot.
- Corrosive gases and particulate material will damage unit. Water vapor, oil-based contaminants or other liquids must be filtered out.
- Consult your Gast Distributor/Representative before using at high altitudes.
- This pump is oil-less and requires NO lubrication.
- Pressure units may be used for both pressure and vacuum. Consult your Gast Distributor/Representative to use vacuum units for pressure.

GAST® A Unit of IDEX Corporation

ISO 9001 & 14001 CERTIFIED **www.gastmfg.com**

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Your safety and the safety of others is extremely important.

We have provided many important safety messages in this manual and on your product. Always read and obey all safety messages.

This is the safety alert symbol. This symbol alerts you to hazards that can kill or hurt you and others. The safety alert symbol and the words "DANGER" and "WARNING" will precede all safety messages. These words mean:

DANGER

You will be killed or seriously injured if you don't follow instructions.

WARNING

You can be killed or seriously injured if you don't follow instructions.

All safety messages will identify the hazard, tell you how to reduce the chance of injury, and tell you what can happen if the safety instructions are not followed.

INSTALLATION

WARNING



Electrical Shock Hazard

Disconnect electrical power at the circuit breaker or fuse box before installing this product.

Install this product where it will not come into contact with water or other liquids.

Install this product where it will be weather protected.

Electrically ground this product.

Failure to follow these instructions can result in death, fire or electrical shock.

Correct installation is your responsibility. Make sure you have the proper installation conditions and that installation clearances do not block air flow.

Blocking air flow over the product in any way can cause the product to overheat.

Mounting
This product can be installed in any orientation. Mounting the product to a stable, rigid operating surface and using shock mounts will reduce noise and vibration.

Plumbing
Remove plugs from the IN and OUT ports. Connect with pipe and fittings that are the same size or larger than the product's threaded ports. Be sure to connect the intake and exhaust plumbing to the correct inlet and outlet ports. **Ports will not support the weight of the plumbing.**

Accessories
Filters and mufflers are supplied with some models. These should be checked periodically and replaced when necessary. Please consult your Gast Distributor/Representative for additional filter recommendations.

Install relief valves and gauges at inlet or outlet, or both, to monitor performance. Check valves may be required to prevent back streaming through the pump.

Motor Control
It is your responsibility to contact a qualified electrician and assure that the electrical installation is adequate and in conformance with all national and local codes and ordinances. The metal capacitor shell must be grounded.
Determine the correct overload setting required to protect the motor (see motor starter manufacturer's recommendations). Select fuses, motor protective switches or thermal protective switches to provide protection. Fuses act as short circuit protection for the motor, not as protection against overload. Incoming line fuses must be able to withstand the motor's starting current. Motor starters with thermal magnetic overload or circuit breakers protect motor from overload or reduced voltage conditions.

The wiring diagram supplied with the product provides required electrical information. Check that power source is correct to properly operate the dual-voltage motors.

Electrical Connection

WARNING



Electrical Shock Hazard

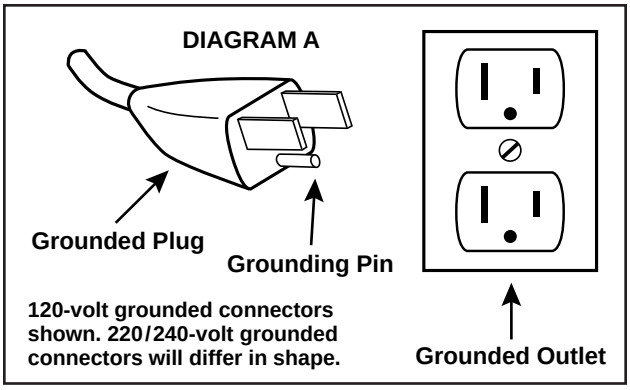
This product must be properly grounded.

Do not modify the plug provided. If it will not fill the outlet, have the proper outlet installed by a qualified electrician.

If repair or replacement of the cord or plug is necessary, do not connect the grounding wire to either flat blade terminal. The wire with insulation that is green with or without yellow stripes is the grounding wire.

Check the condition of the power supply wiring. Do not permanently connect this product to wiring that is not in good condition or is inadequate for the requirements of this product.

Failure to follow these instructions can result in death, fire or electrical shock.



Model with a power supply cord:
This product must be grounded. For either 120-volt or 220/240-volt circuits connect power supply cord grounding plug to a matching grounded outlet. Do not use an adapter. (See DIAGRAM A)

In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current. This product may be equipped with a power supply cord having a grounding wire with an appropriate grounding plug. The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes and ordinances.

Check with a qualified electrician or serviceman if the grounding instructions are not completely understood, or if you are not sure whether the product is properly grounded. Do not modify the plug provided. If it will not fit the outlet, have the proper outlet installed by a qualified electrician.

Model that is permanently wired:
This product must be connected to a grounded, metallic, permanent wiring system, or an equipment grounding terminal or lead on the product.

Power supply wiring must conform to all required safety codes and be installed by a qualified person. Check that supply voltage agrees with that listed on product nameplate.

In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current. This product may be equipped with a power supply cord having a grounding wire with an appropriate grounding plug. The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes and ordinances.

Extension cords:
Use only a 3-wire extension cord that has a 3-blade grounding plug. Connect extension cord plug to a matching 3-slot receptacle. Do not use an adapter. Make sure your extension cord is in good condition. Check that the gage wire of the extension cord is the correct size wire to carry the current this product will draw.

An undersized cord is a potential fire hazard, and will cause a drop in line voltage resulting in loss of power causing the product to overheat. The following table indicates the correct size cord for length required and the ampere rating listed on the product nameplate. **If in doubt, use the next heavier gage cord. The smaller the gage number, the heavier the wire gage.**

-Minimum gage for extension cords

Amps	Volts	Length of cord in feet								
	120v	25	50	100	150	200	250	300	400	500
	240v	50	100	200	300	400	500	600	800	1000
0-2		18	18	18	16	16	14	14	12	12
2-3		18	18	16	14	14	12	12	10	10
3-4		18	18	16	14	12	12	10	10	8
4-5		18	18	14	12	12	10	10	8	8
5-6		18	16	14	12	10	10	8	8	8
6-8		18	16	12	10	10	8	6	6	6
8-10		18	14	12	10	8	8	6	6	4
10-12		16	14	10	8	8	6	6	4	4
12-14		16	12	10	8	6	6	6	4	2
14-16		16	12	10	8	6	6	4	4	2
16-18		14	12	8	8	6	4	4	2	2
18-20		14	12	8	6	6	4	4	2	2

OPERATION

WARNING

Injury Hazard

Install proper safety guards as needed.
Use only recommended air handling parts acceptable for pressure not less than 70 psi.
Keep fingers and objects away from openings and rotating parts.
When provided, motor terminal covers must be in place for safe operation.
Product surfaces become very hot during operation, allow product surfaces to cool before handling.
Do NOT direct air stream at body. Air stream from product may contain solid or liquid material that can result in eye or skin damage, wear proper eye protection.
Do NOT spray flammable or combustible liquid.
Wear hearing protection. Sound level from motor may exceed 70 dBA.
Failure to follow these instructions can result in burns, eye injury or other serious injury.

It is your responsibility to operate this product at recommended pressures or vacuum duties and room ambient temperatures. Do not start against a vacuum or pressure load.

Start Up
If motor fails to start or slows down significantly under load, shut off and disconnect from power supply. Check that the voltage is correct for motor and that motor is turning in the proper direction.

MAINTENANCE

WARNING



Electrical Shock Hazard

Disconnect electrical power supply cord before performing maintenance on this product.

If product is hard wired into system, disconnect electrical power at the circuit breaker or fuse box before performing maintenance on this product.

Failure to follow these instructions can result in death, fire or electrical shock.

WARNING

Injury Hazard

Product surfaces become very hot during operation, allow product surfaces to cool before handling.

Do not direct air steam at body. Air stream from product may contain solid or liquid material that can result in eye or skin damage, wear proper eye protection.

Clean this product in a well ventilated area.

Failure to follow these instructions can result in burns, eye injury or other serious injury.

It is your responsibility to:

- **Regularly inspect and make necessary repairs to product in order to maintain proper operation.**
- **Make sure that pressure and vacuum is released from product before starting maintenance.**

Check intake and exhaust filters after first 500 hours of operation. Clean filters and determine how frequently filters should be checked during future operation. This one procedure will help to assure the product's performance and service life.

WARNING



Solvent Stream

May contain solid or liquid material that can result in eye or skin damage.

Wear eye protection when using this product.

Solvent Cleaning

Use only Gast recommended Solvent or other non-petroleum based solvent. Do Not use kerosene or ANY other combustible solvent to clean product.

1. Remove the four bolts holding the head on.
2. Remove filters and clean with Gast recommended solvent or other non-petroleum based solvent. Use compressed air to dry filters and make sure that all moisture is removed. Reinstall filters in head, set aside.
3. Check to see that the head gasket on the valve plate is not compromised in any way, remove from valve plate, and set aside for reinstallation after cleaning valve plate.
4. Gently remove valve plate from body of unit (CAUTION: DO NOT LOSE THE SHIM WASHERS THAT ARE UNDER EACH CORNER BOLT HOLE BETWEEN THE VALVE PLATE AND BODY. THEY MUST GO BACK BETWEEN THE VALVE PLATE AND BODY EXACTLY AS THEY CAME OUT). Clean the valve plate with soap and water and carefully blow off with compressed air.
5. Reinstall shim washers at each bolt hole on the body and carefully reinstall valve plate over the pump body.
6. Reinstall head gasket on the valve plate, place head over valve plate, install four bolts to hold assembly to body. Torque each bolt in a cross pattern to 90-100 in. lbs.

Check that all external accessories such as relief valves and gauges are attached to cover and are not damaged before re-operating product.

SHUTDOWN PROCEDURES

It is your responsibility to follow proper shutdown procedures to prevent product damage. Store pump indoors. Do Not expose to wet weather conditions. NEVER ADD OIL TO THIS OIL-LESS PUMP.

Proper shutdown procedures must be followed to prevent pump damage. Failure to do so may result in premature pump failure. Gast Manufacturing Rocking Piston Oil-Less pumps are constructed of ferrous metals or aluminum which are subject to rust and corrosion when pumping condensable vapors such as water. Follow the to assure correct storage and shutdown between operating periods.

1. Disconnect plumbing.
2. Operate product for at least 5 minutes without plumbing.
3. Run at maximum vacuum for 10-15 minutes.
4. Repeat step 2.
5. Disconnect power supply.
6. Plug open ports to prevent dirt or other contaminants from entering product.

SERVICE KIT INSTALLATION

WARNING



Electrical Shock Hazard

Disconnect electrical power supply cord before installing service kit.

If product is hard wired into system, disconnect electrical power at the circuit breaker or fuse box before installing service kit.

Disconnect air supply and vent all air lines to release pressure or vacuum.

Failure to follow these instructions can result in death, fire or electrical shock.

Gast will NOT guarantee field-rebuilt product performance. For performance guarantee, the product must be returned to a Gast Authorized Service Facility.

Service Kit contents vary. Most contain gaskets and filter parts.

1. Put on eye protection.
2. Disconnect electrical power to pump.
3. Disconnect air supply and vent all air lines to release pressure or vacuum.
4. Remove the socket cap screws from the head of the pump. Remove the head and valveplate from the pump. (Caution: Do not lose the shim washers that are at each corner between the valveplate and body of the unit. Upon reistallation, these shims must be put back in the same position they were taken from to maintain proper had clearances.

Replacing Diaphragm

1. Remove the two Phillips-head screws then the retainer plate and diaphragm.
2. Install the new diaphragm in any position onto the connecting rod.
3. Replace the retainer plate and attach with two screws. Torque the screws to 30 in. lbs.

Replacing Inlet and Outlet Valves

1. Remove the slotted machine screw that holds each valve in place.
2. Clean the stainless steel valves with water. Valves are interchangeable.
3. Replace both valves or install new valves making sure that the valves completely cover the raised valve seat. Check that the notch marked on the inlet valve is in the lower right hand corner towards the inlet of the air chamber.
4. Replace the head on the pump. Torque the socket cap screws to 90-100 in. lbs.

Do Not replace the connecting rod or motor bearings.

Check that all external accessories such as relief valves and gauges are attached to cover and are not damaged before re-operating product.

If pump still does not produce proper vacuum or pressure, send unit to a Gast Authorized Service Facility for repair.

WARRANTY

Gast finished products, when properly installed and operated under normal conditions of use, are warranted by Gast to be free from defects in material and workmanship for a period of twelve (12) months from the date of purchase from Gast or an authorized Gast Representative or Distributor. In order to obtain performance under this warranty, the buyer must promptly (in no event later than thirty (30) days after discovery of the defect) give written notice of the defect to Gast Manufacturing Incorporated, PO Box 97, Benton Harbor Michigan USA 49023-0097 or an authorized Service Center (unless specifically agreed upon in writing signed by both parties or specified in writing as part of a Gast OEM Quotation). Buyer is responsible for freight charges both to and from Gast in all cases.

This warranty does not apply to electric motors, electrical controls, and gasoline engines not supplied by Gast. Gast's warranties also do not extend to any goods or parts which have been subjected to misuse, lack of maintenance, neglect, damage by accident or transit damage.

THIS EXPRESS WARRANTY EXCLUDES ALL OTHER WARRANTIES OR REPRESENTATIONS EXPRESSED OR IMPLIED BY ANY LITERATURE, DATA, OR PERSON. GAST'S MAXIMUM LIABILITY UNDER THIS EXCLUSIVE REMEDY SHALL NEVER EXCEED THE COST OF THE SUBJECT PRODUCT AND GAST RESERVES THE RIGHT, AT ITS SOLE DISCRETION, TO REFUND THE PURCHASE PRICE IN LIEU OF REPAIR OR REPLACEMENT.

GAST WILL NOT BE RESPONSIBLE OR LIABLE FOR INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND, however arising, including but not limited to those for use of any products, loss of time, inconvenience, lost profit, labor charges, or other incidental or consequential damages with respect to persons, business, or property, whether as a result of breach of warranty, negligence or otherwise. Notwithstanding any other provision of this warranty, BUYER'S REMEDY AGAINST GAST FOR GOODS SUPPLIED OR FOR NON-DELIVERED GOODS OR FAILURE TO FURNISH GOODS, WHETHER OR NOT BASED ON NEGLIGENCE, STRICT LIABILITY OR BREACH OF EXPRESS OR IMPLIED WARRANTY IS LIMITED SOLELY, AT GAST'S OPTION, TO REPLACEMENT OF OR CURE OF SUCH NONCONFORMING OR NON-DELIVERED GOODS OR RETURN OF THE PURCHASE PRICE FOR SUCH GOODS AND IN NO EVENT SHALL EXCEED THE PRICE OR CHARGE FOR SUCH GOODS. GAST EXPRESSLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE WITH RESPECT TO THE GOODS SOLD. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTIONS SET FORTH IN THIS WARRANTY, notwithstanding any knowledge of Gast regarding the use or uses intended to be made of goods, proposed changes or additions to goods, or any assistance or suggestions that may have been made by Gast personnel.

Unauthorized extensions of warranties by the customer shall remain the customer's responsibility.

CUSTOMER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF GAST PRODUCTS FOR CUSTOMER'S USE OR RESALE, OR FOR INCORPORATING THEM INTO OBJECTS OR APPLICATIONS WHICH CUSTOMER DESIGNS, ASSEMBLES, CONSTRUCTS OR MANUFACTURES.

This warranty can be modified only by authorized Gast personnel by signing a specific, written description of any modifications.

PARTS & ORDERING INFORMATION

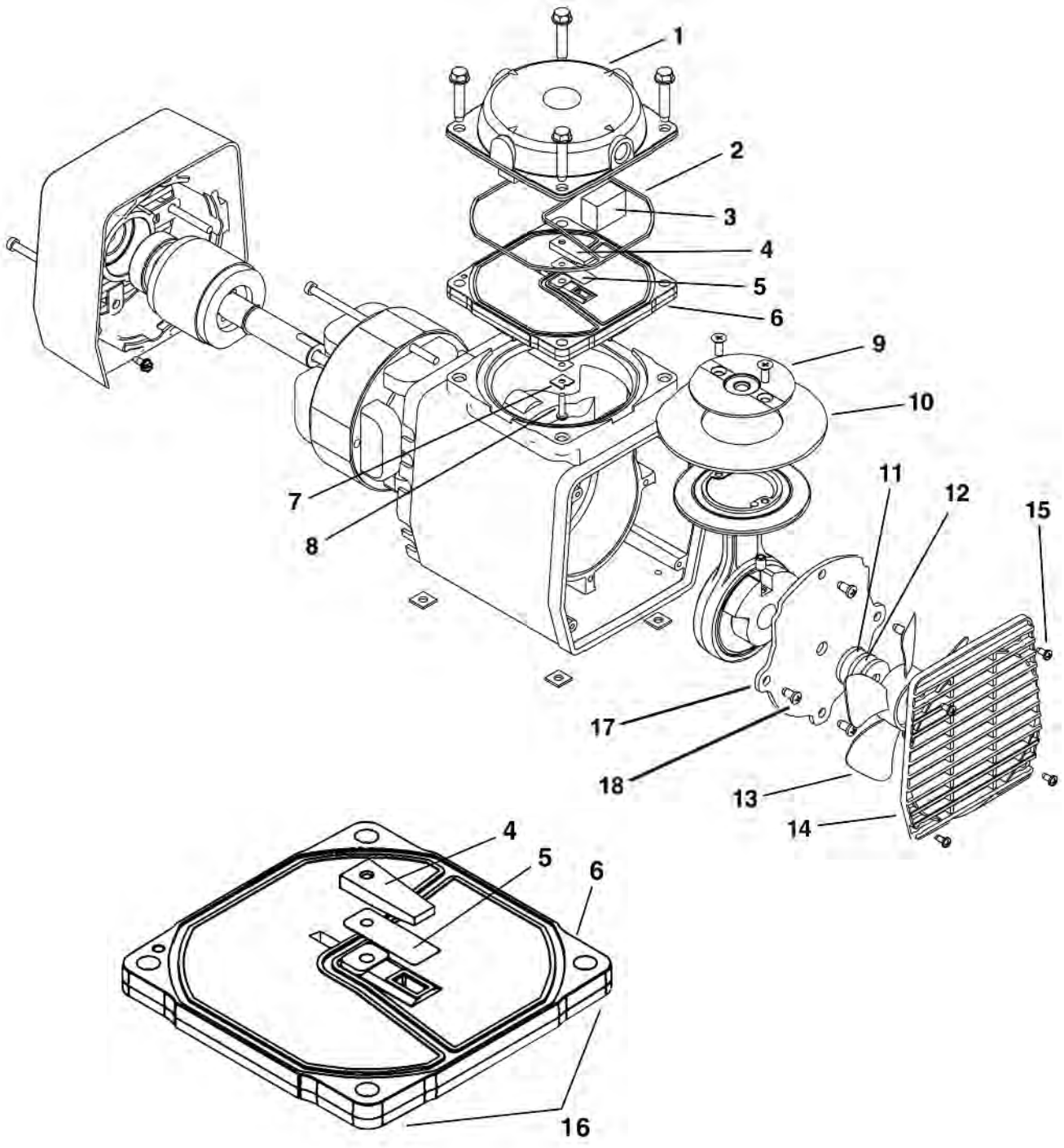
Please reference the exploded views on the next page for the following model and parts table.

DAA / DOA / DOL SERIES

REF	DESCRIPTION	QTY	DOA-P701-AA DOL-701-AA DOA-P501-BN DOA-P501-JH	DAA-P501-EB* DAA-V701-EB*
1	HEAD	1 2	AP500	 AP500
2 Δ	HEAD O-RING	1 2	AP513	 AP513
3 Δ	FILTER/MUFFLER ELEMENT	2 4	AT712A	 AT712A
4 Δ	VALVE LIMITER	1 2	AP110	 AP110
5 Δ	LEAF VALVE	2 4	AF817	 AF817
6	VALVE PLATE	1 2	AP504	 AP504
7 Δ	VALVE RETAINER	1 2	AF819A	 AF819A
8 Δ	VALVE SCREW	1 2	BB330A	 BB330A
9	RETAINER PLATE	1 2	AF809	 AF809
10	DIAPHRAGM–COMPRESSOR	1 2	AF818A	 AF818A
10	DIAPHRAGM–VACUUM	1 2	AF818B	 AF818B
11	FELT SPACER	3 3	AA929	 AA929
12	SPACER	1 2	AD996	 AD996
13	FAN - DOA, DOL FAN - DAA	1 1	AF533	AF533 AF533A
14	GRILLE	1 2	AF807	 AF807
15	RIVET	4 8	AP534	 AP534
16	VALVE PLATE ASSEMBLY	1 2	AP519	 AP519
17	CRANKCASE COVER	1 2	AP526	 AP526
18	CRANKCASE COVER SCREW	2 4	AP525	 AP525
***	SERVICE KIT	1 2	K294A	 K294A

* DOA shown. The double-ended DAA models (not illustrated) are two DOAs mounted back to back with heads rotated.
*** Item not shown.
Δ Denotes parts included in the Service Kit.
Δ The service kit may contain parts for more than one model or style diaphragm pump.
Parts not needed may be discarded.
Parts listed are for stock models. For specific OEM models, please consult the factory.
When corresponding or ordering parts, please give complete model and serial numbers.

EXPLODED PRODUCT VIEWS - MODEL DOA & VALVE PLATE ASSEMBLY



Valve Plate Assembly (available separately)

(Valve Plate Assembly also includes items 7 & 8, as shown in the main exploded view)

TROUBLESHOOTING CHART

Low		High		Pump	Motor	Excess	Reason and remedy
Vacuum	Pressure	Vacuum	Pressure	Overheat	Overload	Noise	for problem.
•	•	At Pump					Filter dirty. Clean or replace.
•	•		At pump				Muffler dirty. Clean or replace.
•	•						Valves dirty or valves bent. Clean or replace.
			•				Relief valve set too high. Inspect and adjust.
•	•						Relief valve set too low. Inspect and adjust.
•	•	At pump	At pump				Plugged vacuum/pressure line. Inspect and repair.
•		At pump					Collapsed vacuum line. Inspect and repair.
				•	•		Low voltage, won't start. Check power source.
				•	•	•	Voltage wrong. Check power source.
				•		•	Cylinder misadjustment. Realign.
•	•						Leaky hose or check valve. Replace.
•	•			•	•	•	Dirt or liquid on top of piston. Inspect and clean.
•	•			•	•		Motor not wired correctly. Check wiring diagram/line voltage.
•	•					•	Blown head gasket. Replace.

For the name of the nearest authorized service facility, contact one of our offices below or visit our website at www.gastmfg.com.

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www.jun-air.com



HYDRASleeve

Simple by Design

US Patents No. 6,481,300; No. 6,837,120; others pending

Field Manual

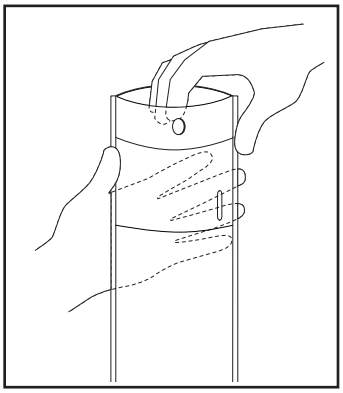
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Introduction

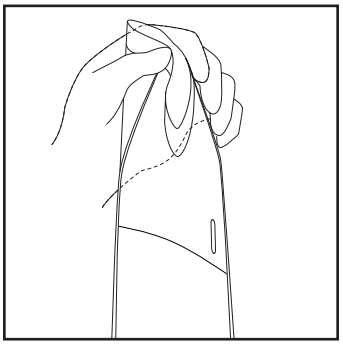
The HydraSleeve groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a whole water sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. One or more HydraSleeves are placed within the screened interval of the monitoring well, and a period of time is allocated for the well to re-equilibrate. Hours to months later, the sealed HydraSleeve can be activated for sample collection. When activated, HydraSleeve collects a sample with no drawdown and minimal agitation or displacement of the water column. Once the sampler is full, the one-way reed valve collapses, preventing mixing of extraneous, non-representative fluid during recovery.

Assembly

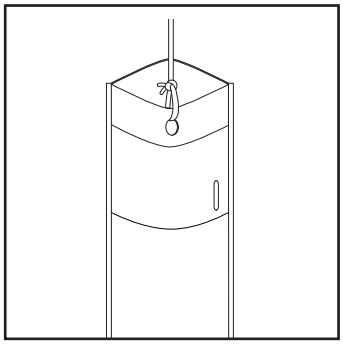
Assembling the HydraSleeve is simple, and can be done by one person in the field, taking only a minute or two.



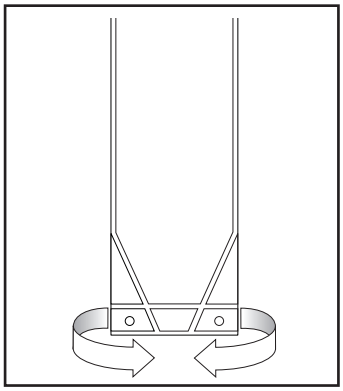
1 Remove HydraSleeve from package and grasp top to "pop" open.



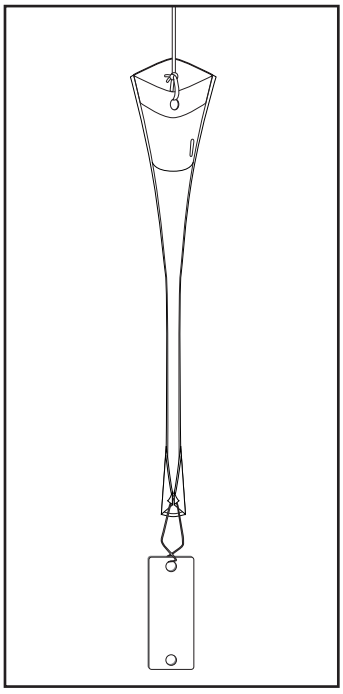
2 Squeeze side fins together at top to bend reinforcing strips outward.



3 Attach line to hole at top of HydraSleeve.



4 Fold the two holes at bottom of HydraSleeve together and attach weight



5 Sampler is ready to insert into the well.

Placing the HydraSleeve(s)

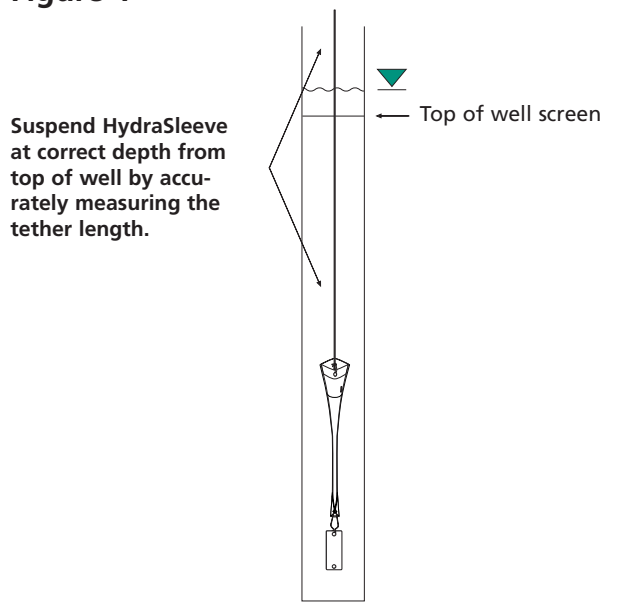
To collect a representative groundwater sample without purging, the well must be allowed time to re-equilibrate after placement of the sampler. When any device is lowered into a well, some mixing of the water column occurs. The diameter of the device and its shape greatly affect the degree of mixing. The flat cross-section of the empty HydraSleeve minimizes the disturbance to the water column as the sampler is lowered into position, reducing the time needed for the well to return to equilibrium.

There are three basic methods for holding a HydraSleeve in position as the well equilibrates.

TOP DOWN DEPLOYMENT (Figure 1)
Measure the correct amount of suspension line needed to "hang" the top of the HydraSleeve(s) at the desired sampling depth (in most cases, this will be at the bottom of the sampling zone). The upper end of the tether can be connected to the well cap to suspend the HydraSleeve at the correct depth until activated for sampling.

Note: For deep settings, it may be difficult to accurately measure long segments of suspension line in the field. Factory prepared, custom suspension line and attachment points can be provided.

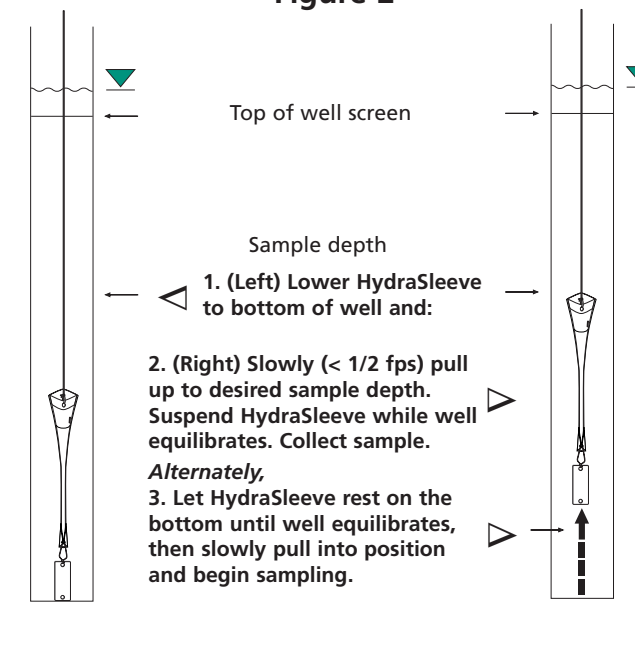
Figure 1



BOTTOM DEPLOYMENT (Figure 2)
Sound the well to determine the exact depth. Lower the weighted HydraSleeve into the well and let it touch the bottom. Very slowly (less than 1/2 foot per second) raise the sampler to the point where the check valve is at the depth the sample is to be collected. Attach the suspension line to the top of the well to suspend it at this depth. (It is often easier to measure a few feet from the bottom of the well up to the sample point, than it is to measure many feet from the top of the well down.)

Alternately, the sampler can be left on the bottom until the well re-equilibrates. For sampling, it can be very slowly pulled (< 1/2 fps) to sampling depth, then activated (see "Sample Collection," p. 6) to collect the sample, and retrieved to the surface.

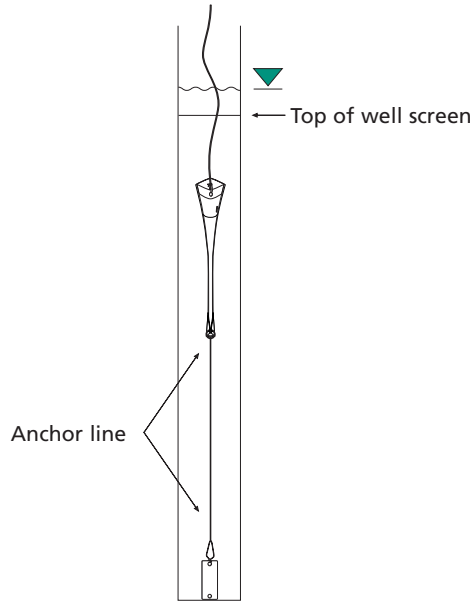
Figure 2



BOTTOM ANCHOR (Figure 3)

Determine the exact depth of the well. Calculate the distance from the bottom of the well to the desired sampling depth. Attach an appropriate length anchor line between the weight and the bottom of the sampler and lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth.

Figure 3



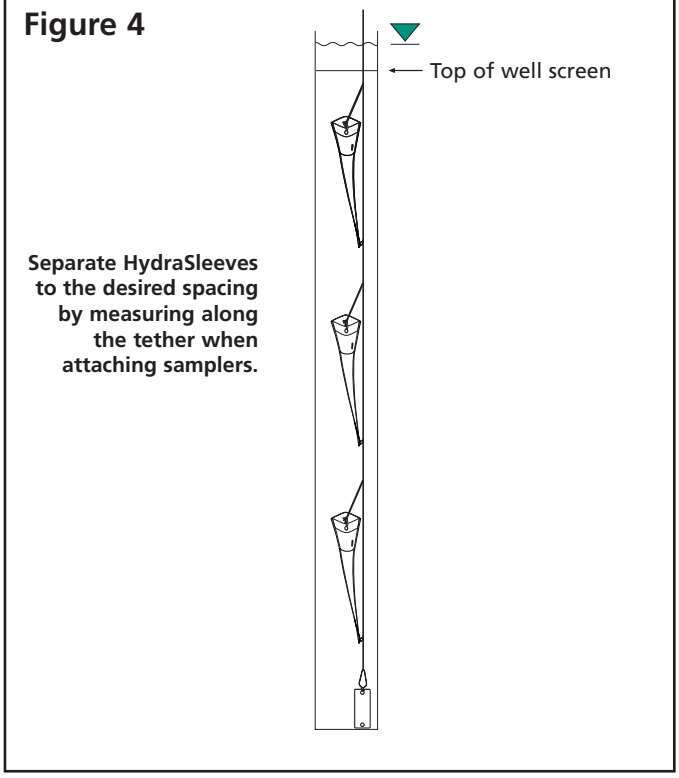
Multiple Interval Deployment

There are two basic methods for placing multiple HydraSleeves in a well to collect samples from different levels simultaneously.

ATTACHED TO A SINGLE TETHER (Figure 4)

To use 3 or more samplers simultaneously, we recommend attaching them all to a tether for support to prevent the sampling string from pulling apart. The weight is attached to a single length of suspension line and allowed to rest on the bottom of the well. The top and bottom of each HydraSleeve are attached to the tether at the desired sample intervals. Cable tie or stainless steel clips (supplied) work well for attaching the HydraSleeves to the line. Simply push one end of the clip between strands of the rope at the desired point before attaching the clip to the HydraSleeve.

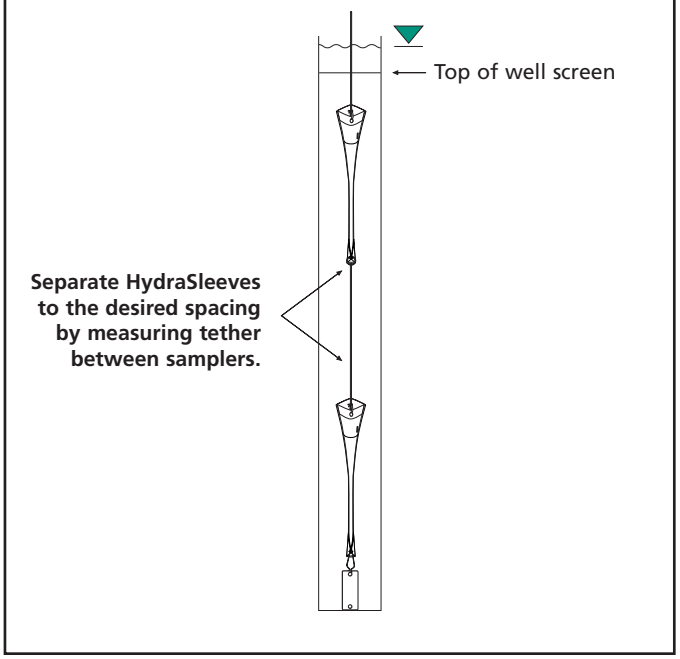
Figure 4



ATTACHED END TO END (Figure 5)

To place 2 or 3 stacked HydraSleeves for vertical profiling, use one of the methods described above to locate the bottom sampler. Attach the bottom of the top sampler to the top of the following HydraSleeve(s) with a carefully measured length of suspension cable. Connect the weight to the bottom sampler. Note: if many HydraSleeves are attached to a tether, more weight may be required than with a single sampler.

Figure 5



Sample Collection

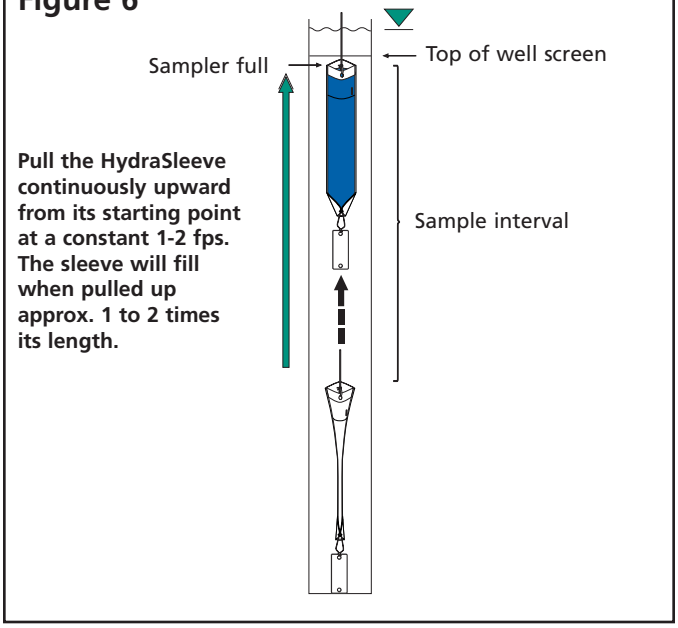
The HydraSleeve must move upward at a rate of one foot per second or faster (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve. The total upward distance the check valve must travel to fill the sample sleeve is about 1 to 2 times the length of the sampler. For example, a 24-inch HydraSleeve needs a total upward movement of 24 to no more than 48 inches to fill. The upward motion can be accomplished using one long continuous pull, several short strokes, or any combination that moves the check valve the required distance in the open position. A special technique is used for sampling low-yield wells.

CONTINUOUS PULL (Figure 6)

Pull the HydraSleeve continuously upward from its starting point at a constant 1 to 2 feet per second until full. This method usually provides the least turbid samples and is analogous to coring the water column from the bottom up.

Note: When using this method, the screen interval should be long enough so the sampler fills before exiting the top of the screen.

Figure 6

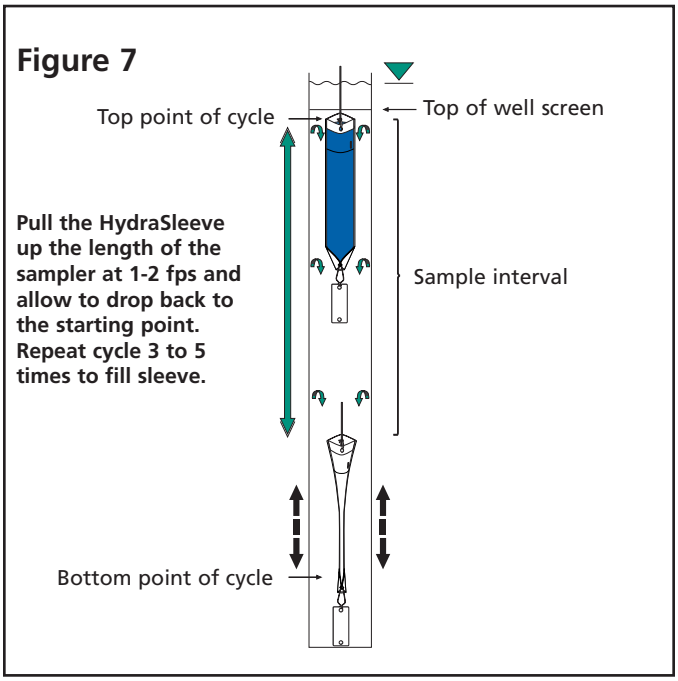


SHORT STROKES (Figure 7)

Pull the sampler upward at about 1 to 2 feet per second for the length of the sampler and let it drop back to the starting point. Repeat the cycle 3 to 5 times.

This method provides a shorter sampling interval than the continuous pull method (above), and usually reduces the turbidity levels of the sample below that of numerous rapid, short cycles (below). The sample comes from between the top of the cycle and the bottom of the sampler at its lowest point.

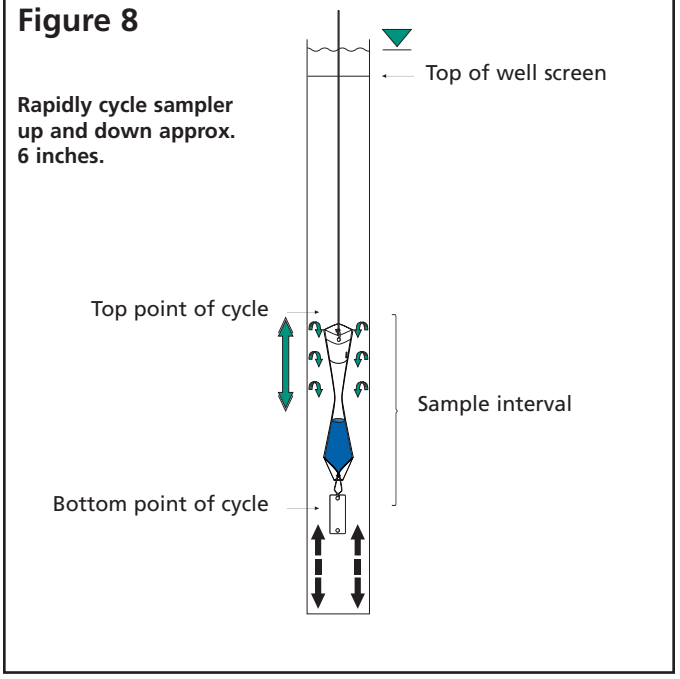
Figure 7



RAPID, SHORT CYCLES (Figure 8)

Cycle the HydraSleeve up and down using rapid, short strokes (6-inch cycle at a minimum of 1 cycle per second) 5 to 8 times. This method provides the shortest sampling interval. Dye studies have shown that when using this method the sample flows into the check valve from along the length of the sampler and immediately above the check valve. The sample interval is from the bottom the sampler at its lowest point in the cycle to the top of the check valve at the peak of the cycle.

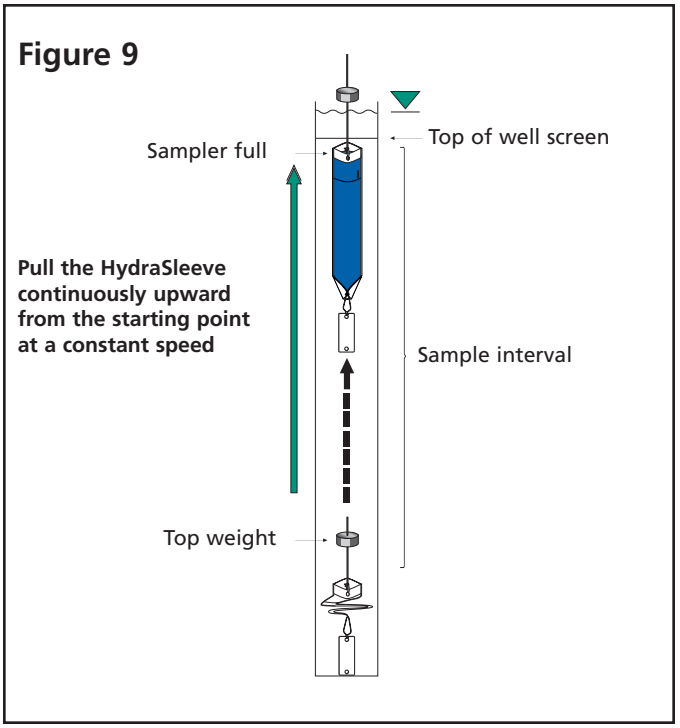
Figure 8



SAMPLING LOW-YIELD WELLS (Figure 9)

HydraSleeve provides the best available technology for sampling low yield wells. When pulled upward after the well re-equilibrates, the HydraSleeve will collect a water core from the top of the sampler to about its own length above that point. The sample is collected with no drawdown in the well and minimal sample agitation. An optional top weight can be attached to compress the sampler in the bottom of the well if needed for an extremely short water column. With a top weight, the check valve is pushed down to within a foot of the bottom of the well.

Figure 9



Sample Discharge

The best way to remove a sample from the HydraSleeve with the least amount of aeration and agitation is with the short plastic discharge tube (included).



First, squeeze the full sampler just below the top to expel water resting above the flexible check valve. (Photo 1, top left)



Then, push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips. (Photo 2, middle left)



Discharge the sample into the desired container. (Photo 3, bottom left)

Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste. With a little practice, and using a flat surface to set the sample containers on, HydraSleeve sampling becomes a one-person operation.

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DATA SHEET

Variable Area Flow Meters



2500 Series

QuickShip

2500 Series

Precision-Machined Acrylic Variable Area Flow (Purge) Meters for Gases & Liquids

Series 2500 is a standard precision-machined acrylic flow meter for liquids and gases, with direct reading air or water scales and is available in either English or metric scales.

Models 2510/2520/2530 can be configured with a control valve on the inlet or no valve. Fittings and valve can be specified in either brass or stainless steel. O-rings are available in Buna-N, Viton® fluoroelastomer or other optional elastomers.

Model 2540 flowmeters have standard 1" FNPT PVC fittings with either an in-line Model 2540-I or panel mount Model 2540-S configuration. The panel mount version is available with an integral valve on the inlet Model 2540-V or no valve.

Typical applications include:

- Air sampling equipment aquaculture
- Gas analyzers
- Photo processing equipment systems
- Desalinization equipment
- Medical systems
- Water treatment and distribution

Features:

- Easy-to-read English or metric scales
- Air ranges from 40 ccm to 4000 LPM
- Easy disassembly/assembly for installation
- Stable easy-to-read float
- Water ranges from 4 ccm to 20 GPM
- Threaded brass inserts for quick maintenance

Product Specifications

	2510	2520	2530	2540
PERFORMANCE				
Accuracy	±5% full scale[1]	±3% full scale[1]		±2% full scale[1]
Flow Rates	See Table A	See Table B	See Table C	See Tables D & E
Floats	Black Glass, 316 Stainless Steel		Stainless Steel	
Body	Clear Acrylic			
Seals	Buna-N O-rings with Brass fittings; Viton® O-rings with 303 Stainless Steel fittings			Buna-N O-rings w/Brass or PVC fittings Viton O-rings w/Stn Stl fittings
Pressure	100 PSIG Max.			
Temperature	150°F/65°C Max.			
Fittings	Brass, 303 Stainless Steel			PVC FNPT Pipe Connections (Std.)
Valves	Brass or Stainless Steel			Integral Valve on "V" models Inline Gate Valve is available for "S and I" models
Certifications	International Calibration Certificate (ICC); Pressure Equipment Directive (97/23/EC); RoHS			

[1] At reference conditions of 70°F (21.1°C)/14.7 psia (1 Bar A)

View 2500 Series Product Page

KEY INSTRUMENTS

Model 2510 Flow Rates - Table A

Range SCFH of Air	Tube Code	Range LPM of Air	Tube Code
.1-1	2A00	0.04-0.5	2A12**
.2-2	2A01	.1-1	2A13**
.4-5	2A02	.2-2.5	2A29**
0.5-10	2A03	.4-5	2A14**
4-50	2A06	1-10	2A15**
10-100	2A07	2-25	2A16**
20-200	2A08	6-50	2A17
		10-100	2A18
CCM of Water	**Tube Code**	**GPH of Water**	**Tube Code**
10-100	2L10	.2-2	2L28
20-240	2L11	.4-5	2L19
		1-10	2L20**
		2-20	2L21
		4-40	2L22

** QuickShip

Select meters ship in 3 days.
Max order quantity = 15 meters.
Consult factory on orders of more than 15 me-

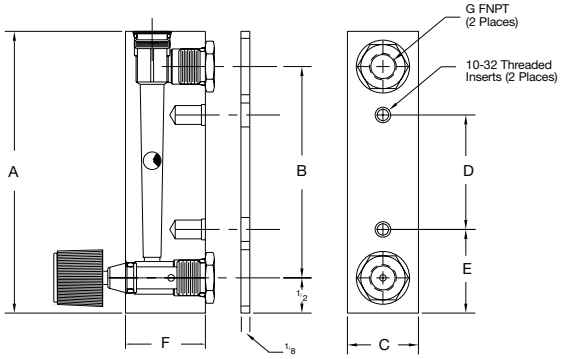
Model 2520 Flow Rates - Table B

Range SCFH of Air	Tube Code	Range CCM of Water	Tube Code
.4-5	4A30	4-50	4L38
1-10	4A31	10-120	4L56
4-40	4A33	25-225	4L51
10-100	4A34**	40-400	4L50
20-200	4A36	40-660	4L52
		100-1500	4L53**
CCM of Air	Tube Code	200-3000	4L54
100-1000	4A39*	300-3700	4L55
LPM of Air	Tube Code	GPH of Water	Tube Code
.4-5	4A40**	1-10	4L45**
1-10	4A41**	2-25	4L48**
2-20	4A42**	6-60	4L46**
3-30	4A43		
4-50	4A44	SCFM of Air	Tube Code
10-100	4A47**	.3-3	4A37**

* Uses Delrin® float.

** QuickShip *Select meters ship in 3 days.*
Max order quantity = 15 meters.
Consult factory on orders of more than 15

Dimensions: Models 2510, 2520 & 2530



Dimensions - Inches (MM)

Model	A	B	C	D	E	F	G
2510	4" (102)	3" (76.2)	1" (25.4)	1-5/8" (41.3)	1-3/16" (30.2)	1-1/8" (28.6)	1/8" FNPT
2520	6-1/2" (165)	5-1/2" (140)	1-3/8" (34.9)	3-1/2" (88.9)	1-1/2" (38.10)	1-1/8" (28.6)	1/8" FNPT
2530*	6-5/8" (168)	5-1/2" (140)	1-1/8" (28.6)	3-1/2" (88.9)	1-1/2" (38.1)	1-3/8" 34.9)	1/4" FNPT

* Does not include 1/8" back plate

Model 2530 Flow Rates - Table C

Range SCFM of Air	Tube Code	Range GPM of Water	Tube Code
.5-5	4A67	.25-2.5	4L64
1-10	4A65	.5-5	4L66
4-20	4A68	LPM of Water	Tube Code
LPM of Air	Tube Code	1-10	4L69
14-140	4A72	2-20	4L71
30-300	4A70	Dual Scales: SCFM/SCFH, GPM/GPH and LPM/LPH	
100-560	4A73		

Ordering Information / Typical Model Code for Models 2510, 2520 & 2530

Code	Description	Code Option	Option Description
I.	Base Model Number	2510	Acrylic Flowmeter: ±5% Full Scale
		2520	Acrylic Flowmeter: ±3% Full Scale
		2530	Acrylic Flowmeter: ±3% Full Scale
II.	Revision	A	Revision Level
III.	Tube Code	XXXX	From Table A, B or C
IV.	Fittings	B**	Brass
		S**	Stainless Steel
V.	Valves	N**	No Valve
		V**	Standard Inlet Valve
		O	Outlet Valve (Vacuum service 2510 & 2520 only)
VI.	Seals	BN**	Buna N (Standard with brass fittings) Brass only
		VT**	Viton® fluoroelastomer (Std. with SS) SS only
VII.	Options	-NL	No Logo

Additional Options
- Certificate of Conformance
- ICC
- Paper Tag
- Stainless Steel Tag
- Degrease for O_2 Cleaning

Sample Standard Model Code

I	II	III	IV	V	VI	VII
2510	A	2A03	B	V	BN	-NL

** QuickShip *Select meters ship in 3 days.*
Max order quantity = 15 meters.
Consult factory on orders of more than 15 meters.

Model 2540 - S Flow Rates - Table D

Range SCFM of Air	Tube Code	Range GPM of Water	Tube Code
3-25	5A50	.4-5	5L56
4-50	5A51	1-10	5L57
10-100	5A52	2-20	5L58
LPM of Air	**Tube Code**	**LPM of Water**	**Tube Code**
100-700	5A53	1-19	5L59
100-1400	5A54	4-36	5L60
400-3000	5A55	5-75	5L61

Model 2540 - I Flow Rates - Table E

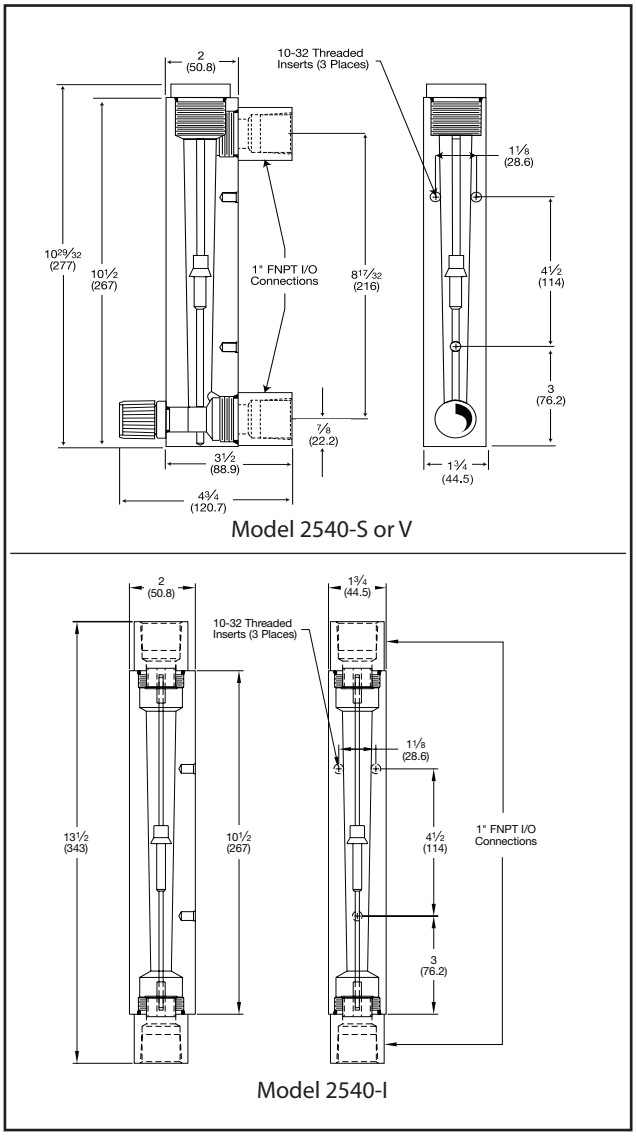
Range SCFM of Air	Tube Code	Range GPM of Water	Tube Code
3-25	5A50	.4-5	5L56
4-50	5A51	1-10	5L57
10-100	5A52	2-20	5L58
LPM of Air	**Tube Code**	**LPM of Water**	**Tube Code**
100-700	5A53	1-19	5L59
100-1400	5A54	4-36	5L60
400-4000	5A55	5-75	5L61

Periodically product revisions occur. Please consult the factory for the latest specifications.

Model 2540 - V Flow Rates - Table F

Range SCFM of Air	Tube Code	Range GPM of Water	Tube Code
3-25	5A50	.8-5	5L56
4-50	5A51	1.5-10	5L57
10-100	5A52	3-20	5L58
LPM of Air	**Tube Code**	**LPM of Water**	**Tube Code**
100-700	5A53	3-19	5L59
100-1400	5A54	6-36	5L60
400-3000	5A55	10-75	5L61

Dimensions: Model 2540 S, V & I



Ordering Information / Typical Model Code for Model 2540

Code Description	Code Option	Option Description
I. Base Model Number	2540	Acrylic Flowmeter: ±2% Full Scale
II. Revision	A	Revision Level
III. Tube Code	XXXX	From Table D or E
IV. Fitting Material	P	PVC (Standard)
	S	Stainless Steel
V. Fitting / Valve	S	Back Connections (Standard)
	I	End Connection
	V	Valve (Back connection only)
VII. Options	-NL	No Logo

Additional Options
- Certificate of Conformance
- ICC
- Paper Tag
- Stainless Steel Tag
- Degrease for O_2 Cleaning

Sample Standard Model Code

I	II	III	IV	V	VI
2540	A	5A53	P	V	-NL

Service and Support

Key Instruments is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.KeyInstruments.com to locate the service location nearest to you.

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Key Instruments can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

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GEM5000 Gas Analyzer

Operating Manual



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Rev.2.1.2018

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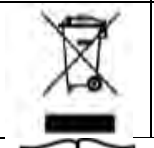
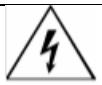
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1.0 Manual guidelines

1.1 Hazard warnings and safety symbols

 Warning	Information in this manual that may affect the safety of users and others is preceded by the warning symbol. Caution - Failure to follow the correct information may result in physical injury which in some cases could be fatal. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

General product label symbols are listed as follows:

	CE conformity-The CE-marking is the manufacturer's statement to the EU authorities that the product complies with all relevant CE-marking Directives.		If the CSA mark appears with the indicator "US" or "NRTL" it means that the product is certified for the U.S. market, to the applicable U.S. standards.
	VDE mark is a symbol for electrical, mechanical, thermal, toxic, radiological and other hazards.		Separate collection, handling and disposal for waste electrical and electronic equipment and its components.
	Electric shock warning.		Refer to operators manual.
	Double insulated construction - does not require an Earth.		Specific marking of explosion protection (ATEX only).
II 2G	Equipment group and category. G = gases; the type of explosive atmosphere.		IECEx licenced mark (IECEx only).
	Fuse.		Equipment for indoor use only.

1.2 Notes

Important/useful information and instructions are shown clearly throughout the manual in a note format. For example:

✍ Note: For further information please contact Technical Support at (800) 968-2026 or email landtec_support@qedenv.com

2.0 Introduction

This manual explains how to use the GEM5000 landfill gas analyzer. The GEM5000 has additional functionality to the GA5000 gas analyzer. The GA5000 measures gas concentrations only, whereas the GEM5000 measures flow and gas concentrations. The GEM5000 measures flow and calculates the calorific values of the gas as well as being a useful tool for balancing the gas field. The GEM5000 gas analyzer may be used to monitor, calculate, adjust and record the flow at each monitoring point.

This instrument may also be used in GA5000 mode of operation if required. The operator may change the analyzer between a gas extraction monitor (a GEM5000 gas analyzer) or a landfill gas analyzer (a GA5000 gas analyzer). The mode of operation can be changed from the 'Special Action' menu. Please refer to section '8.0 – Taking Readings' for further instruction.

The 5000 series of gas analyzers complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1) This device may not cause harmful interference.

2) This device must accept any interference received, including interference that may cause undesired operation.

2.1 Safety instructions

⚠ **Warning**	The 5000 series of gas analyzers can be used for measuring gases from landfill sites and other sources as described in this manual. The operator may be exposed to harmful gases during the use of the instrument. Inhaling these gases may be harmful to health and in some cases may be fatal. It is the responsibility of the user to ensure that he/she is adequately trained in the safety aspects of the gases being used and appropriate procedures are followed. In particular, where hazardous gases are being used the gas exhausted from the analyzer must be piped to an area where it is safe to discharge the gas. Hazardous gas can also be expelled from the instrument when purging with clean air. The instrument has been designed to be used in explosive atmospheres as defined by the classification. The instrument can be configured to measure low levels of several gases, but may not be certified for use in potentially explosive atmospheres of these gases. It is the responsibility of the operator to determine the protection concept and classification of equipment required for a particular application and whether these gases create a potentially explosive atmosphere.

✍ Note: Gas analyzers are a sensitive piece of scientific equipment, and should be treated as such. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

2.2 Instructions for safe use

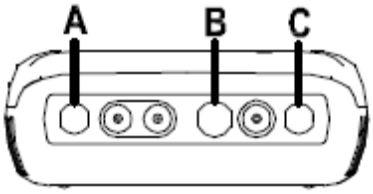
For ATEX and IECEx the 5000 series of gas analysers are certified to Hazardous Area Classification

II 2G Ex ib IIA T1 Gb (Ta = -10ºC to +50ºC)

It is vital instructions are followed closely. It is the responsibility of the operator to determine the protection concept and classification required for a particular application.

(Reference European ATEX directive 2014/34/EU)
The following instructions apply to equipment covered by certificate numbers SIRA 11ATEX2197X and IECEx SIR 11.0089X:

- The equipment may be used with flammable gases and vapours with apparatus group IIA and temperature class T1.
- The equipment can contain gas sensing heads for the detection of particular gases. The inclusion of a sensor does not infer that the equipment is suitable for the use of gases with a temperature class of less than T1.
- The equipment is only certified for use in ambient temperatures in the range -10ºC to +50ºC and should not be used outside this range.
- The equipment must not be used in an atmosphere of greater than 21% oxygen.
- Repair of this equipment shall be carried out in accordance with the applicable code of practice.
- When used in a hazardous area only use GF5.2 temperature probe (SIRA 11ATEX2197X and IECEx SIR11.0089X). For connector C, the GF5.4 anemometer (BVS 04ATEXE194) for use with ATEX only. The analyser should not be connected to any other devices in the hazardous area including the GF-USB lead (connector A) or GF3.9 battery charger (connector B) supplied with the analyzer.



Do not charge, recharge or open in a potentially explosive atmosphere.
In hazardous area only use "Temperature Probe GF5.2" in Connector B.
Connector C (Uo=10V,Io=5mA,Po=50mW,Ci=0,Li=0,Co=100uF,Lo=1000mH),
Connector B (Uo=5V,Io=6mA,Po=7mW,Ci=0,Li=0,Co=100uF,Lo=1000mH)

MAXIMUM NON-HAZARDOUS SUPPLIES:
Connector A - Um=6V Connector B - Um=10.1V

- The safe area apparatus that is to be connected to the USB Port shall be a Safety Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV) circuit.
- Only a Geotechnical Instrument battery pack part number 20087 or 2011113 is permitted as a replacement. This battery pack is not field replaceable and shall only be changed in a safe area by QED personnel.
- Only Battery Charger type GF3.9 shall be used to recharge the batteries via Connector 'B'.
- If the equipment is likely to come into contact with aggressive substances, e.g. acidic liquids or gases that may attack metals, or solvents that may affect polymeric materials, then it is the responsibility of the user to take suitable precautions, e.g. regular checks as part of routine inspections or establishing from the material's data sheet that it is resistant to specific chemicals that prevent it

from being adversely affected, thus ensuring that the type of protection is not compromised.

- The relative pressure range is +/-500 mbar. Note, however, that the input pressure should not exceed +/- 500 mbar relative to atmospheric pressure and the output pressure should not exceed +/- 100 mbar relative to atmospheric pressure.

For CSA (Canada) the 5000 series of gas analysers are certified to Hazardous Area Classification

CLASS 2258 03 - PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non-Incendive Systems - For Hazardous Locations



Ex ib IIA:

Model GA 5000, GEM 5000 and BIOGAS 5000 Methane Detectors; portable, battery powered with non-field-replaceable Battery Pack P/N 20087 or 2011113; intrinsically safe and providing intrinsically safe circuits ("[ib]" for Zone 1) to Model GF5.2 Temperature Probe (Connector B) and with entity output parameters as tabulated below; Temperature Code T1; -10 ºC ≤ Tamb. ≤ +50ºC.

Connector	Entity Parameters						
	Uo (V)	Io (mA)	Po (mW)	Co (uF)	Lo (mH)	Ci (uF)	Li (mH)
B	5.0	6	7	100	1000	0	0
C	10.0	5	50	100	1000	0	0

✍ Note: This device has been investigated for electrical safety features only.

For CSA (USA) the 5000 series of gas analysers are certified to Hazardous Area Classification

CLASS 2258 83 - PROCESS CONTROL EQUIPMENT - Intrinsically Safe and Non-Incendive Systems – For Hazardous Locations - CERTIFIED TO U.S. STANDARDS



AEx ib IIA:

Model GA 5000, GEM 5000 and BIOGAS 5000 Methane Detectors; portable, battery powered with non-field-replaceable Battery Pack P/N 20087 or 2011113; intrinsically safe and providing intrinsically safe circuits ("[ib]" for Zone 1) to Model GF5.2 Temperature Probe (Connector B) and with entity output parameters as tabulated below; Temperature Code T1; -10 ºC ≤ Tamb. ≤ +50ºC.

Connector	Entity Parameters						
	Uo (V)	Io (mA)	Po (mW)	Co (uF)	Lo (mH)	Ci (uF)	Li (mH)
B	5.0	6	7	100	1000	0	0
C	10.0	5	50	100	1000	0	0

✍ Note: This device has been investigated for electrical safety features only.

2.3 MCERTS

MCERTS is the UK Environment Agency's Monitoring Certification Scheme. The scheme provides a framework within which environmental measurements can be made in accordance with the Agency's quality requirements. The scheme covers a range of monitoring, sampling and inspection activities.

MCERTS promotes public confidence in monitoring data and provides industry with a proven framework for choosing monitoring systems and services that meet the Environment Agency's performance requirements.

The Environment Agency has established its Monitoring Certification Scheme (MCERTS) to deliver quality environmental measurements. The MCERTS product certification scheme provides for the certification of products according to Environment Agency performance standards, based on relevant CEN, ISO and national standards.

MCERTS certified instruments have been tested by an independent body to ensure that they meet certain performance requirements. In addition the manufacturer of an MCERTS product is regularly audited to ensure that the performance requirements of the certification are being continually met.

The 5000 series of gas analyzers have been certified to Version 3.1 of the 'Performance Standards for Portable Emission Monitoring Systems'.

2.4 CIRIA

The CIRIA guideline 'Assessing the risks posed by hazardous ground gases to buildings' proposes that gas concentrations and flow rates should be monitored.

As an example methodology, they suggest using a gas analyser to first measure flow and pressure and then afterwards to measure gas concentration.

The logging profile option offers frequency of data to be collected within a timed period which, in return, identifies a gas profile of the sample point being monitored, information about whether the sample point is performing correctly, when the peaks occur and whether air is drawn in after a certain period. This logging option is available on firmware software version 1.6.5
Versions of the GA5000 analyzer range with internal flow on firmware version 1.6.5 and above have the ability to take measurements according to the CIRIA guidelines, while still allowing other users to take the measurements as before.

3.0 The GEM5000 Gas Analyzer

3.1 The GEM5000



The GEM5000 gas analyzer is designed to monitor landfill gas extraction systems.

Benefits:

- Allows balancing of gas extraction site.
- Maximize power generation from site.
- Field proven.
- Standardizes monitoring routines.
- Easy transfer of data.
- GPS for compliance.

Features:

- ATEX certified.
- MCERTS certified.
- H_2 compensated CO.
- Calculates flow (m^3/hr) and calorific value (kW or BTU).
- Technician log-in.
- Event log.
- Two instruments in one (GA and GEM mode).
- Measures static and differential pressure.
- Simultaneous display of gases.
- Storage of changes in set-up of gas field.
- Data logging.

Applications:

- Gas extraction fields.
- Flare monitoring.
- Landfill sites.

3.2 GEM5000 standard product



Reference:

A	Hard carry case
B	In-line water trap tubing & filter
C	Gas analyser instrument
D	H2S filter (optional – if the compensated CO cell is fitted)
E	5000 series safety manual
F	Mains battery charger and adaptors: - UK - Europe - US - Australia

4.0 GEM5000 Optional Products and Accessories

4.1 Optional products

The GEM5000 gas analyzer has a number of optional products for purchase which enhance the usability and enable further analysis of data and reading information.

✍ Note: For more information on the features listed in this section please contact Sales at (800) 624-2026 or email info@qedenv.com

4.1.1 Pitot tube (optional)

The GEM5000 gas analyzer enables the use of a pitot tube to aid accurate flow measurement. The pitot tube is used for gas extraction systems and the pressure readings are taken in mbar. High gas flow is calculated in the analyzer in m^3/hr (metres cubed per hour).

4.1.2 Orifice plate (optional)

QED recommends the use of orifice plates as good practice when using the GEM5000 gas analyzer, enabling repeatability in flow measurement via a fixed method. Contact Sales at (800) 624-2026 or email info@qedenv.com if the use of Orifice plates is required.

4.1.3 Temperature probe (optional)

The GEM5000 gas analyzer has the facility to automatically display and record the borehole temperature via an optional temperature probe.

When a temperature probe is fitted the temperature reading will be displayed on the 'Main Gas Read Screen' and recorded with all other data.

✍ Note: Temperature probes with an Ex label are part of the GEM5000 Ex certification SIRA 11ATEX2197X and IECEx SIR11.0089X, and therefore certified for use under the same conditions as the analyzer.

4.1.4 Anemometer (optional)

The GEM5000 gas analyzer has the facility to automatically display and record high flow via an optional anemometer probe. It is designed to plug into the instrument and instantly provide a flow indication. An anemometer probe adds flow measurements to the professional reporting ability of the GEM5000 range along with gas concentrations, pressure and temperature.

The anemometer has a simple connection, a narrow diameter measurement head (11mm), a wide temperature operating range (up to 80°C) and indicates flows up to 40 m/sec.

When an anemometer probe is fitted to the analyzer the flow will be displayed in the 'Main Gas Read Screen' and recorded with all other data.

Flow can be measured in either m/s (gas velocity) or m^3/hr (volume flow rate). In order to calculate the volume flow rate the pipe diameter will need to be entered into the instrument, either manually or via the Landtec Systems Gas Analyser Manager, (LSGAM), software.

✍ Note: The anemometer probe is ATEX certified for use in a potentially explosive atmosphere under Ex certificate BVS 04ATEXE194.

4.1.5 H_2S filter (optional)

The GEM5000 gas analyzer has the capability to use an H_2S filter and is required as standard if the compensated CO cell is fitted and configured at the time the instrument is manufactured. H_2S gas can have a cross-gas effect on the CO reading. By using a filter, the H_2S is removed from the gas sample, therefore providing a more accurate CO reading.

The filter only needs to be used when you are trying to get rid of any possible cross gas effects H_2S might have on other gases. Do not use the filter on all boreholes.

4.1.6 Landtec Systems Gas Analyzer Manager – LSGAM (optional)

Landtec Systems Gas Analyzer Manager (LSGAM) enables the operator to maximize the operation of the gas analyzer. It enables direct communication with the unit, features a simple upload and download facility and is fully compatible with the latest Microsoft™ operating systems.

Features:

- Organization and transfer of borehole IDs and readings to and from the gas analyzer.
- Configuration of the gas analyzer.
- Flexible grouping of the IDs.
- Structured organization of transferred data.
- Automatic detection of instrument type and available options.
- Secure data mode to prevent tampering.
- First time set-up wizard.
- Enable flow measurements for GEM5000 gas analyzers.

4.1.7 GPS (optional)

An optional GPS feature is available for the GEM5000 gas analyzer. It enables the site engineer to automatically locate borehole IDs using GPS satellite signal from predefined borehole IDs uploaded from LSGAM or set on the analyzer when out in the field prior to taking a reading. The GPS reading data is stored for each measurement reading providing an audit trail confirming that a reading was taken.

4.1.8 Bluetooth

The analyzers are fitted with a Bluetooth receiver which enables the operator to download readings and upload IDs without the need to connect the analyzer to a PC via a USB cable.

5.0 GEM5000 Instrument Features

5.1 Physical characteristics of the instrument panel

Front view:



Reference:

A	Main Gas Read Screen
B	Soft-keys
C	Backlight Key
D	Menu Key
E	Pump key
F	LED Light
G	On/Off Key
H	Assistance key
I	Enter Key
J	Scroll up key
K	Scroll down key
L	Key 0 – Space key

Back view:



Reference:

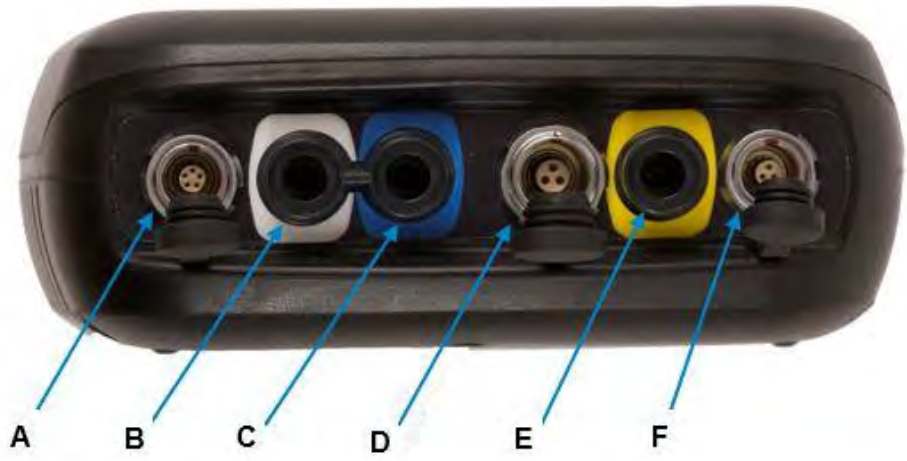
M	Model Number
N	Serial number
O	Part number
P	Certificate number
Q	Recalibrated date

5.2 Analyzer features and keys

A	Main Gas Read Screen	Start and end screen when using the instrument.
B	Soft-keys	The function of the three 'soft-keys' on the front of the instrument panel is determined by menu options taken. Functions vary from screen to screen.
C	Backlight key	Enables the operator to turn the backlight on/off on the analyzer display panel.
D	Menu key	Press the 'Menu' key to view and maintain User, Device and Operation settings.
E	Pump key	Press the 'Pump' key to start or stop the pump.
F	LED light	LED power light is visible on the front of the analyzer when the instrument is powered on.
G	On/Off key	Press the 'On/Off' key for 2 seconds to switch the instrument on and off.
H	Assistance key	Press for on-screen assistance and help.
I	Enter key	Use to accept changes, options, user inputted answers etc.
J	Key 2 – Page Up	Also 'Key 2'. Press scroll up to view further information on the instrument screen.
K	Key 8 – Page down	Also 'Key 8'. Enables the operator to scroll down to display more information.
L	Key 0 – Space key	Also 'Key 0'. Press to enter a space when entering text on the instrument screen.
M	Model Number	Instrument model type identification.
N	Serial Number	Unique identification for the instrument. Verification of the serial number will be required if Technical Support assistance is needed.
O	Part Number	Manufacturer's part number.
P	Certification Number	Displays instrument certification information.
Q	Recalibrated Date	The date displayed is the date the instrument is due to be calibrated.

5.3 Instrument connection points

Top view:



Ref:	Connection Point:	Function:
A	Connector A	Attach the USB cable for PC-to-analyzer connectivity.
B	Inlet Port & Static Pressure Port (White port)	Attach the sample tube to take a gas sample. Also used to measure the static pressure.
C	Differential Pressure Port (Blue port)	Attach the sample tube to measure differential pressure.
D	Connector B	Attach the temperature probe and also used to attach the mains charger to the analyzer for charging.
E	Gas Outlet Port (Yellow port)	The gas outlet port is the point at which the sample gas is expelled. Tubing may also be attached to the port.
F	Connector C	Attach the anemometer.

6.0 General Operational Instructions

6.1 Switching the instrument on

1) To switch on the analyzer, press and hold the 'On/Off' key. The Landtec logo will display followed by the instrument warm up.

2) Following the instrument warm up, the 'Date and Time' screen is displayed prompting the technician to set the date and time and required format.

3) When complete, select the soft-key to 'Exit' and the 'Power On Self-test' screen is displayed followed by instrument status. Instrument status displays the instruments service due date, serial number, options, service scheme and software version. Text will also display stating 'Self-test complete'.

4) Select the soft-key 'Next' to move onto the next screen and the 'Technician Login' screen is displayed.

5) Use the cursor keys to move through the list of ID's. Select either the required 'Technician ID' from the list followed by the soft-key 'Accept', or select 'Default'' followed by the soft-key 'Accept' to continue to the 'Main Gas Read Screen'.

   ✍ Note: The selected technician ID is displayed at the top left corner of the Main Gas Read Screen.

6.1.1 Power on self-test

When switched on, the read-out will perform a pre-determined self-test sequence. During this time many of the analyzer's functions are tested, including:

- General operation
- Gas flow measurement
- Calibration
- Battery charge level

During the self-test the following information is also displayed:

- Manufacturer's service due date
- The last gas check date
- Software version programmed
- Date format
- Serial number
- Operating language
- The currently enabled sales option

✍ Note: The self-test should only be done with the analyzer sampling fresh air.

6.2 Switching the instrument off

1) To switch off the analyzer, press and hold the 'On/Off' key, at which point a clean air purge will be carried out and the instrument will then switch off.

2) If for any reason the analyzer 'locks up' and will not switch off in this manner, press and hold the 'On/Off' key for 15 seconds; this will force the instrument to switch off.

6.3 Instrument status icons

The following icons may be displayed on the instrument screen:

Icon	Description	Icon	Description
	**Battery charge state** Gives the operator an estimation of the battery charge state. For example 100% gives about 8 hours use in the field and 50% would mean that there is approximately 4 hours battery life remaining.		**Battery charge state** Indicates less than 2 hours of charge remaining.
	**Pump status** This icon is displayed along with a counter showing the pump run-time. This counts down where the operator has specified the pump run-time; if not it counts up; the icon turns red when stalled.		**Pump stalled** This icon is displayed when the pump stalls. The instrument's gas inlet (or outlet) may be blocked. This warning is most commonly caused by a water-logged or dirty sample filter. Change the sample filter and check for obvious blockages in the sample tubes. Alternatively, a small amount of adjustment can be made to the low flow detection point to compensate for minor changes in the performance of the pump fitted to the instrument.
	**GPS signal strength** This icon shows the signal strength the analyzer's GPS module is able to provide. Full, okay and fair strength respectively.		**GPS failure** The GPS was unable to get a line of sight lock on enough satellites. Or, it may be that it hasn't had time to get a lock.
	This indicates when Bluetooth has been enabled. The color changes from gray to blue when connected.		**Language** This icon indicates the currently selected operating language. This can be changed via the main menu.
	**Data logging** This icon indicates that the data logging feature is in operation.		**Service overdue** This icon indicates that the analyzer is overdue for service
	**Legacy mode** This icon indicates that the analyzer is in legacy mode and hence is ready to connect to a PC.		**USB disabled** This icon indicates that the analyzer has reached a battery critical state, and hence has turned off its USB connectivity.

6.4 Instrument LED power states

When the instrument is powered on a LED power light is visible on the front of the analyzer, located above the 'On/Off' key. The following LED power light states are as follows:

Steady yellow	Unit turning on. This will extinguish when software has loaded correctly.
Flashing (rapid)	Unit is powering off.
Flashing (slow)	Power off is being delayed for purge/shutdown handling.
Flashing yellow	Unit is turning off due to power button being pressed.
Flashing red	Unit is turning off due to critically low battery.

✍ Note: Pressing and holding the power button for ~20s resets the analyser.

6.5 Changing between parameters

By default, the instrument displays the 'Main Gas Read Screen' (for gas measurement). The instrument will return to this screen after power on or when returning from the menus. The 'Scroll' keys can be used to switch to another measurement screen.

6.6 Entering data

During normal operation the operator may be prompted to enter data or information via the keypad, i.e. entering an ID code or setting an alarm level.

When entering data into the instrument all fields are fixed format and are populated from the left.

Text:

Entering text uses similar multi-tap functionality as a mobile phone. Key the numeric/alpha key pad the required number of times to select the appropriate letter. To key numeric data continue to press the numeric/alpha key until the required number is displayed.

Numeric data:

To enter a new date 09/15/116 the operator would type in 091516 using the numeric keypad in the following sequence:-

* 0_/__/__
* 09/__/__
* 09/1_/__
* 09/15/__
* 09/15/1_
* 09/15/16

Press the 'Enter' key to confirm/accept data keyed.

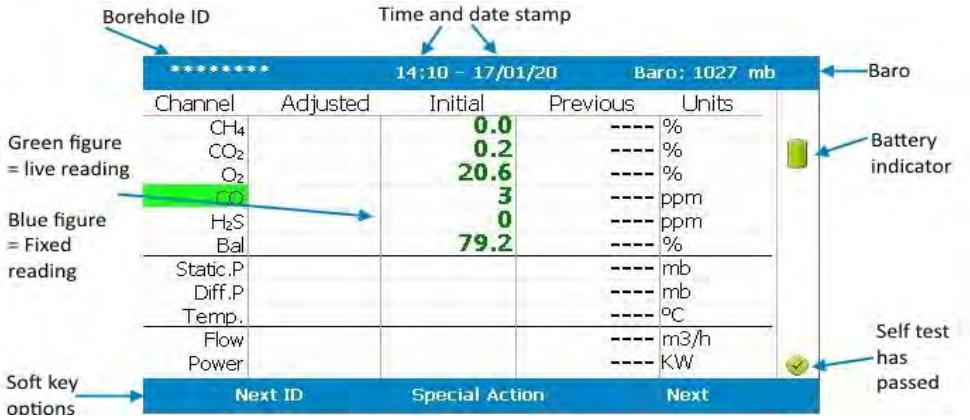
Any mistakes can be corrected using the soft-key 'Delete' which will delete the last digit typed. Alternatively, the sequence can be retyped before the 'Enter' key is pressed and the existing numbers will be pushed off the screen.

✍ Note: The instrument will not allow invalid data to be entered; this should be deleted and re-entered.

6.7 Instrument main gas read screen

The 'Main Gas Read Screen' is considered to be the normal operating screen and all operations are carried out from this starting point.

The actual data shown on this display will depend on the version of the instrument and the options that have been selected.



Main Gas Read Screen

You can also press key 2 and access a zoomed version of the main read screen, once you have entered this mode, simply use keys 4 and 6 to switch between the gases and pressures. Examples of both screens can be seen below:



Zoomed version

6.8 Storage

The analyzer should not be exposed to extreme temperature. For example, do not keep the analyzer in a hot car. When not in use, analyzers should be kept in a clean, dry and warm environment, such as an office. Protect the analyzer with either the soft carry case or store in the hard carry case provided with the instrument.

The instrument should be discharged and fully charged at least once every four weeks, regardless of indicated charge state.

6.9 Battery/charging

The battery used in the 5000 series of gas analyzers is nickel metal hydride and manufactured as a pack from six individual cells. This type of battery is not so susceptible to the top-off charging 'memory effects' as nickel cadmium batteries, although it is not recommended that the unit is given small top-off charges.

✍ Note: **To reach optimum charge, it is recommended that the instrument is switched off when being charged and remains switched off during the charging process.**

A full charge will take approximately 4 hours from a fully discharged battery.

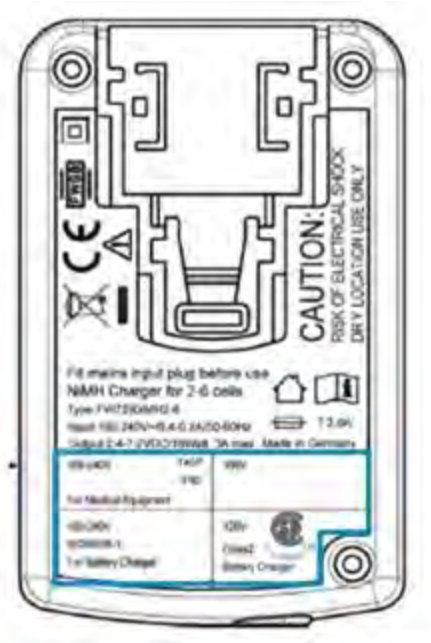
⚠ **Warning**	The battery charger is NOT covered by the Ex certification. The battery must be charged only in a safe area.

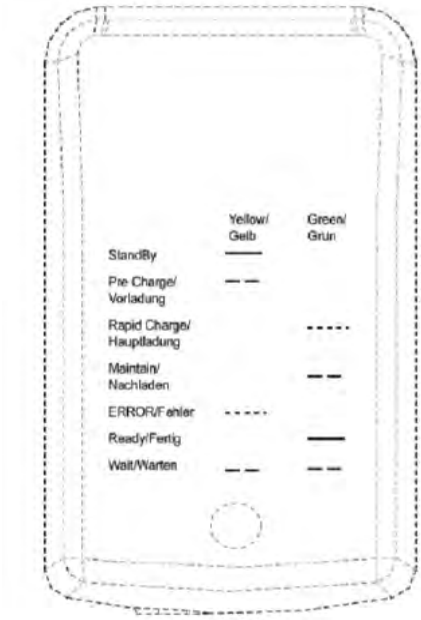
The battery charger is intelligent and will indicate when the unit is charging and charged.

The instrument must be charged ONLY using the battery charger supplied with the instrument. The battery charger supplied is intended for indoor use only. Please ensure adequate ventilation while charging. Typically, a fully charged battery will last 7-8 hours. A quick 30 minute charge can be used to give approximately one hours use in the field but this may shorten the battery life. Temperature can dramatically affect the battery life; please take this into account when estimating battery life.

✍ Note: Connect the charger to the mains attaching the appropriate adaptor.

Power supply front and back drawing:





Charger:	Input voltage:	100-240V AC +/- 10%
	Input frequency:	50-60Hz +/- 10%
	Input current:	0.4A@100VAC .. 0.2A@240VAC
	Output voltage:	10.1VDC max
	Output current:	1.5A max

✍ Note: This charger has been internally restricted to 1.5A

6.10 Cleaning instructions

Do NOT use any cleaning agents to clean the analyzer or battery charger as they may have an adverse effect on the safe use of these devices.

6.11 Memory

The analyzer's memory is stored in a readings and configuration database. The analyzer will prompt when its memory is full, and you will not be able to store any further readings. Please download your readings via LSGAM or the Basic Download Software and then clear the memory.

✍ Note: The analyzer should never be stored for prolonged periods with valuable data in its memory. It is advisable to download all readings to LSGAM at the end of each day's monitoring. To clear the memory, please refer to the LSGAM operating manual.

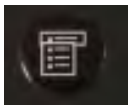
6.12 Warning and error codes

When switched on the instrument will perform a predetermined self-test sequence taking approximately ten seconds. During this time many of the instrument's working parameters and settings are checked. If any operational parameters are out of specification or if the pre-programmed recommended calibration/service date has passed, errors or warnings may be displayed.

✍ Note: For further information please refer to section '10.0 Problem Solving'.

7.0 Operator Settings

7.1 Menu key



The 'Menu' key enables the operator to select options to set up specific parameters and perform operational tasks prior to sample readings being taken or to view data and information stored in the instrument.

1) Select the 'Menu' key on the front of the analyzer and the following screen is displayed:



2) Press the relevant numeric key on the analyzer keypad to select the required option.

3) To exit this menu, select the soft-key 'Exit' on the front of the analyzer and the operator is returned to Main Gas Read Screen.

7.2 Operation settings

To access the 'Operation settings' menu, select the 'Menu' key on the front of the analyzer. The following menu is displayed:



7.2.1 Timers



The timers function enables the operator to set standard purge times and set auto-power off if the unit is untouched for the period of time specified.

1) Select 'Key 1 – Timers' and the following screen is displayed:



1) Select 'Key 1' to edit the purge time. Enter the 'Pump Running Time' in seconds; this is the length of time you wish to run the pump to draw the sample, e.g. key in 030 then press the 'Enter' key to accept.

2) Select 'Key 2' to edit the auto power off time. Enter the 'Auto power off' in minutes; the instrument will automatically power off to preserve the battery life after the specified time if no activity has occurred on the instrument. Press the 'Enter' key to accept.

3) Select the soft-key 'Exit' key to exit the screen and return to the 'Operation settings' menu.

✍ Note: Setting the purge time and auto power off functions to zero, disables the option. It is not recommended to reduce the purge time to below 30 seconds.

7.2.2 Gas Check



This option displays the 'Gas Check' menu and enables the operator to zero and span the gas channels on the instrument. Historical/previous gas checks data can also be viewed and factory settings can be restored.

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft key to display 'Operation Settings'.

2) Select 'Key 2 – Gas Check' and the following menu is displayed:



3) For more information about the Gas Check Menu please refer to section 9.0 – Calibration.

4) Select soft-key 'Exit' to exit operation settings and return to the main screen.

7.2.3 View data



This option enables the operator to view the readings collected and stored on the instrument. Readings many be downloaded to the optional LSGAM software if further analysis is required.

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft-key to display 'Operation Settings'.

2) Select 'Key 3 – View Data' and the following screen is displayed:



3) Toggle through the reading by selecting 'Key 4 – Scroll left' and 'Key 6 – Scroll right' on the analyzer. Select 'Key 2 – Page up' and 'Key 8 – Page down' to page through the auxiliary channels listed.

4) Select the soft-key 'Filter' to filter the data by sample point ID, or specify before or after date. Press the soft-key 'Exit' to exit the filter menu and return to the 'View Data' screen.



5) Select the soft-key 'Delete' followed by the appropriate soft-key to delete a single reading or all filtered readings. Press soft-key 'Cancel' to cancel the deletion request.

6) Select the soft-key 'Exit' to exit the view data screen.

7.2.4 Set alarms



This option enables the operator to define the conditions for which an alarm/target will be triggered. These conditions apply to the general operation of the instrument and are not ID specific. A summary of the alarm settings can be found in 'Key 3 – Summary'.

Types of alarms

Common Alarms – Are non-ID specific alarms which apply to all the readings taken with the analyzer.

ID specific alarms – Are ID specific, i.e. they will only trigger when a certain Id is being used.

Tuning/targets – You can also set targets for your gas channels; these will highlight gas channels green as oppose to when they alarm (yellow). These can be common or ID specific.

Setting up alarms/targets

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft key to display 'Operation Settings'.

2) Select 'Key 4 – Set Alarms' and the following menu is displayed:



3) Select the corresponding key to select the gas for which you wish to set an alarm/target trigger for, followed by 'Key 1' to change the trigger condition of an alarm.

4) To manually adjust the alarm/target set press (<) 'Key 4 – Scroll left' or 'Key 6 – Scroll right' (>) and enter the trigger value. Once you are happy, press the middle soft key for 'save'.

5) For pressure, temperature and flow alarms, press the left soft key for 'Secondary' and then select the corresponding key to select the channel for which you wish to set an alarm trigger for, followed by 'Key 1' to change the trigger condition of an alarm/target. Once you are happy, press the middle soft key for 'save'.



6) To disable all alarm settings select key 0 – 'Disable All'

✍ Note: ID specific alarms cannot be added/edited on the analyzer, to add/edit ID specific alarms, please use the optional LSGAM Software.

7.2.5 Adjust flow fail



This option enables the operator to adjust the flow fail tolerance of the instrument, i.e. the operator can adjust the sensitivity for when the pump will stop operating on the presence of a blockage or low flow.

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft-key to display 'Operation Settings'.

2) Select 'Key 5 – Adjust Flow Fail' and the following screen is displayed:



3) Manual adjustment of the flow fail is available via this option and can be carried out with use of 'Key 4 – Scroll left' (<) less sensitive and 'Key 6 – Scroll right' (>) more sensitive.

4) Select the soft-key 'Save' to store the setting or select soft-key 'Exit' to exit the screen without saving the change.

5) The operator will return to the 'Operation settings' menu.

✍ Note: The default setting displays the bar in the centre. BEFORE altering this setting, please contact Technical Support at (800) 968-2026 or email landtec_support@gedenv.com

7.2.6 Technician login



This option enables the operator to select or change a pre-defined technician login and all subsequent readings will be tagged with this Technician Login ID. The technician ID must already have been created using the LSGAM software and uploaded to the instrument.

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft key to display 'User Settings'.

2) Select 'Key 6 – Technician login' and the following screen is displayed:



3) Use the cursor keys to move throughout the list of IDs displayed; select the 'Enter' key to select choice of ID, default if no IDs are listed or soft-key 'Skip' to skip the selection.

4) The operator will return to the 'User settings' menu.

✍ Note: If no technicians are loaded via LSGAM, this section is skipped during start up and the 'Technician ID' icon is removed from the menu.

7.3 Device settings

To access the 'Device Settings' menu, select the 'Menu' key on the front of the analyzer to display the 'Operating Settings' menu followed by the soft-key to display 'Device Settings' menu. The following menu is displayed:



7.3.1 Date and time



This option enables the operator to set the instrument date and time or to receive and update the settings automatically from satellite signal.

1) Select the 'Menu' key on the front of the analyzer to display the 'Device Settings' menu followed by 'Key 1 – Date and Time' and the following screen is displayed:



2) Select 'Key 1 – Set Date' and key in the required date. Type the date using the numeric keypad. Press the soft-key 'Date Format' to toggle and select the required date format i.e. dd/mm/yy. Press the 'Enter' key to confirm and update the date setting.

3) Select 'Key 2 – Set Time' and key in the required time (hh:mm). Type the time using the numeric keypad and press the 'Enter' key to confirm the update.

4) The operator may also change the default time zone. Selecting the 'Key 4 Scroll-left' or 'Key 6 – Scroll right' to move through the different time zones. Press the 'Enter' key to confirm your default setting.

5) Select 'Key 3' to toggle between 'Manual Update' and 'Automatic Update' in order to choose how the date and time is set if updating from satellite signal.

Manual	Used to manually obtain and update the date and time from the satellite signal when requested. Select soft-key 'Set now' to set date and time from satellite when available.
Automatic	Used to automatically update the date and time received from the satellite signal when available. This option is only available when the GPS option is fitted to the analyser at the time of manufacture.

6) Select the soft-key 'Exit' to exit and return to the 'Device Settings' menu.

7.3.2 Bluetooth



This option enables the operator to set and utilize Bluetooth technology. This may be useful when downloading gas readings from the analyzer to the PC instead of connecting the analyzer to a PC via a USB cable. Bluetooth may also be used to transfer Site IDs to other 5000 series gas analyzers if required.

1) Select the 'Menu' key on the front of the analyzer to display the 'Device Settings' menu.

2) Select 'Key 2 – Bluetooth' and the following screen is displayed:



3) Enter the 'Pairing PIN' value when prompted by your computer for the device's pairing code.

4) Select soft-key 'Exit' to exit the screen and return to the 'Device Settings' menu.

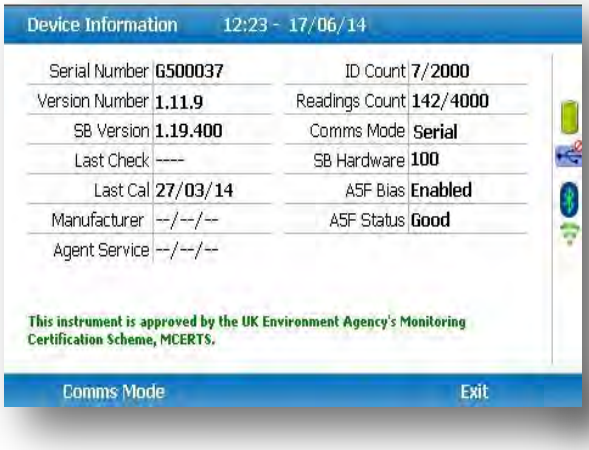
7.3.3 Device information



This option displays default instrument information and settings such as serial number, service due date, last zero calibration date and last span calibration date.

1) Select the 'Menu' key on the front of the analyser to display the 'Device Settings' menu.

2) Select 'Key 3 – Device Information' and the following screen is displayed:



3) The information displayed on this screen is informational only and cannot be edited by the operator. The operator may be asked serial number, service due date and version number information when contacting QED.

✍ Note: The communications setting 'Legacy' mode is for use with GAM >=v1.5. GA5K mode is reserved for future applications – use with 5000 series updater tool

4) Select soft-key 'Exit' to exit the screen and return to the 'Device Settings' menu.

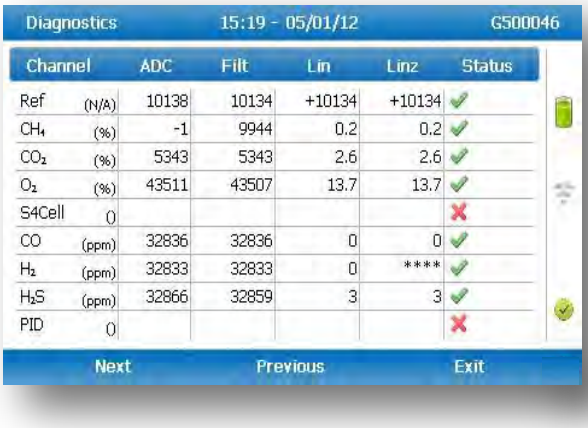
7.3.4 Diagnostics



This option enables the Technical Support Team to identify and resolve issues with the instrument and settings. If required, the operator may be asked to confirm the diagnostics displayed.

1) Select the 'Menu' key on the front of the analyser to display the 'Device Settings' menu.

2) Select 'Key 4 – Diagnostics' and the following screen is displayed:



3) Select soft-key 'Next' to display the next screen, 'Previous' to return to the previous screen, or select soft-key 'Exit' to exit this screen and return to the 'Device Settings' menu.

✍ Note: For further information please contact Technical Support at (800) 968-2026 or email landtec_support@gedenv.com

7.3.5 Navigation (optional)



Navigation is On

This option enables the operator to switch the 'GPS Navigation' functionality on or off. (This is optional and dependent upon purchasing the navigation option).

1) Select the 'Menu' key and the 'Device Settings' menu is displayed.

2) Select 'Key 5 – Navigation On' to switch on the GPS navigation functionality or 'Key 5 – Navigation Off' to switch the GPS navigation functionality off.



Navigation is On



Navigation is Off

✍ Note: For further information please refer to section '8.0 – Taking Readings'.

7.4 User settings

To access the 'User settings' menu, select the 'Menu' key on the front of the analyzer to display the 'Operating Settings' menu followed by the soft-key to display 'User Settings' menu. The following menu is displayed:



To exit the user settings menu select the soft-key 'Exit'.

7.4.1 Operating language



This option enables the operator to specify the operating language displayed for the instrument.

1) Select 'Key 1 – Operating Language' and the following screen is displayed:



Set the required language for the gas analyser by selecting the appropriate function key. Choose from, on the first page:

Key 1	English
Key 2	Spanish
Key 3	French
Key 4	German
Key 5	Italian
Key 6	Portuguese

Use the soft-keys to move to the next page for further language options, including simplified Chinese

2) To exit this option, select the soft-key 'Exit' and the operator is returned to the 'User Settings' menu.

7.4.2 Units of measurement



This option enables the operator to specify the default units of measurement for the instrument.

1) Select 'Key 2 – Units of Measurement' and the following screen is displayed:



2) To set the required units of measurement toggle and choose from the following:

Key 1	Temperature	^{O}C ^{O}F
Key 2	Flow	scfm m3/hr
Key 3	Measurement	Inches Millimetres
Key 4	Pressure	mb "H2O
Key 5	Balance	Balance Residual N2

3) Select soft-key 'Exit' to exit this screen and return to the 'User Settings' menu.

7.4.3 ID selection

The ID selection screen allows the operator to scroll through all IDs, including those uploaded from LSGAM and added directly onto the instrument, and then make a selection. Detailed information regarding the currently selected ID, such as flow device type and pump runtime, are displayed below:-



By selecting 'Key 5' the operator can toggle between showing 30 IDs and showing 5 IDs with more detailed information relating to the chosen ID.



The technician can scroll between the IDs using the following keys on the instrument keypad:

Two (2) and eight (8) move the selection up/down
Four (4) and six (6) move the selection left/right on the list view
One (1) and three (3) move the selection left/right a page in the list view only
Seven (7) and nine (9) move the selection to first/last ID

Five (5) toggles between the 'ID with information' and 'ID list'
Return/enter key selects the desired ID and proceeds to the navigation or reading screen.

If there are no IDs present the technician can either add a new ID or press the enter key on the instrument keypad to return to the previous screen.

Soft keys:

Left - Select 'No ID' and go to the purge/reading screen.
Center - Enabled when there is a list of IDs, allowing the technician to dynamically filter the IDs displayed in the list.
Right - Allows the technician to add a new ID to the instrument 'in the field'.

✍ Note: If your analyzer has firmware version v1.12 or greater, used IDs will have a strikethrough.

Changing the sort order

By default the IDs are sorted in the order in which they were transferred to the instrument. To change the sort order between unsorted, sort by name or sorted by distance to travel press Key 0.


Sorted by original order (not sorted)


Sorted alphabetically


Sorted by distance to travel

✍ Note: Only available when GPS is enabled

For analyzers with firmware v1.12 and above:

1) Press the menu key

2) Press the middle soft key for 'User Settings'

3) Press key 3 – 'ID options

   a. Key 1 to change the sort order
   b. Key 2 to change how the IDs are displayed
   c. Key 3 to clear the line through on the current ID being used
   d. Key 4 to remove the line through on all IDs



7.4.4 Routes

Using the optional LSGAM Software, you can upload a route. This is a predefined list of IDs that you can go through in an order. This feature is useful if you have a certain order to complete your IDS in.

Furthermore if your GA5000 has v1.12 or higher firmware it will strike through your IDs once you have used them.



✍ Note: If the analyzer is set to "route mode" (v1.12 and above), the filter box will no longer be there, as you cannot filter in this mode. It will be replaced by "Route" and the route name.

7.4.5 Adjust backlight



This option enables the operator to adjust the backlight (brightness). Having this set to a darker setting will help preserve the battery power

1) Select 'Key 4 – Adjust Backlight' and the following screen is displayed:



2) Keys 4 and 6 can be used to adjust the brightness of the display screen.

   'Manual' disables the backlight timeout.

3) Select the soft-key 'Save' to store the setting or select soft-key 'Exit' to exit the screen without saving the change.

4) The operator will return to the 'User settings' menu.

Selecting 'Key 1' allows the operator to configure the dimmer settings from 'Auto Dim' to 'Auto Off' in order to help preserve power consumption when data logging.



This icon represents 'Auto Dim' – this enables the backlight idle timeout, which means the backlight will go dim after a specified period of inactivity. This will help save battery life.



This icon represents 'Auto Off' – this switches the backlight off, saving power.

✍ Note: The manually set contrast setting is retained when the read-out is switched off and may require resetting when next switched on.

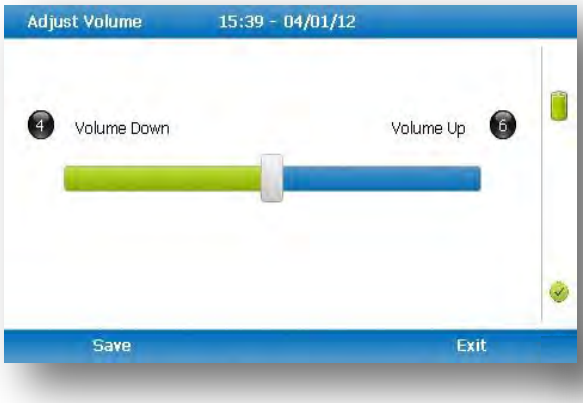
7.4.6 Adjust volume



This option enables the operator to adjust the volume for the internal speaker, for example the alarm tone. A lower setting will help preserve the battery power.

1) Select the 'Menu' button on the front of the analyzer to display the 'Device Settings' menu. Press the soft-key to display 'User Settings'.

2) Select 'Key 5 – Adjust Volume' and the following screen is displayed:



3) Manual adjustment of the volume is available via this option and can be carried out with use of 'Key 4 - Scroll left' (<) volume down and 'Key 6 - Scroll right' (>) volume up.

4) Select the soft-key 'Save' to store the setting or select soft-key 'Exit' to exit the screen without saving the change.

5) The operator will return to the 'User settings' menu.

7.4.7 User Prompts



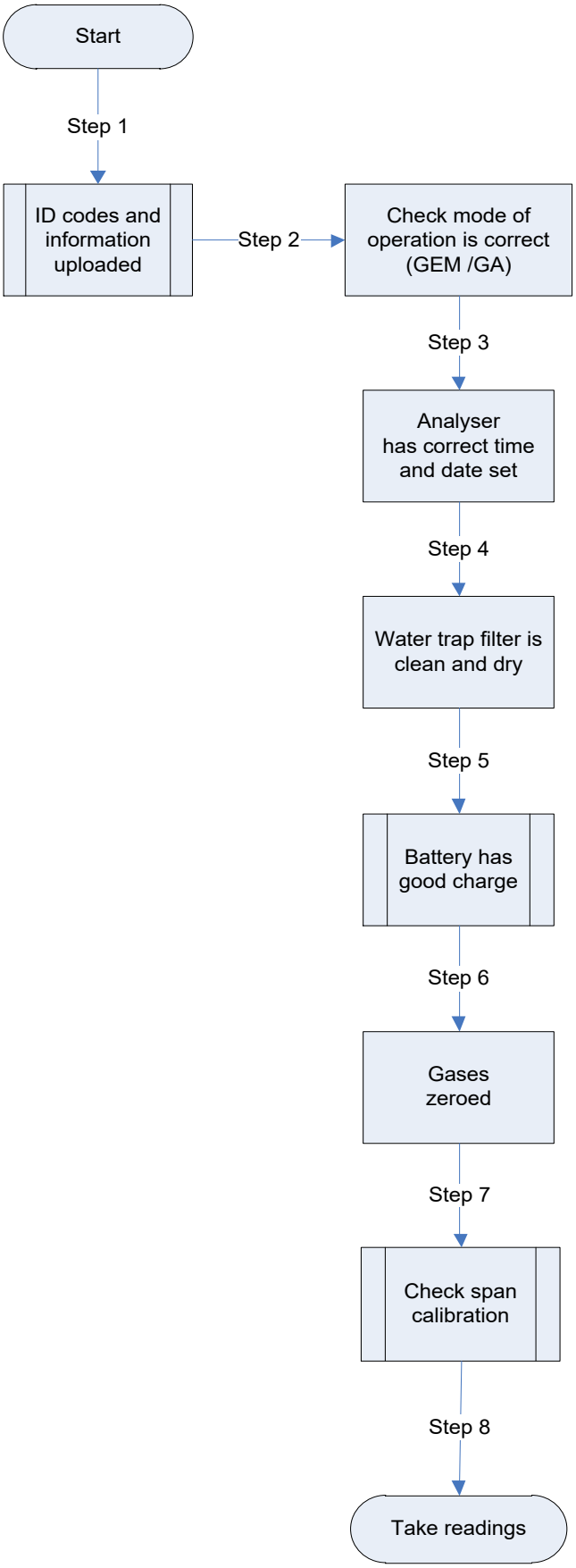
This option enables the operator to either turn on or off the context-sensitive user prompts which are displayed during the gas sample process. The analyzer will have the user prompts on when it is first used, so if they are no required they can be switched off by selecting soft-key '6' and this will now be its default setting. Prompts can be switched back on at any time by returning to this menu and selecting soft-key '6'.

7.5 Exit menu

1) Press the 'Menu' button on the front of the analyzer to exit settings.

8.0 Taking Readings

8.1 Preliminary checks before taking readings (best practice)



Prior to use, it is good practice to ensure that:

Step 1 If using LSGAM - all necessary ID codes and information have been uploaded from LSGAM to the analyzer. Please see section 8.1.1 for more information on this.

Step 2 Check the 'Mode of Operation' is correct. Choose either GEM5000 for gas extraction monitoring analyzer or GA5000 for landfill gas analyzer. Change using 'Special Actions'.

Step 3 The instrument has the correct time and date set.

Step 4 The water trap filter is fitted and is clean and dry.

Step 5 The battery has a good charge (minimum 25% charge, even if only a few readings are required).

Step 6 The gas channels have been zeroed, without gas concentration present.

Step 7 If necessary check the span calibration with a known concentration calibration gas.

Step 8 Take readings.

⚠ **Warning**	Inhaling hydrogen sulphide gas (H_2S) or other harmful gases can cause death. It is the responsibility of the user to ensure that he/she is adequately trained in the safety aspects of using H_2S and other harmful gases. In particular, where hazardous gases are being used the gas exhausted from the analyser must be piped to an area where it is safe to discharge the gas. Hazardous gas can also be expelled from the instrument when purging with clean air.

Good practice

- Travel to site with the gas analyzer in the vehicle's interior - not in the trunk or truck bed, where it may be subjected to extremes of temperature and possible shock damage. Do not place the gas analyzer against anything hot (e.g. gas extraction pipe, car body or in an unattended car during the summer) as this will cause a temperature increase in the gas analyzer and may cause erroneous readings.

- When moving around a site, protect the gas analyzer from strong direct sunlight and heavy rain.

- Always use the water trap! If the water trap becomes flooded, change the filter and ensure all tubes are clear of moisture before re-use.

  ✍ Note: If the exhaust of a 5000 series gas analyzer is connected to a pressurized system then this results in a flow of gas out of the inlet flow port.

8.1.1 Creating an ID

There are two different methods to creating an ID, either via LSGAM or via the instrument.

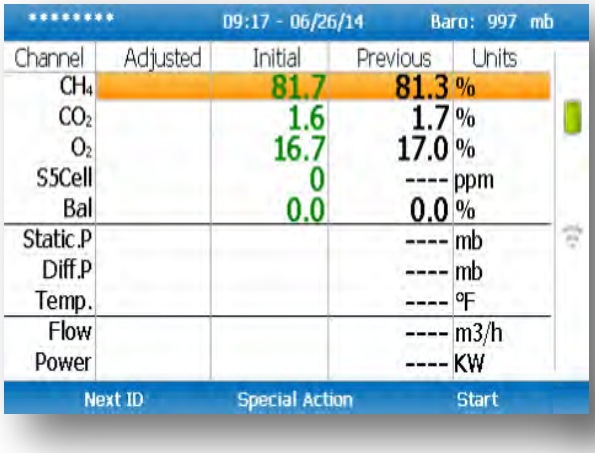
If created on the analyzer, you can only fill out basic information, such as ID code, description and ID type. Whereas on LSGAM, you can assign site and ID questions (please see below), assign flow devices, input GPS coordiantes etc.

To create an ID on LSGAM please consult the LSGAM operating manual. To create an ID on the instrument:

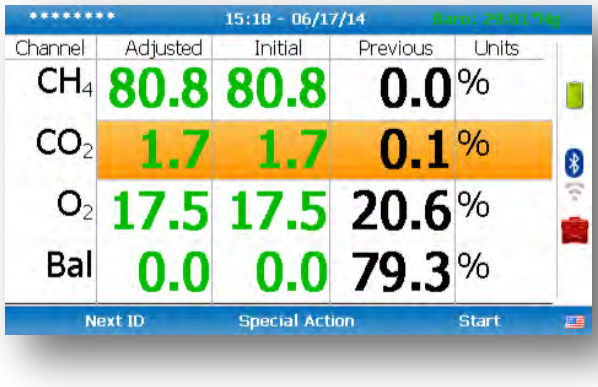
1) Press the left blue arrow key for 'Next ID'
2) Press the right blue arrow key for 'Add'
3) Input an ID code using the keypad
4) Press enter
5) Using the corresponding number to input different properties of the ID
6) Once you are happy, press the middle key for 'add'

8.2 Change screen layout

Use key 2 to toggle between 2 different ways of viewing the gas reading screen:



Default view



You can use key 4 and key 6 to switch between the gases page and the pressure & flow page. This feature is only available on analyzers running on firmware version 1.11 or later.

8.3 Answering site questions

Prior to taking the readings at a particular site, the site questions should be populated, this is only necessary when using site questions, if not, please proceed with the reading as normal. This is accessed via the 'Special Action' menu. The answers to these questions are then stored and appended to each reading stored thereafter, until the site questions are updated for another site. You will need LSGAM software to create site questions and if you are using LSGAM, this data will be uploaded to LSGAM along with the reading data.

8.4 Answering ID questions

Prior to, or after, you have taken the reading, the ID questions should be populated, this is only necessary when using ID questions, if not, please proceed with the reading as normal. When you have uploaded IDs with ID questions assigned to them (LSGAM software required), you will be prompted to answer these questions at the end of the reading, this means that the answer only equates to that reading.

8.5 Special action

This menu enables the operator to perform the additional following functions out of sequence if so desired.

1) From the 'Main Gas Read Screen' select the soft-key 'Special Action' and the following menu is displayed:



✍ Note: The list of special action options displayed on the special action menu is dependent upon device type and sequence.

The following actions may be available:

Action	Function
Key 1 – Simple Gas	This action enables the operator to take a quick gas reading. The pump will start running automatically when this key is selected. The operator can stop the pump by pressing the pump key on the keypad at any time and the reading can then be stored by selecting soft-key 'Store'.
Key 2 – Site Questions	This action enables the operator to update site questions prior to taking a reading.
Key 3 – ID Questions	This action enables the operator to update ID questions specific to sample points prior to taking a reading.
Key 4 – Flow	This action enables the operator to measure internal flow first when taking a reading. Connect the blue hose to the sample point. The yellow hose can be vented a safe distance from the sample point or re-circulated back into the system. Select either soft-key 'Zero Flow',' Flow Options' or 'Start' to commence internal flow. Select soft-key 'Store' to store and record the reading.
Key 5 – Enter Temperature	This action enables the operator to manually enter a temperature reading if not using a temperature probe prior to taking a gas measurement.
Key 6 – Start Logging	This action enables the operator to leave the analyzer unattended to take samples at a predetermined time. The reading interval and pump run times may be edited prior to commencing the logging cycle.

8.5.1 Configuration of the data logging option



1) Connect the gas inlet (white port) to the sample point. The yellow exhaust hose can be vented a safe distance from the sample point; do NOT re-circulate back into the system.
2) By selecting 'Next ID' the operator can select the ID which is being sampled at present.
3) Once the ID has been chosen the analyzer will commence and complete its clean air purge cycle.
4) To gain access to the data logging option the operator will be required to select the 'Special Action' key to obtain the special user options. The data logging option can then be selected via 'Key 6' to configure the logging parameters.
5) Once the operator has confirmed the logging parameters, select soft-key 'Start Logging'.
6) Once the logging function has been activated the analyzer will carry out a 30 second warm-up (displayed below the temperature read out at the right of the main gas read screen) and begin the first sample.
7) If for any reason during the logging cycle the inlet port becomes blocked, the analyzer will sense this as a 'Flow Fail' and the pump will automatically retry until the reading can be obtained. As such care must be taken when positioning the sample tubing to ensure water/moisture ingress does not occur.
8) Select soft-key 'Stop Logging' to stop logging if required.

8.5.2 Profiling option

1) The 'Logging Mode' center soft-key toggles between 'Logging Mode' and 'Profiling Mode' and pressing it will change the mode to the one the soft-key describes. For example, when on the profiling page the key will display as 'Logging Mode' and when on the logging page the key will display as 'Profiling Mode'.

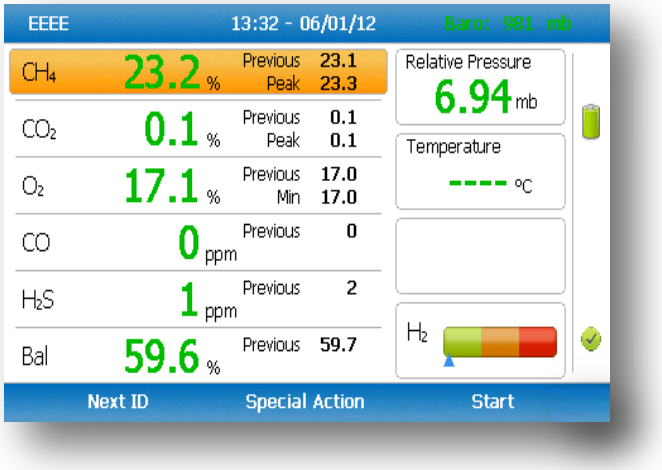


2) To edit the parameter the operator will be required to select 'Key 3' to select the number of reading required. Once the number of readings has been updated press the return key to confirm parameter setting.
3) By selecting 'Key 2' the operator can edit the logging interval of their logging preferences and then confirm the amendments by pressing the return key.
4) Once the logging parameters are confirmed, commence the logging by selecting the 'Start Logging' key.
5) If for any reason during the logging cycle the inlet port becomes blocked, the analyzer will sense this as a 'Flow Fail' and the pump will automatically retry until the reading can be obtained. As such care must be taken when positioning the sample tubing to ensure water/moisture ingress does not occur.
6) Select soft-key 'Stop Logging' to stop logging if required.

Select the soft-key 'Exit' to exit this menu and return to the 'Main Gas Read Screen'.

8.6 GEM analyzer in GA mode

The operator may toggle between GEM (a gas extraction monitor) and GA (a landfill gas analyzer) mode of operation if required. From the 'Special Action' menu, select the middle soft-key to toggle between GEM and GA Mode.



✍ Note: For operating instructions on how to use the GA5000 mode of operation, please refer to the GA5000 gas analyzer operating manual.

8.7 The gas flow measurement screen

The GEM5000 gas analyzer enables gas and flow measurements to be recorded by using:

- A flow device i.e. a PITOT tube, Orifice plate, Accu-Flo or anemometer.
- A temperature probe.

The GEM5000 instrument has the extra functionality to measure the calculated calorific value of the gas. The site engineer uses the information recorded by the analyzer to make adjustments to the gas flow for specific boreholes. The initial and adjusted flow rates are recorded.

8.8 How to use an anemometer (optional)



The GEM5000 gas analyzer has the facility to attach an anemometer device enabling the site engineer to measure the flow of gas within an extraction system. The anemometer can be set to display two values; m/s (meters per second) and m^3/hr (metres cubed per hour).

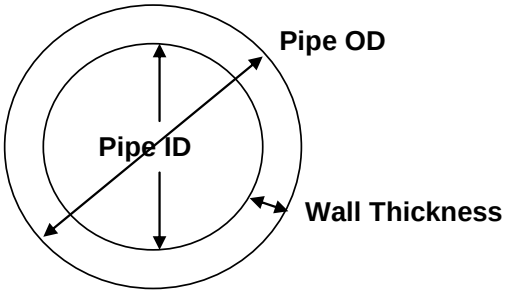
It is best practice to take the gas reading first before taking the flow reading with the anemometer attached.

If using a 'borehole ID' the internal pipe diameter can be predetermined in the optional LSGAM software. Once set, the site engineer cannot edit the pipe diameter setting.

If the site engineer is not using a borehole ID or the pipe diameter is not set in LSGAM the operator will be prompted to enter a pipe diameter with a new ID on the analyzer. Select soft-key 'Next ID' from the Main Gas Read screen, followed by soft-key 'Add' and add a new borehole location.

In order to use the anemometer it is important to know the internal diameter (ID) of the pipe if you want to calculate the flow in m^3/hr (metres cubed per hour). This must be the internal diameter not the outer diameter (OD) i.e. pipe outer diameter minus twice the pipe wall thickness.

For example:



If you do not have any suitable monitoring points you will need to drill (tap of ¾″ BSP pipe thread) a hole in the piping of between 25mm and 30mm in diameter to seat the conical fitting on the anemometer (which is roughly between 20mm to 34mm). When not in use the hole can be re-sealed with a ¾″ BSP male bung.

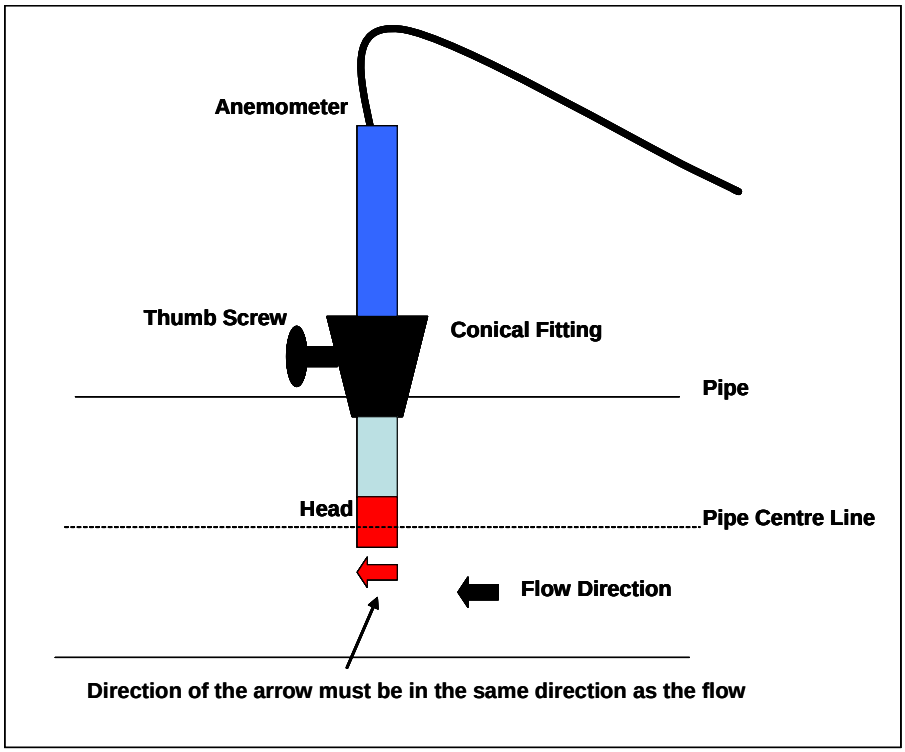
✍ Note: When the anemometer is not in use the conical fitting should be placed over the probe to protect it.

The anemometer must fit centrally (the conical fitting must be set on the probe to half the pipe ID before insertion). The arrow on the tip of the probe must point in the direction of the gas flow.

✍ Note: Use the thumb screw to help align the direction of the probe into the gas stream.

Flow readings are most accurate when there is laminar flow (not turbulent). Turbulence can be caused by a change in pipe direction or restriction. Ideally, upstream you want at least 20 times the pipe ID along the length of the pipe without restriction or bend. Downstream, you want at least five times the pipe ID along the length of the pipe i.e. for a 100mm ID you need 2000mm of clear pipe upstream, 500mm downstream.

Example to show anemometer fitting into the sample point:



Instructions for use:

1) Attach the anemometer to 'Connector C' (refer to section 5.3 – Instrument connection points).

2) Place the anemometer into the pipe (sample point) ready to take the reading.

3) To take a flow measurement when using an anemometer, follow the instructions displayed on the analyzer. When the reading has stabilized press the 'Enter' key to store the reading.

Anemometer cleaning instructions:

General handling tips:

- Protect the probes against severe vibration.
- Do not kink the connector cable (risk of cable breakage).
- Never allow hard objects to contact rotating impellers.
- Always carry out probe cleaning according to the cleaning instructions.
- Never immerse probes in solvent.
- Never blow probes through with compressed air.
- Allow hot probes to cool slowly, never cool by plunging them in cold water etc.

Cleaning instructions:

- Instrument and probe must be switched off or disconnected prior to cleaning.

Vane probes:

- As the probes are highly sensitive measuring instruments, they must be cleaned with great care.
- Fibres or other foreign bodies can be carefully removed with fine tweezers. When doing so, take care not to bend or otherwise damage the vanes or the spindle.
- The adjustment of the bearing screws must never be changed. This can result in an erroneous measurement.
- Never allow hard objects to contact rotating impellers.
- Cleaning agents that extract the plasticizer from the plastic are never to be used for plastic probes (practically all solvents).

Cleaning the probes – best practice:

✍ Note: Use soapy water.

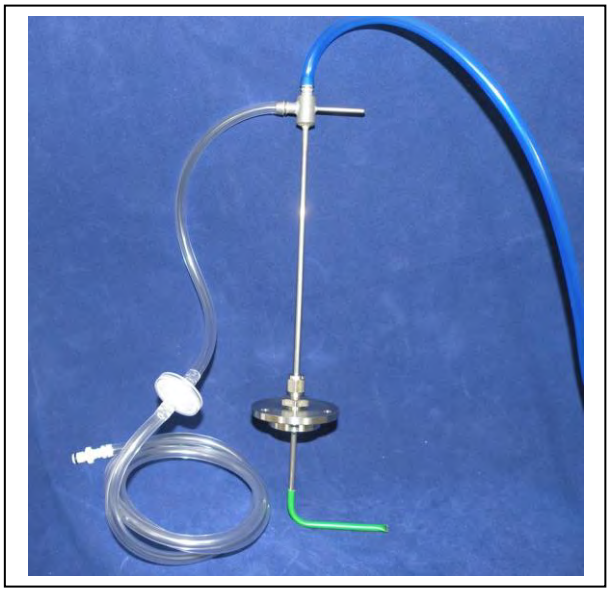
Cleaning example:

1) Carefully, swish the top part of the impeller back and forth in clean soapy water for approximately 10 minutes. Then swish the top part of the impeller back and forth in clean soapy water. If soapy water is used as a cleaning agent it is advisable to wash out the soap solution thoroughly with distilled water.

2) After cleaning the probe, rub it dry with a clean, dry cloth.

8.9 How to use a pitot tube (optional)

The GEM5000 gas analyzer enables the site engineer to take gas measurements using a pitot tube. The pitot tube is used for gas extraction systems and the pressure readings are taken in mbar. Gas flow is calculated in the analyzer in m^3/hr (metres cubed per hour).



Example of a pitot tube

Fitting a pitot tube to the analyzer:

1) It is important to seat the pitot tube into the monitoring point with the tip facing into the gas flow. The pitot tube should also be housed half way down the monitoring pipe. (Please refer to the anemometer instructions, which detail how to calculate the pipe diameter correctly).

2) Make sure that the sample tubing attached to the pitot tube fits correctly.

3) Attach the sample tube from the top connection of the pitot tube to the 'blue port' (the differential port) on the analyser making sure that the gas port connector secure into place.

4) Attach the sample tube from the side of the pitot tube to the 'white port' (inlet port/static pressure port) on the analyser making sure that the gas port connector secures into place.

5) House the pitot gland correctly onto the monitoring point.

6) When taking a gas reading and flow measurement follow the instruction as displayed on the front of the instrument.

✍ Note: Please refer to the following section for a diagram showing how to fit the tubing to the pitot tube.

8.10 How to use an H_2S filter (optional)

8.8.1 Cross gas effects on chemical cells

Measurements of CO are important in landfill management. The GEM5000 analyzer incorporates an improved CO measurement.
Measurements of CO can be affected by two other gases that can be found in landfill gas – hydrogen and hydrogen sulphide.

To reduce the effect of hydrogen, the GEM5000 analyzer uses a technique that is hydrogen compensated. Hydrogen compensation is achievable up to a level of around 2000ppm. Above this level the CO reading will not be compensated for.

In order to assist the operator the GEM5000 instrument also indicates the level of hydrogen present as low, medium or high. If a high hydrogen reading is present then the CO reading may be affected.

The effect of hydrogen sulphide is eliminated by the use of a H_2S filter.

CO measurement

The CO measurement is sensitive to hydrogen sulphide. The presence of hydrogen sulphide can cause the CO reading to elevate (not to be the true value due to the interfering gas). If the presence of hydrogen sulphide is suspected to be causing false CO readings, then it is recommended that the external hydrogen sulphide filter is used while obtaining the CO measurement.

The H_2S filter only needs to be used when you are trying to remove of any possible cross gas effects H_2S might have on other gas channels. Do not use the filter on all boreholes.

When using the H_2S filter you will need to increase the gas sample and clean air purge run-time, as using an H_2S filter decreases the response time of the analyzer.

✍ Note: There is an internal H_2S filter incorporated in the chemical cell that removes the H_2S; however this has a limited life span.

The electrochemical cells used to measure H_2S and CO do suffer from cross-gas effects. Such effects are not accurately specified. However, the following table may be useful as a guide; it represents how many ppm would be read by a cell if 100 ppm of the interfering gas were applied, with no other cross-contaminates being present in the sample.

GEM5000

		Interfering Gas				
		CO	**H_2S**	**SO_2**	**NO_2**	**H_2**
Chemical Cell	**CO (H2 compensated**	100	0 / ~300*	0	0	<1
	CO	100	<4 /~300*	0	-20 to +5	<60
	H2S	<4	100	20	<-25	<0.2

*after internal filter depleted.

✍ Note: Other gases could cause cross-gas effects. If you suspect a cross sensitivity problem please contact Technical Support (800) 968-2026 or email landtec_support@gedenv.com

8.9.2 Cross-gas effects on methane, carbon dioxide and oxygen

Methane is measured using dual beam infrared absorption. Analyzers are calibrated using certified methane mixtures and will give correct readings provided there are no other hydrocarbon gases present within the sample (e.g. ethane, propane, butane, etc.). If there are other hydrocarbons present, the methane reading will be elevated (never lower) than the actual methane concentration being monitored.

The extent to which the methane reading is affected depends upon the concentration of the methane in the sample and the concentration of the other hydrocarbons. The effect is totally non-linear and difficult to predict.

✍ Note: The effect can be reduced by using an H_2S filter as it can reduce higher order hydrocarbons. When using the H_2S filter you will need to increase the gas sample and clean air purge run-time, as using an H_2S filter increases the response time of the analyzer.

Carbon dioxide is measured by infrared absorption at a wavelength specific to carbon dioxide. Therefore, the carbon dioxide reading will not be affected by any other gases usually found on landfill sites.

The oxygen sensor is a galvanic cell type and suffers virtually no influence from CO_2, CO, H_2S, NO_2, SO_2 or H_2, unlike many other types of oxygen cell.

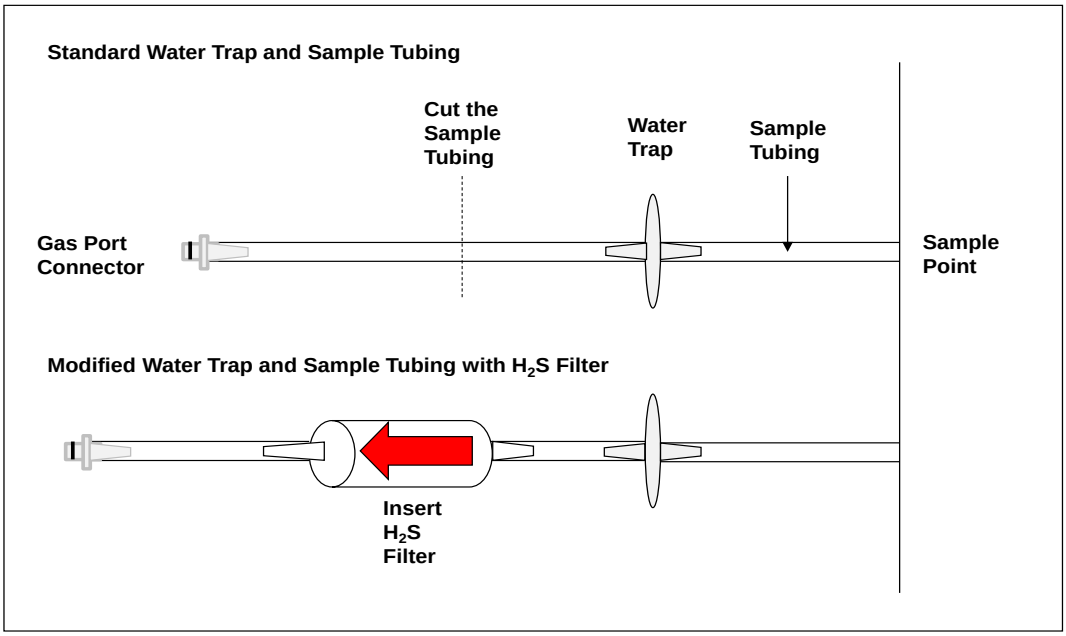
The infrared sensors will not be 'poisoned' by other hydrocarbons and will revert to normal operation as soon as the gas sample has been 'purged'.

H_2S filter:



Instructions for use:

The following diagram shows how to modify the standard water trap and sample tubing to fit the H_2S filter.

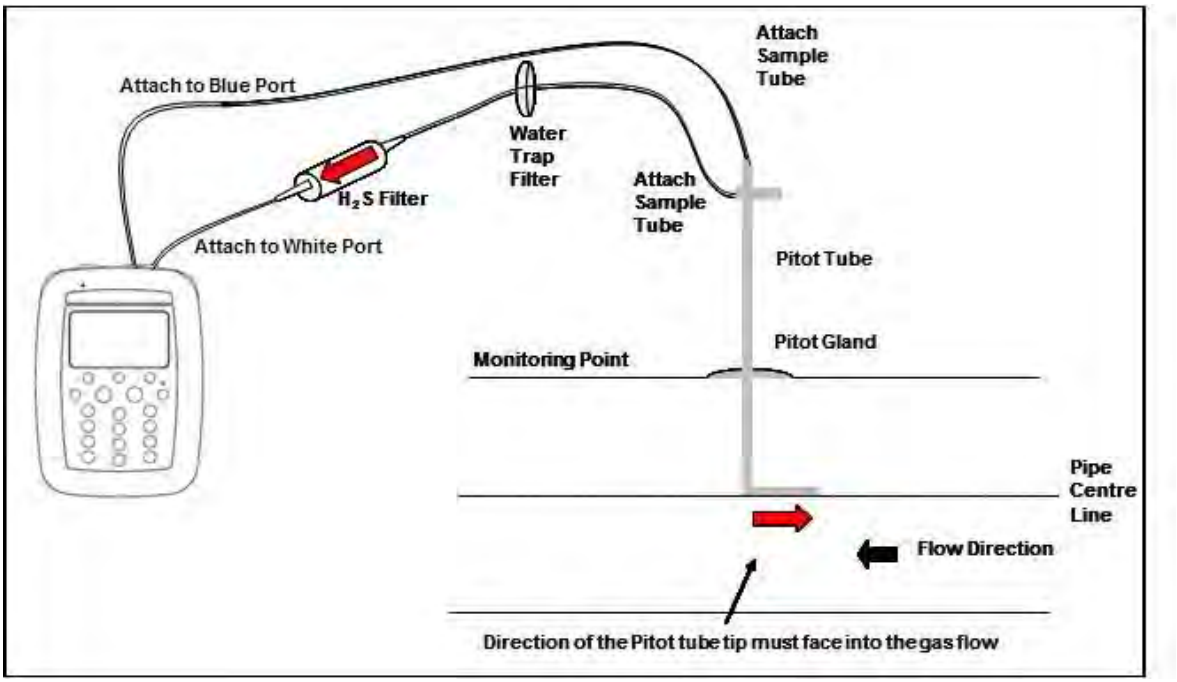


✍ Note: When onsite the site engineer must have an unmodified water trap assembly in addition to the modified water trap with a H_2S filter in order to take readings with and without a filter.

1) Once the H_2S filter is fitted follow the instructions as detailed on the front of the gas analyser displayed when taking readings using a H_2S filter.

   ✍ Note: This is only for analysers fitted with the CO compensated cell.

Fitting a pitot tube to a sample point when using an H_2S filter:



2) Make sure the water trap filter is fitted as close as possible to the pitot tube. This will help protect and trap moisture before it reaches the H_2S filter. Make sure that the water trap filter is clean and dry.

3) Attach the sample tubing into the analyzer.

4) To take flow readings using a pitot tube, please follow the instructions displayed on the front of the instrument. The user will be prompted to complete each step and should follow the instructions on screen.

   ✍ Note: It is important to fit the pitot tube central and parallel with the pipe.

8.11 How to use a temperature probe (optional)

The temperature probe enables the site engineer to measure the temperature of the gas within a sample point. The GEM5000 gas analyzer uses the temperature of the gas to give more accurate flow measurement readings as part of the instrument calculation.



Instructions for use:

1) The temperature probe reading is taken along with the gas measurement reading.

2) The analyzer must be at the 'Main Gas Read Screen'.

3) Attach the temperature probe to 'connector B' (refer to section 5.3 – Instrument connections points).

4) Insert the temperature probe into the sample point (borehole) at the same time as you attach the sample tube to the sample point (two sample points are required for the borehole).

5) Follow the instructions on the front of the instrument when taking your gas and measurement reading.

6) At the point in which the operator presses 'Enter' to store the gas reading the temperature is recorded.

✍ Note: Temperature probe readings can be analysed further when downloaded to LSGAM.

8.12 How to identify a borehole using the GPS feature (optional)

An optional GPS feature is available for the GEM5000 gas analyzer. It enables the site engineer to automatically locate borehole IDs using GPS satellite signal from predefined borehole IDs uploaded from LSGAM. The GPS reading data is stored for each measurement reading.

✍ Note: Borehole IDs may be uploaded from LSGAM with or without location information. If location details are not uploaded the location longitude and latitude coordinates can be stored when the borehole is located and downloaded to LSGAM with the reading measurements.

Screen navigation:

1) Switch on the analyzer and wait for the self-test warm-up to complete and the analyser will display the 'Main Gas Read Screen'.

2) In order to use the navigation function if configured, you must switch 'Navigation - On' on the analyzer. Select the 'Menu' key followed by 'Key 5' to toggle navigation to on. Select the 'Menu' key to exit and return to the 'Main Gas Read Screen'.

3) Select the soft-key 'Next ID', then select a borehole ID from the list displayed and press the 'Enter 'key to continue.

⚠ **Warning**	Before entering the GPS Navigation Screen for the first time the following health and safety message will be displayed. "Please be aware of the terrain when using this screen. You are responsible for your own safety whilst walking on-site!"

4) After reading the user warning message, select the soft-key 'Dismiss'. Use the tracking display to locate the borehole

✍ Note: There is often a wait time frame of between 30 seconds to two minutes while getting a satellite signal. Be aware that heavy rain, trees overhead etc. will give a bad fix.

5) Once the operator selects a borehole ID the 'GPS Navigation' screen is displayed.



6) If required, select soft-key 'Options' to go to the 'Navigation Options' menu and the following screen is displayed:



Navigation options

Key 1 — Key 1 to toggle between 'Meters', 'Feet' or 'Yards' to define the unit of measurement.

Key 2 — Key 2 to toggle between 'Manual Scaling' and 'Automatic Scaling' to locate a sample point using a satellite signal.

Key 3 — Key 3 to display sample point information:

- Bearing: Direction.
- UTC time: 'Universal Time Code' received from the satellite and displays GMT.
- Latitude: Latitude displays as degrees, minutes, seconds and decimal seconds. The equator is 0.
- Longitude: E (East) or W (West) displays the longitude as degrees, minutes, seconds and decimal seconds. The Greenwich meridian defines the zero point.
- Altitude: Altitude displays in meters, feet or yards.
- Satellite: This is the number of satellites that the system can select. Four satellites will give reasonable position accuracy; eight or more satellites will increase accuracy.
- Horizontal: Estimate of horizontal error on the indicated position. The location is accurate to horizontal error 1.6m.
- Vertical: Estimate of vertical error on the indicated position.
- HDOP: 'Horizontal Dilution of Precision' which measures the accuracy of the indicated position.

Changing the selected ID

It is possible to change the currently selected ID (identified by green icon) by pressing the 2 and 8 and keys to move the cursor up and down the list of visible Ids. To change the selection press Enter. Notice that the selected ID moves to the top of the list and its icon turns green.

Changing the scale

You can change the display's scale by using the 4 and 6 keys to zoom in and out.

GPS signal strength:



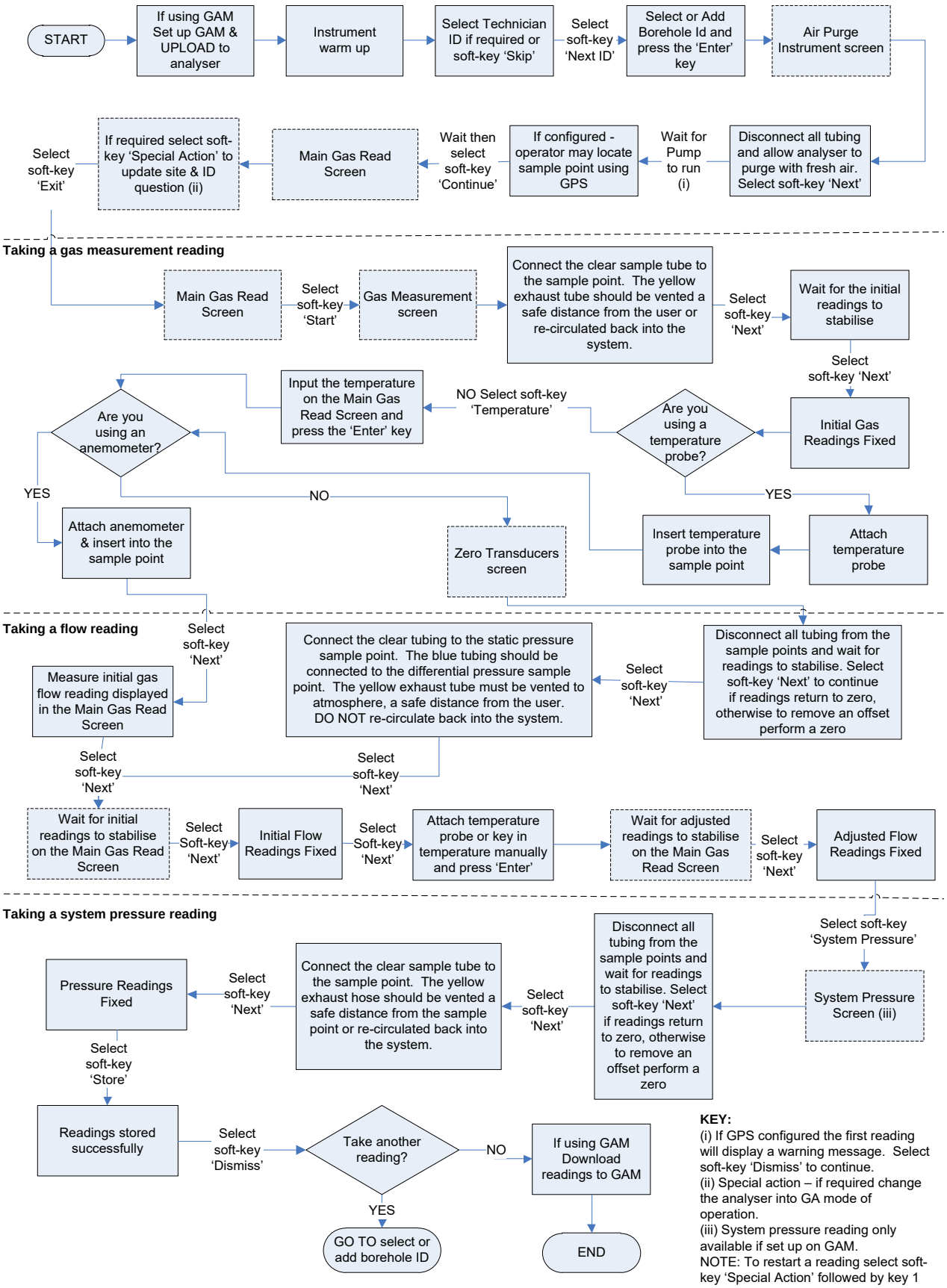
This icon shows the signal strength the analyzer's GPS module is able to provide. Full, okay and fair strength respectively.



GPS failure - the GPS was unable to get a line of sight lock on enough satellites. Or, it may be that it hasn't had time to get a lock.

7) Select soft-key 'Continue' and the operator is returned to the 'Main Gas Read Screen'.

8.13 Taking gas and flow measurement



KEY:
(i) If GPS configured the first reading will display a warning message. Select soft-key 'Dismiss' to continue.
(ii) Special action – if required change the analyser into GA mode of operation.
(iii) System pressure reading only available if set up on GAM.
NOTE: To restart a reading select soft-key 'Special Action' followed by key 1 'Restart Process'.

9.0 Calibration

9.1 Calibration introduction

The GEM5000 gas analyzer is carefully calibrated at manufacture and when returned for service. However, it is sometimes desirable to be able to carry out a calibration process between services.

This section outlines the correct procedures to enable the site engineer to field calibrate the gas analyzer.

✍ Note: This does not replace the factory service and calibration. If this calibration is completed incorrectly it may decrease the accuracy of the gas analyzer.

CH_4, CO_2 and O_2 can be measured by GEM5000 gas analyzer as standard; these channels can be user calibrated. The analyzers have other gas channel options that are specified at manufacture; these too can be calibrated. This section will describe in detail how to calibrate the three standard gas channels plus the CO channel.

The GEM5000 instrument can have a H_2 compensated CO channel. This option requires that H_2 is used in the calibration process and is also set out within this section.

For the other gas channel options contact QED for advice.

Two important terms that are used within this section are 'Zero' and 'Span'.

Zero: The point at which the gas analyzer is calibrated when there is none of the target gases present.

Span: The point at which the gas analyzer is calibrated when a known quantity of the target gas is present.

9.2 Frequency of calibration – best practice

The GEM5000 gas analyzers can be checked against a known concentration of gas, to give confidence that the analyzer is operating as expected at the time and conditions in which it is being used.

It is recommended that the instrument is regularly serviced and calibrated by QED in accordance with the due date on the instrument.

When defining the frequency of user calibration, the following are factors to be considered:

- The frequency of use of the analyzer. (daily?/monthly?)
- The level of confidence and accuracy required for readings to be taken.
- Historical user calibration data.
- Site specific requirements or conditions.
- Historical understanding of expected readings on site.

Zeroing of the gas analyzer should be undertaken at the start of each day's monitoring.

Use historical data to drive your frequency of calibration.
If there is no historical data a good starting point for a daily monitoring round is performing a calibration once every week or every other week.

The results of the calibrations will need to be recorded to monitor over time whether the frequency of calibration needs to be increased or decreased relative to the confidence required.

The confidence required will be driven by the site specific / user requirements.

When undertaking the monitoring with an understanding of the history of the gas levels of that site, a calibration check could be triggered if the readings measured are different to what is expected.

✍ Note: For assistance please contact Technical Support at (800) 968-2026 or email landtec_support@qedenv.com

9.3 Calibration gases

User calibration of a gas analyzer will greatly improve the data accuracy in the range of the calibration gases used. This may cause less accurate readings of concentrations outside this calibrated range. Users should select the correct calibration gas for the expected gas levels on their particular application.

- To improve calibration at lower levels requires the use of gas mixtures 1 and 2.
- To improve higher levels use gas mixture 3.
- For standard CO only 100ppm CO gas is needed.
- For CO (H_2 compensated) both CO 100ppm and H_2 1000ppm gases are needed.

The following table indicates the different gas mixture canisters used for calibration:

Calibration gas	CH_4	CO_2	O_2
Mixture 1	5%	5%	6%
Mixture 2	5%	10%	0%
Mixture 3	60%	40%	0%

Calibration targets for gas cells are dependent on the gas/range and type of cell fitted. Contact Technical Support for assistance.

These are for general use but other gas concentrations can be used.

✍ Note: The above gases and most other gas concentrations can be supplied by QED. For further information please contact Sales at (800) 624-2026 or email info@qedenv.com

⚠ **Warning**	Calibration gases can be dangerous. For each gas used the appropriate material safety data sheet must be read and understood before proceeding.

9.4 Calibration set-up

⚠ **Warning**	Do NOT attach the gas supply to the gas analyzer before putting the analyzer into the 'Gas Check' screen. Select 'Check Spans' from the 'Operation Settings' menu.

The regulator supplied with the calibration kit has been configured to deliver a fixed flow.

As the regulator's flow is factory set, it only requires a few turns to open, no adjustment is necessary.

⚠ **Warning**	**Exhaust port** When the gas analyzer is being calibrated, there are two possible exits for the gas, via the usual manner out of the exhaust (yellow) port of the analyzer or in cases of over-pressurisation the 1/16″ port on the red pressure relief valve located on the regulator. It is recommended that both ports have exhaust tubing attached. The exhaust tubing must emerge in a well-ventilated area. Ensure there are no leaks in the tubing and connections. The calibration of the gas analyzer should be carried out in a safe area with all necessary precautions taken when using potentially dangerous, explosive or toxic gases.

✍ Note: There is also potential for gas to expel from the internal flow (blue) port of the gas analyzer (applies to the GA5000 only).

9.5 Calibration equipment

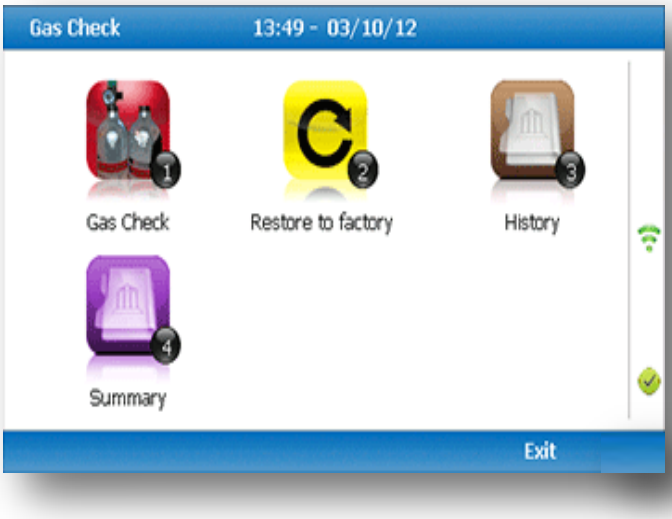
The diagram below displays the regulator and tubing equipment for user calibration:



- Certified calibration gas, available in either 29 liter, 34 liter or 58 liter gas canisters are supplied with the Landtec calibration kit. Please refer to the Landtec website www.landtecna.com for further information.
- The regulator supplied with the calibration kit is pre-set for flow and pressure rates that are factory set.
- If you are using a non Landtec supplied regulator, please ensure that it does not supply any greater than 200 mbar pressure.

9.6 Gas analyzer

For the GEM5000 gas analyzer the calibration options can be found by selecting the 'Menu' key followed by soft-key 'Operation Settings'. Select 'Key 2 – Gas Check' then follow the instructions on the analyzer screen by selecting 'Key 2 – Gas Check'.



9.7 Calibration processes – best practice

The following process diagrams outline the calibration steps.

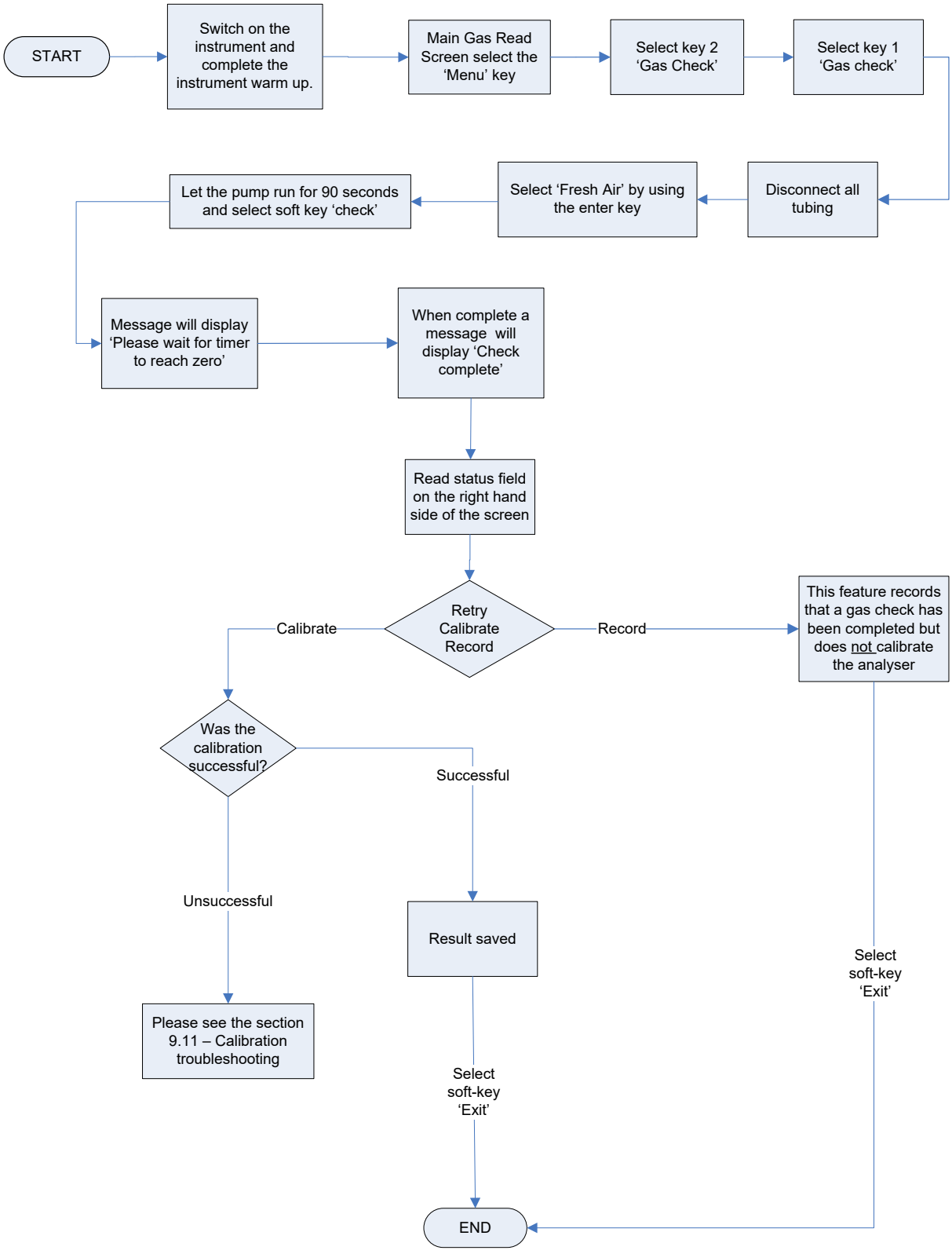


- Ensure that you are regulating calibration gas down to below 200 mbar pressure, if you're not using a Landtec regulator. The use of a pressure relief valve is also highly recommended.

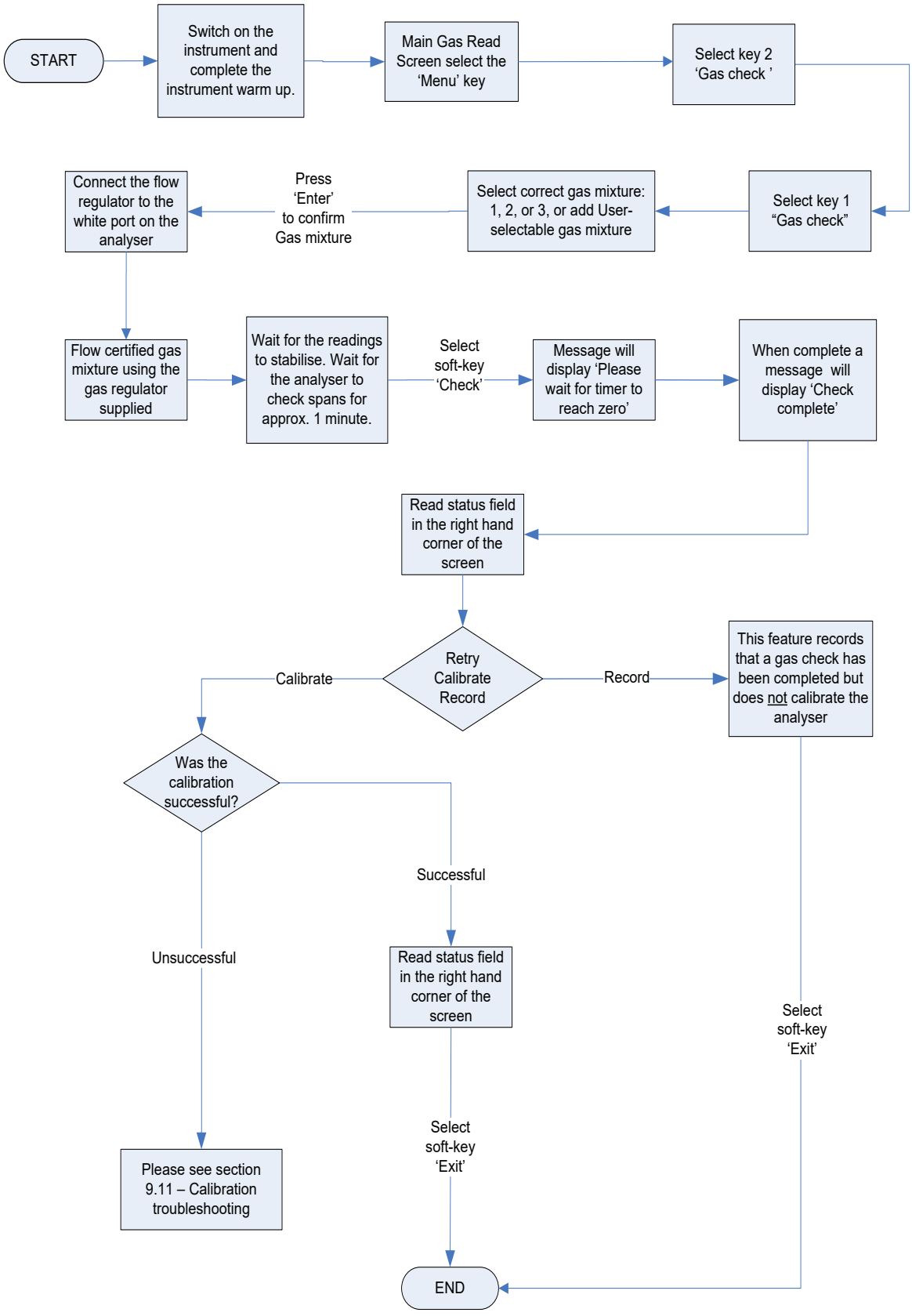
- When calibrating, it is recommended to use a calibration mixture close to the levels you are trying to measure, i.e. if you are trying to measure gas migration on a closed landfill, we'd recommend calibrating with CH4 5%/CO2 5%.

- In regards to frequency, we would recommend that you perform a fresh air calibration before each monitoring session, and a span calibration typical every 4 – 6 weeks.

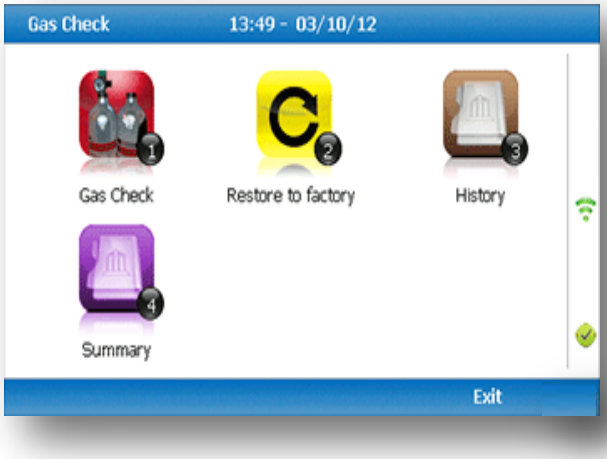
9.7.1 Gas Check in fresh air



9.7.2 Calibration – mixtures 1, 2, & 3



9.8 Restore to factory settings



This option will reset the gas analyzer to all of its factory programmed calibration settings and will clear ALL the user defined calibration points. It will not affect or remove ID's or readings from the analyzer.

1) Select 'Key 2 - Restore to factory' followed by the soft-key 'Confirm' or 'Cancel'.

2) A validation message is displayed 'Reset user calibration?' Press the soft-key 'Confirm' to continue with the factory settings or soft-key 'Cancel' to cancel the operation and return to the Gas Check menu.

9.9 Calibration history

The GEM5000 gas analyzer logs user calibrations in 'History' application. This can be used as an aid to ensuring that gas measurements are valid and accurate. Both good and failed calibration results are recorded for each channel calibrated.

1) Select 'Key 3 – History'.

2) The operator may view the calibration data stored. Use the soft-key 'Filter' to add a sort filter to the history enquiry.

9.10 Calibration summary

The GEM5000 gas analyzer has the facility to log the history of user calibrations.

1) Select 'Key 4 – Summary'.

2) The operator may view the calibration data history stored by ID, technician, timestamp, type and calibration result. Use the soft-key 'Exit' to exit and return to the 'Gas Check' menu.

10.0 Problem Solving

This section outlines various warning and error messages which the operator may receive during general operation of the instrument. For further assistance please contact Technical Support at (800) 968-2026 or email landtec_support@gedenv.com

11.0 Warning and error display

When switched on, the instrument will perform a pre-determined self-test sequence taking approximately 15 seconds. During this time many of the instrument's working parameters and settings are checked.

If any operational parameters are out of specification or the pre-programmed recommended calibration/service date has passed, errors or warnings may be displayed.

Use the 'Scroll up' and 'Scroll down' keys to move through the list if required.

Only three warnings/errors can be displayed at any time.

To ascertain if more errors have occurred use 'Key 8' – Scroll down' and 'Key 2' - Scroll up' through the list.

Warnings displayed:

All warnings displayed will be prefixed by the word WARNING followed by a relevant description.

There are two types of warning that may be displayed:

1. General warnings that may not affect the instrument's function and those where the self-test has detected a function that is outside the usual programmed operating criteria, e.g. battery charge low, memory nearly full.

2. Operational parameters that could affect the performance of the analyzer: Cell out of calibration, CH_4 out of calibration, CO_2 out of calibration.

The most likely reason for the errors is either an incorrect user calibration or sensor failure. If an incorrect user calibration has caused the warning it should be correctable by way of returning the instrument to factory settings, zeroing or carrying out a user calibration as necessary for the relevant function.

12.0 Service

The GEM5000 gas analyzer should be regularly serviced to ensure correct and accurate operation. QED recommends a service and recalibration every **12 months**.

The GEM5000 range is ATEX certified for use in potentially explosive areas. As such it should be serviced only by qualified engineers. Failure to observe this will result in the warranty becoming invalid and could invalidate the ATEX certification.

⚠ **Warning**	If the GEM5000 is serviced by unqualified engineers the ATEX certification may be invalidated and the instrument may be unsafe for use in a potentially explosive atmosphere.

User serviceable parts:

There are no user serviceable parts inside the instrument.

The following parts can be user serviced:

In-line water filter	This should be regularly inspected for obstructions, moisture or damage and changed if needed. The instrument should never be operated without the in-line water filter as this may result in water entering the instrument.
Sample tubing	Always ensure that sample tubes are not contaminated or damaged.
Gas port connectors	Periodically check that the O-rings on the gas port connectors are not damaged. A damaged O-ring can let air into the sample gas and result in incorrect readings. If the O-ring is damaged the complete gas port connector should be replaced.
H_2S filter material	When the filter material changes color to a *light gray* color the filter should be replaced.

13.0 Warranty policy

This instrument is guaranteed, to the original end user purchaser, against defect in materials and workmanship for a period of **3 years** from the date of the shipment to the user.

During this period QED will repair or replace defective parts on an exchange basis.

The decision to repair or replace will be determined by QED.

To maintain this warranty, the purchaser must perform maintenance and calibration as prescribed in the operating manual.

Normal wear and tear, and parts damaged by abuse, misuse, negligence or accidents are specifically excluded from the warranty.

✍ Note: Please contact Technical Support at (800) 968-2026 or email landtec_support@qedenv.com for further information.

14.0 Glossary of terms

5000 series	The 5000 series refers to the GA5000, GEM5000 and the Biogas5000 gas analyzers.
Accu-Flo	A flow device used to aid accurate flow measurement.
Analyzer error messages	Operational errors are prefixed on the analyzer by the word ERROR followed by an error code. Refer to the list of standard error codes for more information.
Analyzer warning	Analyzer warnings are prefixed by the word WARNING followed by a relevant description. There are two types of warning messages displayed; general warnings that may not necessarily affect the instrument's function (for example, battery power low) and operational parameters that could affect the performance of the analyser (for example, CH_4 out of calibration).
Anemometer probe	Device for measuring velocity of gas in the pipe. The GEM5000 analyzer can be set to convert into a flow. See also flow measurement.
ATEX certification	The GEM5000 is ATEX certified to zone 1 & 2 areas above ground not in mines.
Auxiliary channel	This refers to the channels where external devices will be connected or displayed.
Backlight	The analyser has a built-in backlight for low ambient light conditions. This can be toggled on/off using the backlight key.
Barometric pressure	The atmospheric pressure at the given location.
Borehole	Typical location from which a gas sample is obtained.
Calibration	The gas analyzer is carefully calibrated against known standards.
Calibration record	The GEM5000 instrument has the facility to log user calibrations as a validation tool.
CH_4	Methane
Chemical cells	A method of gas detection that works on the basis of a chemical reaction with the target gas.
Clean air purge	Process used to clear out gas from the sample tube and analyser prior to taking a new reading.

CO	Carbon monoxide
CO_2	Carbon dioxide
Data logging	Data logging enables the operator to leave the analyzer unattended to take samples at predetermined intervals for a set period of time
Download	Terminology used for the movement of data from the analyzer to the LSGAM application on the PC.
Dual beam infrared absorption	Method of gas detection by measuring how much infrared is absorbed by the target gas.
Event log	Used as an aid to monitoring the use of the analyser. It can also be used as a diagnostic tool. The event log can be viewed via LSGAM. It cannot be viewed on the analyzer screen.
Exhaust port	The usual manner for the gas to exit the analyzer is via the exhaust port located on the top side of the analyzer. This port should have an exhaust tube attached.
Exhaust tube	Clear plastic tubing used to expel gases from the exhaust port.
Factory settings	Default settings preset at time of manufacture or service.
Firmware	Firmware is the term by which the internal analyzer software is known and is not accessible by the client. This firmware is updated to the latest version when the analyzer is returned for servicing.
Flow measurement	Flow can be measured by either gas velocity m/s or volume flow rate m^3/hr. This measurement of flow relates to the use of the anemometer and not the internal flow measurement technique.
Flow port	For the measurement of gas flow at the sample point.
Landtec Systems Gas Analyser Manager	Also referred to as LSGAM. PC based software which enables the operator to upload and download information to/from the analyser. LSGAM enables operators to maximise the operation of their gas analyzer. It features a simple upload and download facility and is fully compatible with the latest Microsoft™ operating systems. This is optional.

Gas channels	The gases that are analyzed by the instrument.
Gas velocity	The positional rate of change of the gas. Measured using the optional anemometer.
General warnings	Displayed throughout the documentation with a warning symbol. Warning information may affect the safety of operators.
H_2	Hydrogen
H_2S	Hydrogen sulphide
H_2S filter	Filter required for removal of H_2S. When the filter material changes color to a light gray color or if H_2S values are displayed, then the filter should be replaced.
Hydro-carbons	Organic compound consisting of only hydrogen and carbon.
In-line water filter	The component used to help protect the instrument from water ingress.
LCD display	Liquid Crystal Display
LEL	Lower Explosive Limit. Lower explosive limit of methane in air. 5% methane in air is the point at which it becomes explosive. 100% LEL equates to 5% methane.
m/s	Meters per second – measurement of gas velocity.
m^3/hr	Meters cubed per hour – volumetric flow rate measurement.
Main Gas Read Screen	The main analyzer screen for normal operations and all operations are carried out from this screen.
Material data sheet	Document from which information about a certain substance can be obtained.
MCERTS certification	MCERTS is the UK Environment Agency's Monitoring Certification Scheme. The scheme provides a framework within which environmental measurements can be made in accordance with the Agency's quality requirements. The scheme covers a range of monitoring, sampling and inspection activities.
Memory	Location where data and ID information is stored. The analyzer memory should not be used as a permanent storage medium. Stored data should be regularly transferred using the LSGAM download software.

NO_2	Nitrogen dioxide
Operating language	The operator can choose the default operating language for the analyzer. Choices are English, German, Spanish, French and Italian.
PPM	Parts per million
Pump	Used to draw the gas sample from the sample point to the analyzer. Select the pump key on the analyzer to activate.
ID	The user definable identification tag allocated to a sample point.
Relative pressure	The pressure at the sample point 'relative' to atmospheric (barometric) pressure.
Relative pressure transducer	The internal component used to measure the relative pressure.
Residual N_2	The calculation for the residual N_2 used on the latest version of the GEM5000 platform is as follows: Residual N_2 = Balance − (O_2% x 3.76) Where, Balance = 100% - (CH_4% + CO_2% + O_2%) and 3.76 is the ratio of O_2 to N_2 in ambient air (79/21)
Sample tube	The tube used to obtain a sample of gas from the sample point to the analyzer.
Span	The point at which the gas analyzer is calibrated when a known quantity of the target gas is present.
Span multi gas	Term by which the span calibration of the three main gas channels is known. This option must only be used when the calibration gas being used is a combination of CH_4 CO_2 O_2.
Technician ID	An alpha-numeric code tagged to each gas reading. Facility only available via LSGAM. This is an optional feature.
Temperature probe	External device used to measure the gas temperature at the sample point. This is optional.
Update site data	Enables the operator to answer pre-defined questions relating to the site, environment etc. These questions are defined via LSGAM software.

Upload	Terminology used for the movement of data from the PC via LSGAM software application to the analyzer.
Volume flow rate	The volume of a gas that passes through a given surface per unit of time e.g. m^3/hr
Warm-up self-test	Pre-determined self-test sequence to test the analyser functions which takes place after the analyzer is switched on.
Warranty	The instrument is under guarantee against defect in materials and workmanship for a period of 3 years from the date of shipment to the operator and is subject to the recommended service and recalibration requirements.
Water trap	Device used to protect the instrument from water or moisture ingress.
Zero	The point at which the gas analyzer is calibrated when there is none of the target gas present.
Zero transducers	This option allows the relative pressure transducer to be zeroed.

OPERATIONS MANUAL

Westbay MOSDAX Sampler Probe - Model 2531



Schlumberger
WATER SERVICES

NOTICE

Operation of Westbay System equipment should only be undertaken by qualified instrument technicians who have been trained by Westbay authorized personnel.

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DO NOT OPEN THE SAMPLER

All warranties expressed or implied will be void if, after examination by Westbay Instruments Inc. personnel, it is established that any of the instrument housings have been opened without prior authorization from Westbay Instruments Inc.

DO NOT LET THE SAMPLER FREEZE

Extreme care should be taken to avoid freezing the MOSDAX Sampler probe. Permanent transducer damage may result from freezing.

Manual Revision: 1.13 20 October 2006

Issued for Serial No.: _____

Date: _____

Signature: _____

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1. DESCRIPTION

1.1 MOSDAX Sampler Probe, Model 2531

The MOSDAX Sampler is a downhole probe designed to collect fluid pressure information and fluid samples from Westbay System monitoring wells. Each MOSDAX pressure sensor is calibrated over its full pressure range for nonlinearity and temperature variation. MOSDAX Sampler probes are available in a variety of pressure ranges to permit operation to various depths. The shoe and valve motors can be operated from the surface. The power for the shoe and valve motors is supplied from the surface.

1.2 MOSDAX Automated Groundwater Interface (MAGI), Model 2536

The MOSDAX Sampler can be operated directly by the keypad on the MOSDAX Automated Groundwater Interface (MAGI), or by a Hand Held Controller (HHC) connected to the MAGI, or with a computer running Microsoft Windows (2000 or higher) and Westbay software connected to the MAGI. The MAGI translates the signals between the computer or HHC and the MOSDAX Sampler. The MAGI requires 12 volt DC power to operate.

Older versions of MOSDAX sampling equipment may incorporate a Model 2522 MOSDAX PC Interface (MPCI) and HHC rather than a MAGI. For such systems, reference to the MAGI in this document can be considered as reference to the MPCI and HHC.

1.3 Cable Reels

The manual cable reel can operate all Westbay probes and tools to a depth of 300m (1,000 ft) on a single-conductor cable. The manual reel is hand operated with an internal brake to control the speed of descent of the probe in the well. The two-pin cable connects the MAGI to the reel and the signals pass through a slipring located in the hub of the reel into the control cable. For maintenance information, see the appropriate cable reel manual.

Motorized cable reels are available for deeper applications.

1.4 Sample Containers

Sample containers can be used with the MOSDAX Sampler. The nonvented stainless steel sample containers maintain samples under formation pressure while the sampler and container are brought to the surface.

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2. PRESSURE PROFILING

2.1 Items Required

- MOSDAX Sampler Probe, Model 2531
- MAGI, Model 2536 with:
  - one two-pin data cable
  - one three-pin power cable
  - hand held controller with cable and user's guide (optional)
  - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sheave with counter and tripod
- 12 VDC, 2 Amp power source (Battery pack, car/truck battery, or transformer)
- Water level measuring tape
- MProfile User's Guide for computer or the Handheld Controller Operations Manual
- Westbay Casing Log showing depths to ports and couplings in hole to be tested.

2.2 Surface Checks

1. Remove the MOSDAX Sampler from its storage case. Inspect the probe housing and body for any damage. Please contact Westbay for advice on any cover tube damage.
2. Assemble the tripod and counter over the well. Run the cable over the counter.
3. Connect the probe to the cable. Before attaching, inspect the O-ring at the top of the probe and lubricate with silicon. The O-ring should be clean and intact. Tighten the nut hand tight only.
4. Connect the two-pin cable from the MPCI to the cable reel. With the MPCI OFF connect the three-pin cable from the MPCI to the 12 v power supply.
5. Connect the 9 pin cable from computer or HHC to the MPCI and turn the MPCI ON.
6. Perform the following surface checks to ensure that the location arm and the shoe mechanisms are operating normally: Release the location arm. The location arm should extend smoothly. The number of revolutions used to release the location arm is displayed and should be 15 to 16 revolutions. If a smaller number of revolutions is reported, retract the arm and repeat. Place the probe in a piece of Westbay casing or coupling. Activate the shoe. The shoe should extend and hold the probe firmly in the coupling or casing. The display should indicate 16 to 19 revolutions. A reading of 23 revolutions indicates the probe is activated in open air. Retract the backing shoe.

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7. Check that the face plate for sampling and the plastic plunger are installed on the sampler.
8. The probe is now ready to be lowered down the well.

2.3 Pressure Measurement Procedures

1. Obtain the completed Westbay Casing Log.
2. With the location arm retracted, lower the probe into the Westbay casing to immediately below the lowest measurement port coupling to be monitored. If magnetic collars have been installed on the well, the Collar Detect Command can be used to detect the collars. The Collar Detect Command is cancelled by pressing any key.
3. Release the location arm. The display should update and beep after the arm is released.
4. Raise the probe about 0.5 m (1.5 ft) above this measurement port. If the probe is accidentally lifted above the next higher coupling, it will be necessary to retract the location arm and lower the probe to below the measurement port and release the arm.
5. Lower the probe gently until the location arm rests in the measurement port.
6. Record the pressure and temperature inside the Westbay casing.
7. Optional: If a water level tape is available, measure and record the depth to water in the Westbay casing.
8. Activate the shoe. The pressure on the display should change to the formation pressure.
9. When the reading has stabilized, record the formation pressure.
10. Once the pressure has been recorded, retract the shoe.
11. Record the pressure of the fluid in the Westbay casing. This reading should be similar to that recorded in Step 6. If a large difference is noted between the readings, record the water level inside the Westbay casing again using the water level tape.
12. The three pressure readings plus the time and water level constitute a complete set of readings at a measurement port coupling.
13. Continue up the Westbay casing to obtain the pressure data from other measurement ports.
14. Take one last set of pressure and temperature readings at the surface. These readings should be similar to those recorded in Step 2.

CAUTION: If a water level tape was used, remove the water level tape from the Westbay casing before removing the sampler probe from the well to prevent them from becoming jammed.

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3. FLUID SAMPLING

3.1 Items Required

- MOSDAX Sampler, Model 2531
- MAGI, Model 2536 with:
  - one two-pin data cable
  - one three-pin power cable
  - hand held controller with cable and user's guide (optional)
  - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sample containers and connecting tubes
- Westbay Casing Log
- Groundwater Sampling Field Data Sheet
- 12 VDC, 2 amp power source (battery pack, car/truck, or transformer)
- Counter and tripod
- Westbay Sampling Kit including vacuum pump

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3.2 Surface Checks and Preparation

1. Set up the MOSDAX Sampler probe following Steps 1 through 8 of Section 2.2.
2. Attach the sample containers.
3. Release the location arm. Locate the probe in the vacuum coupling.
4. Activate the shoe in the vacuum coupling.
5. Close the sampler valve. The motor should run about 5 seconds. The display should indicate one revolution.
6. Use the vacuum pump to apply a vacuum through the vacuum coupling. The vacuum should remain constant. If the vacuum is not maintained, inspect for leaks at the face seal of the probe, the connection to the pump and at the probe sampling valve.
7. Once a vacuum has been maintained, open the sampler valve. Apply a vacuum again to check that all connections are sealed.
8. Close the sampler valve. A vacuum has now been applied to the sample bottles.
9. Retract the shoe.

3.3 Drillhole Sampling

1. Check recent pressure logs of the hole and ensure that the head inside the Westbay casing is lower than the head outside the measurement port to be sampled.
2. After completing the surface checks, follow Steps 1 to 5 of Section 2.3 to locate the sampler at the measurement port in the monitoring zone to be sampled.
3. Record the pressure reading.
4. Activate the probe and record the formation pressure.
5. Open the sampler valve. The pressure should drop and then slowly increase as the bottles fill. When the pressure in the bottle equals the zone pressure from Step 4, the bottle is full. Wait a maximum of two minutes per sample bottle even if the pressures are not equal.
6. Close the sampler valve and retract the shoe.
7. Record the pressure reading. A reading the same as in Step 3 indicates that the sample is OK.
8. Reel the sampler to the surface and remove it from the Westbay casing.
9. **Do not open the sampler valve as damage to the probe or injury to the operator could occur.**
10. Remove the cap from the bottom sample bottle and open the valve on the bottle to release the pressure and to transfer the sample.
11. Open the sampler valve to allow the sample to flow from the bottles. Once the pressure in the sampler and bottles has decreased to atmospheric, the bottles may be disconnected to speed the process.
12. Take particular care in handling pressurized samples.

3.4 Rinsing Instructions

Rinse the sampler around the face seal and the bottom connector. With the sampler valve open, flush the interior of the sampler from the bottom connector. Rinse the sample bottles and connectors.

Note: Project specific procedures for decontaminating the sampler and sample bottles are the responsibility of the project manager and are not covered in this manual.

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4. Care and Maintenance

The MOSDAX Sampler System must be routinely maintained for optimum performance. The procedures outlined here are required to keep the instrument operating properly. For any additional information or advice, please contact Westbay Instruments Inc.

4.1 MAGI

The MAGI should be cleaned to remove dirt and dust and inspected for damage or wear. If any part requires replacement, contact Westbay for information.

4.2 Cable Reels and Control Cable

The cable reels should be kept clean and protected from damage. The cable and cable head should be inspected for kinks and corrosion. Rehead the cable if necessary. For more information concerning cable reels and the control cable, refer to the appropriate reel manual.

4.3 MOSDAX Sampler Probe

1. Never allow the probe to freeze or the pressure transducer may be damaged.
2. Clean and inspect the probe for dents and scratches on the cover tube. Clean the threads with a nylon brush, such as a toothbrush. DO NOT use a wire brush. Protect the O-rings from damage and dirt.

4.3.1 Face Seal

Inspect the face seal and replace if damaged or worn.

1. Remove the two screws holding the face plate to the probe body and lift the face plate off.
2. Remove the face seal and plunger. Set the location arm assembly aside. Clean the plunger and probe body.
3. When reinstalling the face plate hold the face seal, plunger and location arm assembly in place. Replace the two screws the hold the face plate on the probe.

4.3.2 Location Arm

Release the location arm. Check that the arm moves smoothly and freely and check for damage and sharp edges due to wear. Replace the location arm if necessary.

1. Release the location arm. Remove the two screws and face plate (Section 4.3.1).
2. Remove the location arm with its spring and pivot pin. Clean and inspect all parts and replace if needed.
3. Insert the spring and pivot in the location arm and place the assembly in the probe body. Place the face plate over the face seal and location arm and tighten the two screws.

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SECTION 4.3.2 SUPPLEMENT

WESTBAY Probe Location Arm replacement

a) It is easier when the arm is first extended to the "out" position (Fig. A). Do this before powering down and disconnecting the probe.

b) Remove the face seal slowly and stabilize the arm as it is under tension from the spring (Section 4.3.2.2) and may suddenly pop out. Observe the position and orientation of the parts as they are removed (Fig. B).

c) Insert the hook of bent leg of the spring into the tiny hole on the neck of the new arm and align the spring coil opening alongside the larger hole in the arm with the spring leg positioned directly against the arm and over the pivot facing out (Fig. C-1). The metal pivot pin goes through the hole in the arm and through the spring coil (Fig. C-2). The straight leg of the spring leads under the pivot into the smaller side slot on the side of the main arm aperture, parallel with the probe. Place the assembly into its space in the probe body (Fig. C-3). The arm assembly has to be held in place while replacing the face seal to counter the force of the slightly compacted spring (Fig.C-4).

d) Replace the face seal by sliding it toward the top of the probe and sliding the top edge into the slot while at the same time allowing the arm to protrude through the face seal. The arm should remain in the extended position while screwing down the face seal.

e) Check to see that the arm can be freely, manually pushed in and that it pops back out when released. Attach the probe to the cable and mechanically retract the arm using the MAGI commands.

Figure **A** - Arm is extended out at start of replacement operation.



Figure **B** - Disassembled face seal and location arm.



Figure **C-1** - Orientation of spring relative to arm.

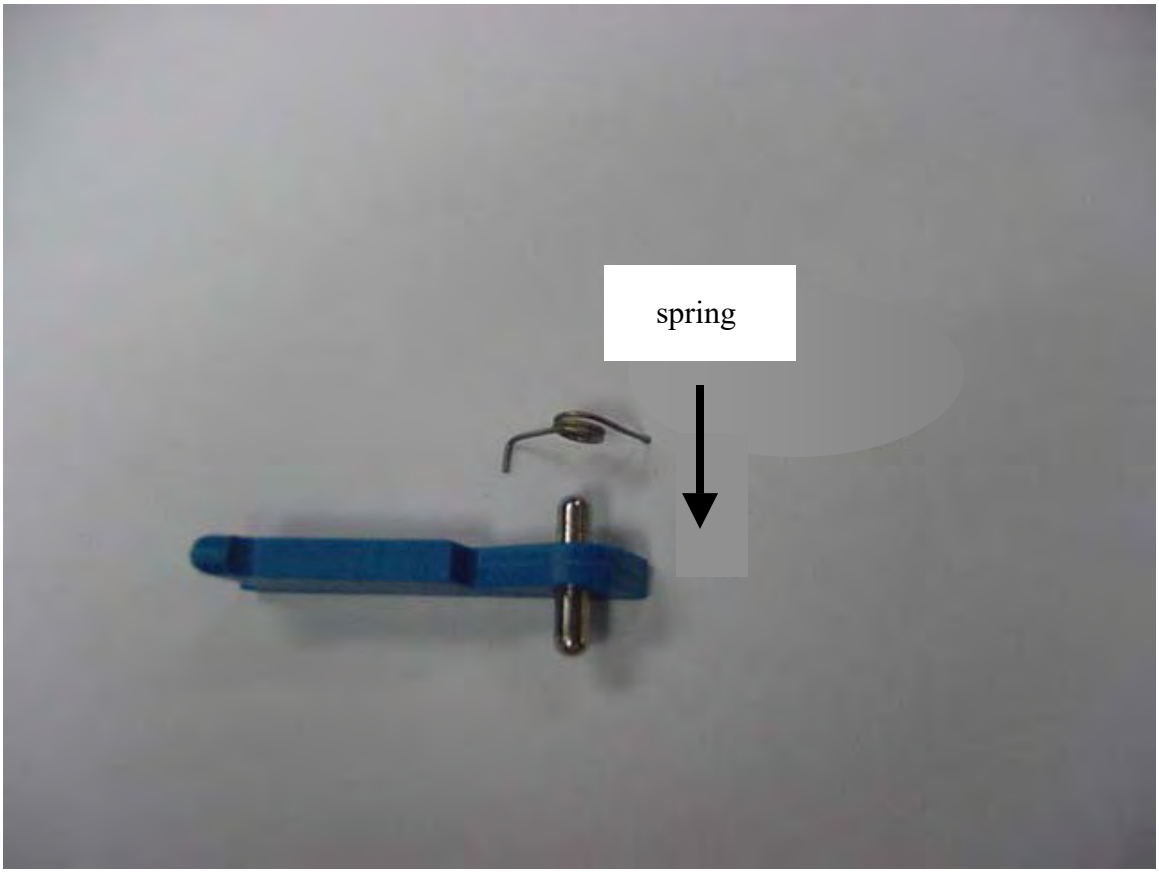


Figure **C-2** - Position of spring and pivot in the arm.



Figure **C-3** - Placement of arm assembly.

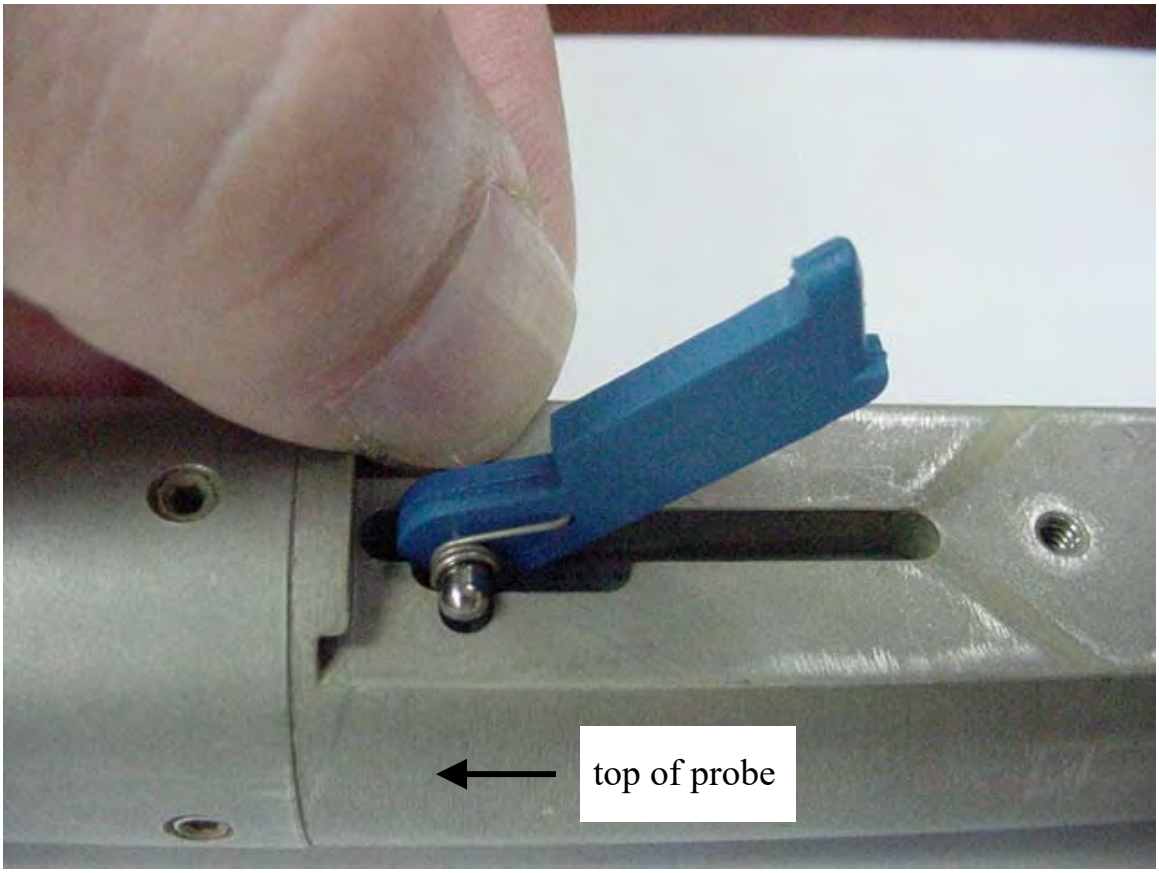
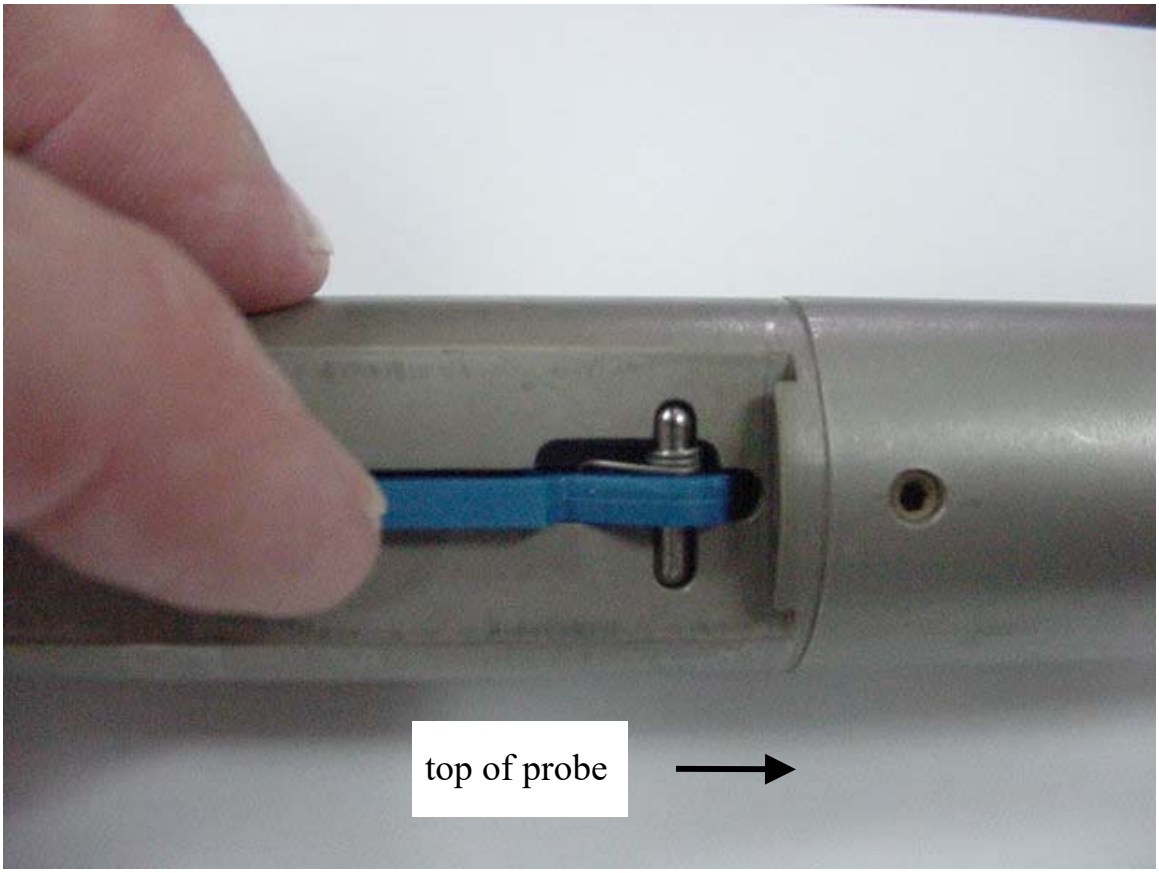


Figure **C-4** - Top view of arm and spring placement.



Check that the arm is moving freely and the face seal insert and plunger are held securely in place.

4.3.3 Shoe Replacement

Activate the shoe and inspect for damage or wear. The shoe should rotate freely about the pivot pin. When the shoe is retracted it should retract quickly and smoothly back into the probe. The shoe may be replaced in the following manner:

1. Release the location arm and extend the shoe to expose the pivot pin.
2. Unscrew the shoe pivot pin from the lever arm and remove the shoe.
3. Place a new shoe in the lever arm and install the shoe pivot pin.

4.3.4 Actuator Nut

The actuator nut needs to be routinely cleaned to remove particles of grit which can interfere with its movement. Remove the actuator nut in the following manner:

1. Remove the two set screws that hold in the lever arm pivot pin. Using the Allen key, push the lever pivot pin out of the probe body.
2. Remove the set screws on the side of the probe body that holds the plastic support block.
3. Remove the screw closest to the top of the probe.
4. Lift out the lever arm, guide plate, shoe, spring and plastic support block as one unit.
5. Use the Clean Nut Command to remove the actuator nut from the actuator screw. Turn off the MPCI and remove the nut from the probe.
6. Clean the actuator nut with the cleaning tap. Use the Clean Nut Command and clean the actuator screw with a nylon brush. DO NOT use a wire brush.
7. Apply a thin coating of silicone lubricant to the actuator screw. Place the actuator nut in the probe body against the actuator screw and retract the arm to thread the nut onto the actuator screw. Allow the nut to travel along the full length of the screw. YOU MAY HAVE TO REPEAT THIS OPERATION.
8. Install the single unit from Step 4 in the probe body. Install the lever arm pin through the probe body, lever arm, and spring. Lock the pin in position with two set screws.
9. Install the top screw into the guide plate and install the set screws to secure the support block.

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5. CALIBRATION

The Westbay System permits frequent or periodic calibration of the transducers used for pressure measurement. Contact Westbay for details.

6. SPARE PARTS LIST

Item	Part No. or Size	Qty
Face Seal Insert	200302	5
Plunger	(see Note 1)	5
Location Arm	252112	5
Shoe	252313	5
Pin 3 (Location Arm)	252320	2
Spring 2 (Location Arm)	252319	2
Pin 1 (Shoe)	252316	2
Spring 1 (Shoe Lever)	252318	2
Pan Head Screw	# 4-40 x 1/4 - inch	2
Pan Head Screw	# 6-32 x 3/16 - inch	2
Pan Head Screw	# 6-32 x 1/2 - inch	2
Hex Socket Head Screw	# 8-32 x 1/8 - inch	4
Hex Socket Head Screw	# 10-32 x 3/16 - inch	4
Hex Socket Set Screw	# 8-32 x 5/16 - inch	2
Allen Key	5/64 - inch	1
Allen Key	3/32 - inch	1
Actuator Nut Tap	208001	1
Cablehead Parts:		
O-ring	# 111 B	2
Termination Sleeve	251805	1
Termination Insert	251806	1
Feedthru Connector	251814	1
Bushing 1	251812	1
Bushing 2	251813	1
O-Ring	# 108 V	1
O-Ring	# 010 V	1
O-Ring	# 004 V	1
Boot	JF0602CF	1
Contact	JF0603CF	1
Cable Heading Tool	208100	1

1. Plunger appropriate to type of measurement port to be accessed.

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Schlumberger WATER SERVICES

Groundwater Sampling

Field Data Sheet

Project: _____ Date: _____

Monitoring Well No.: _____ Start Time: _____ Atm. Rdg: _____

Sampling Zone No(s).: _____ End Time: _____ Atm. Rdg: _____

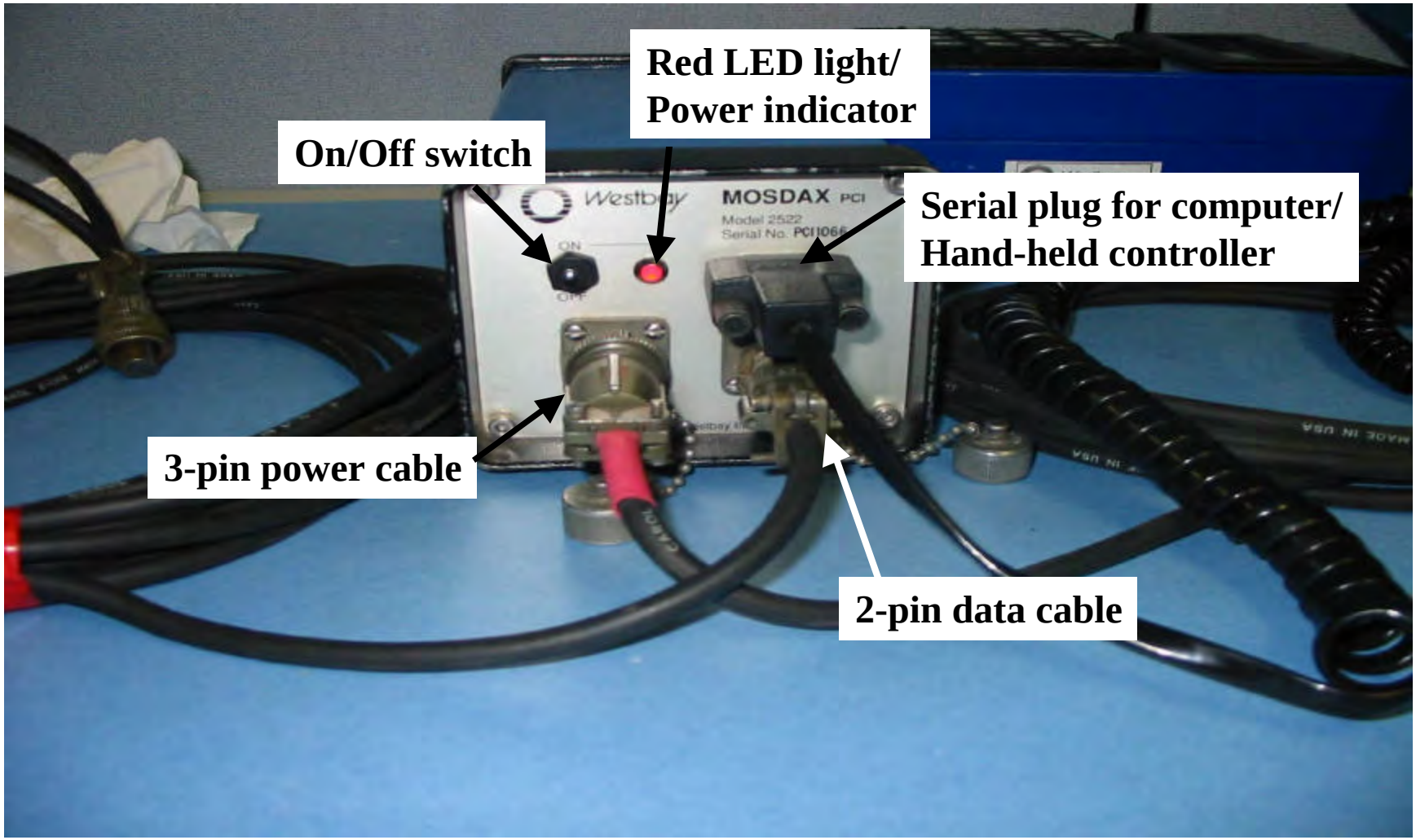
Operators: _____

Port No.	Run No.	Surface Function Tests (probe in flushing collar)						Position Sampler			Sample Collection Checks (probe located at sampling zone in Westbay casing)								Comments (volume recovered)
		Shoe Out	Close Valve	Check Vacuum	Open Valve	Apply Vacuum	Close Valve	Locate Port	Arm Out	Land Probe	Pressure in Westbay ( )	Shoe Out	Zone Pressure ( )	Open Valve	Zone Pressure ( )	Close Valve	Shoe In	Pressure in Westbay ( )	

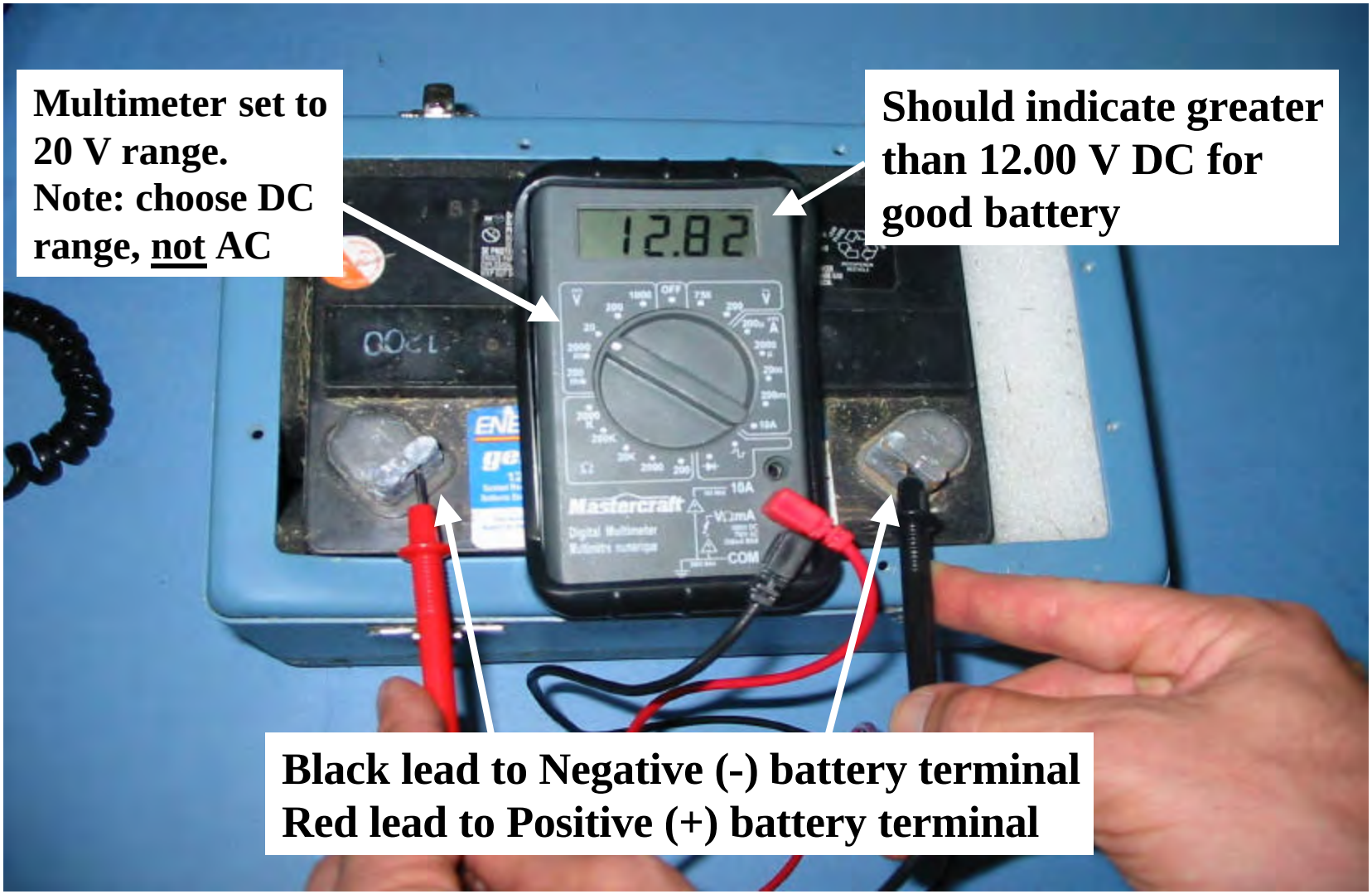
Additional Comments: (pH, turbidity, S.C., etc.)



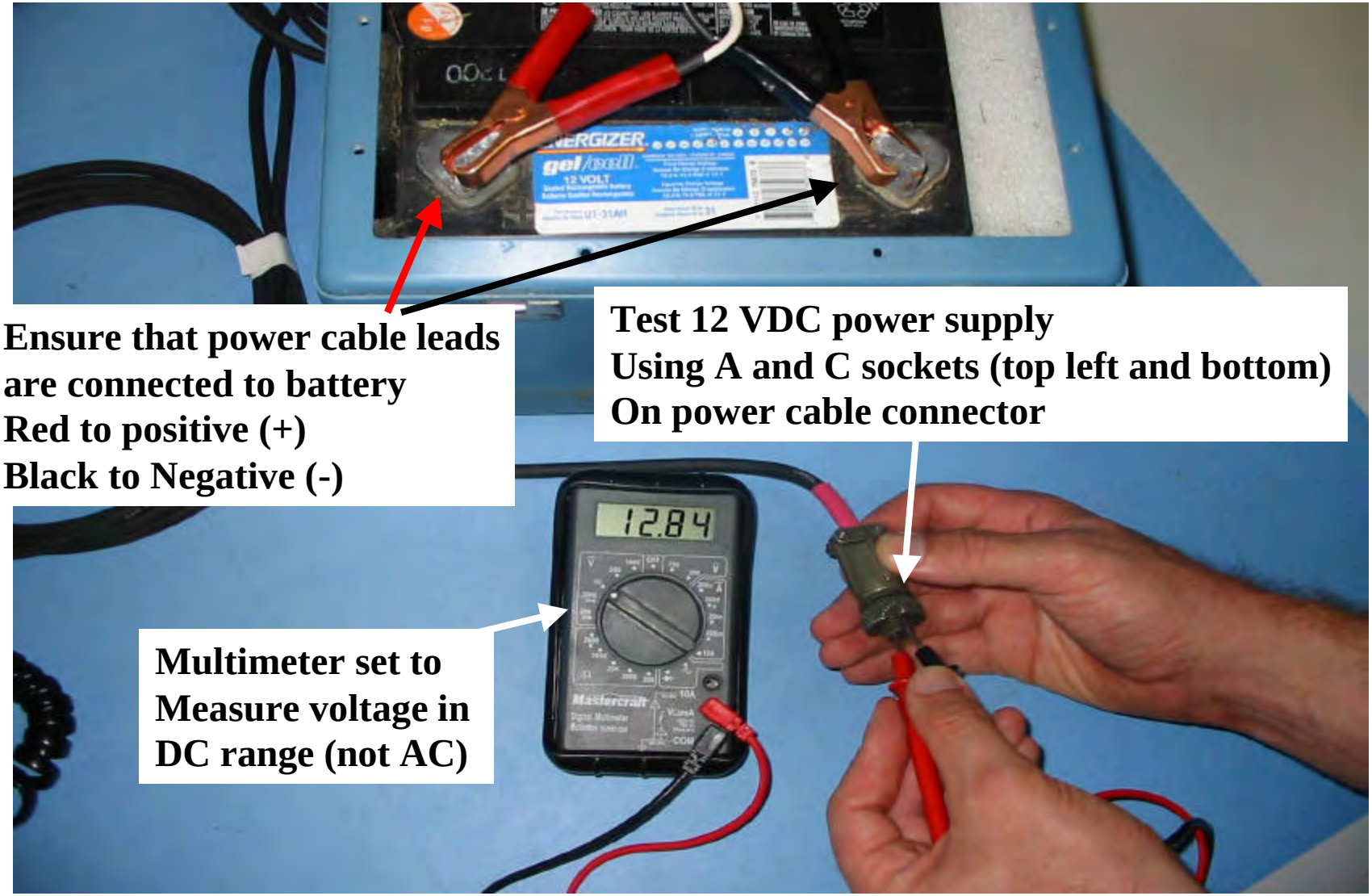
Pic.1 Computer Interface Units, old and new:
MPCI model 2522 (left) and MAGI model 2536 (right)



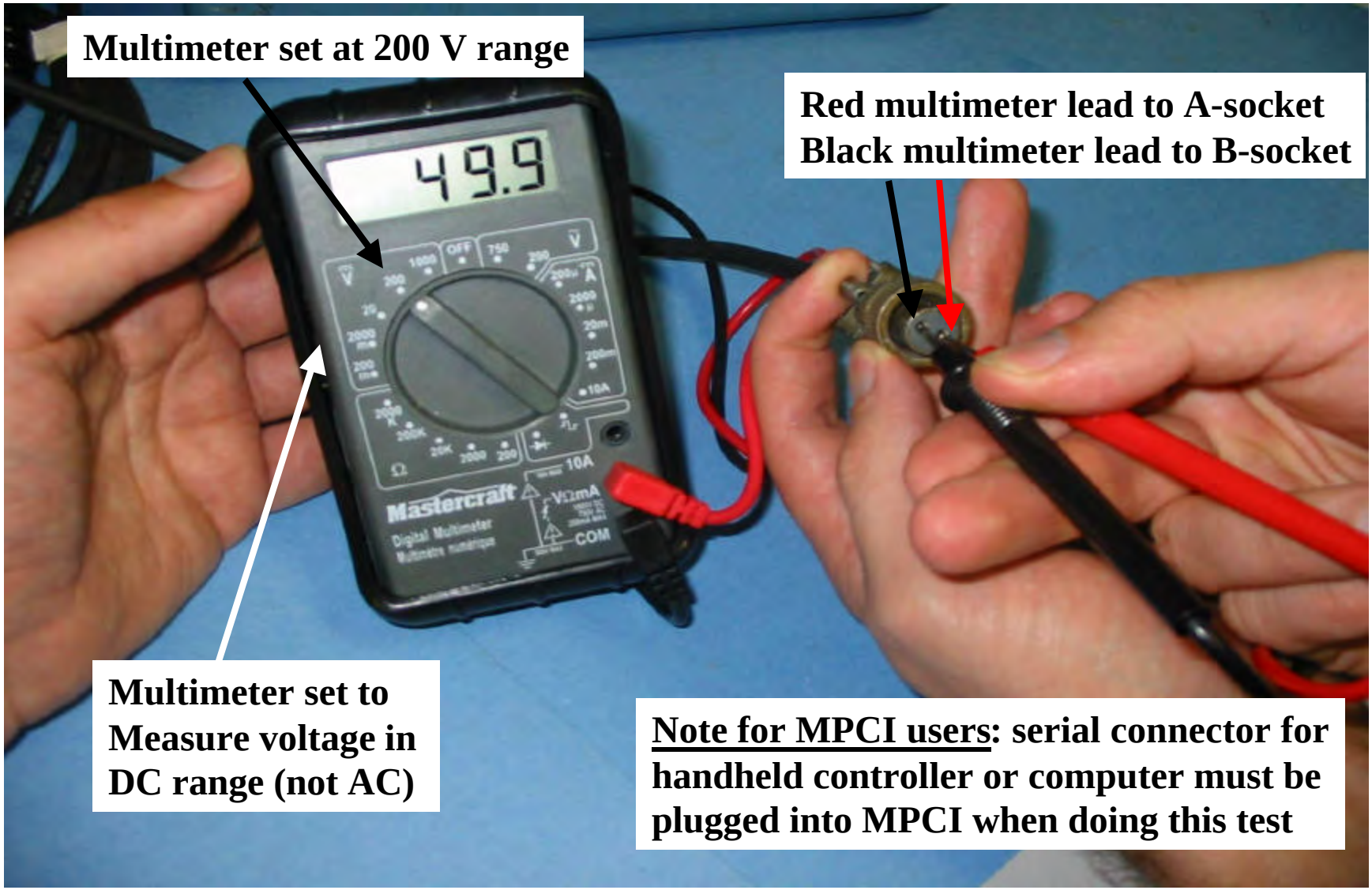
Pic.2 MPCI unit showing typical set-up configuration



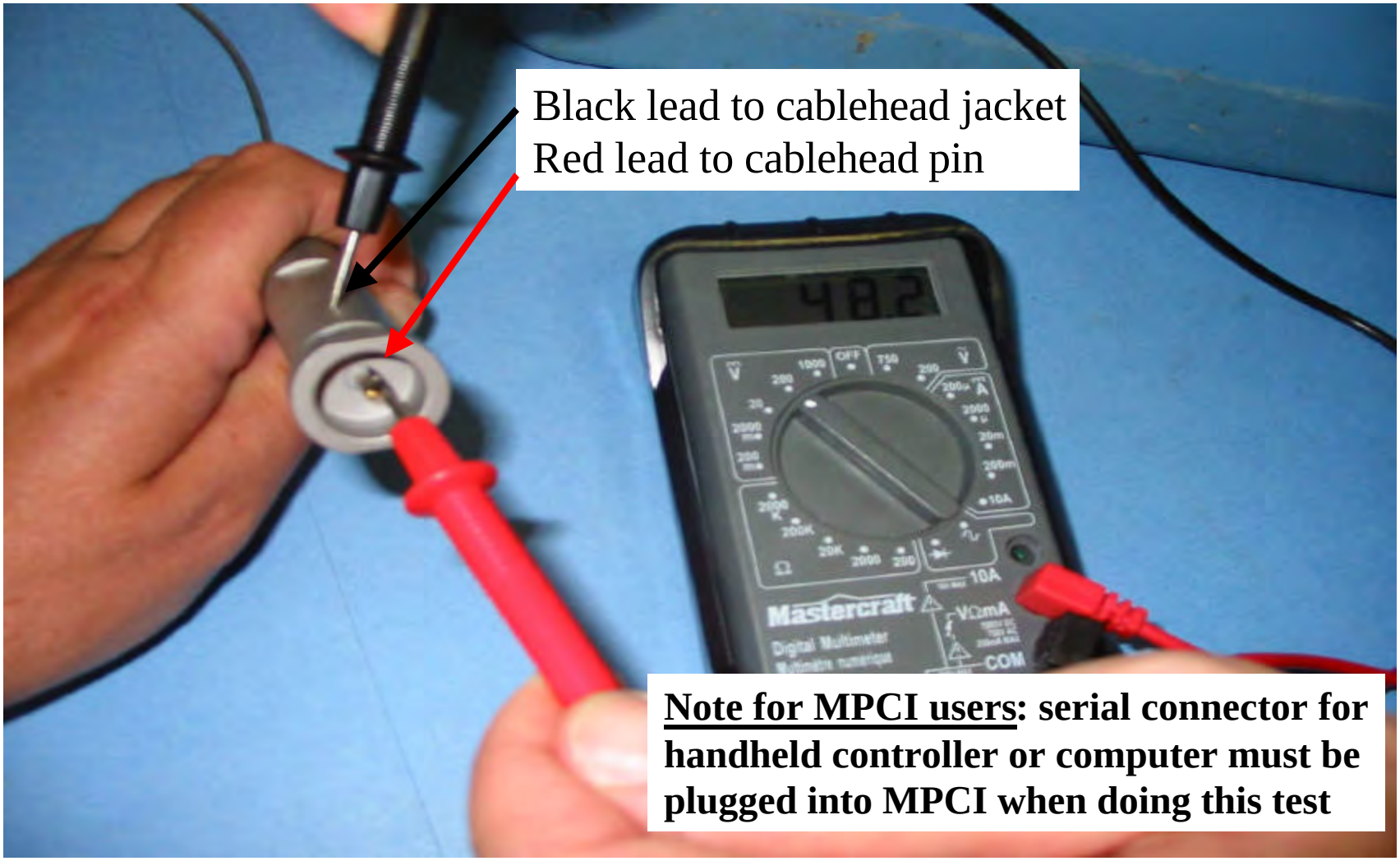
Pic.3 Testing 12 VDC Power Supply using Multimeter



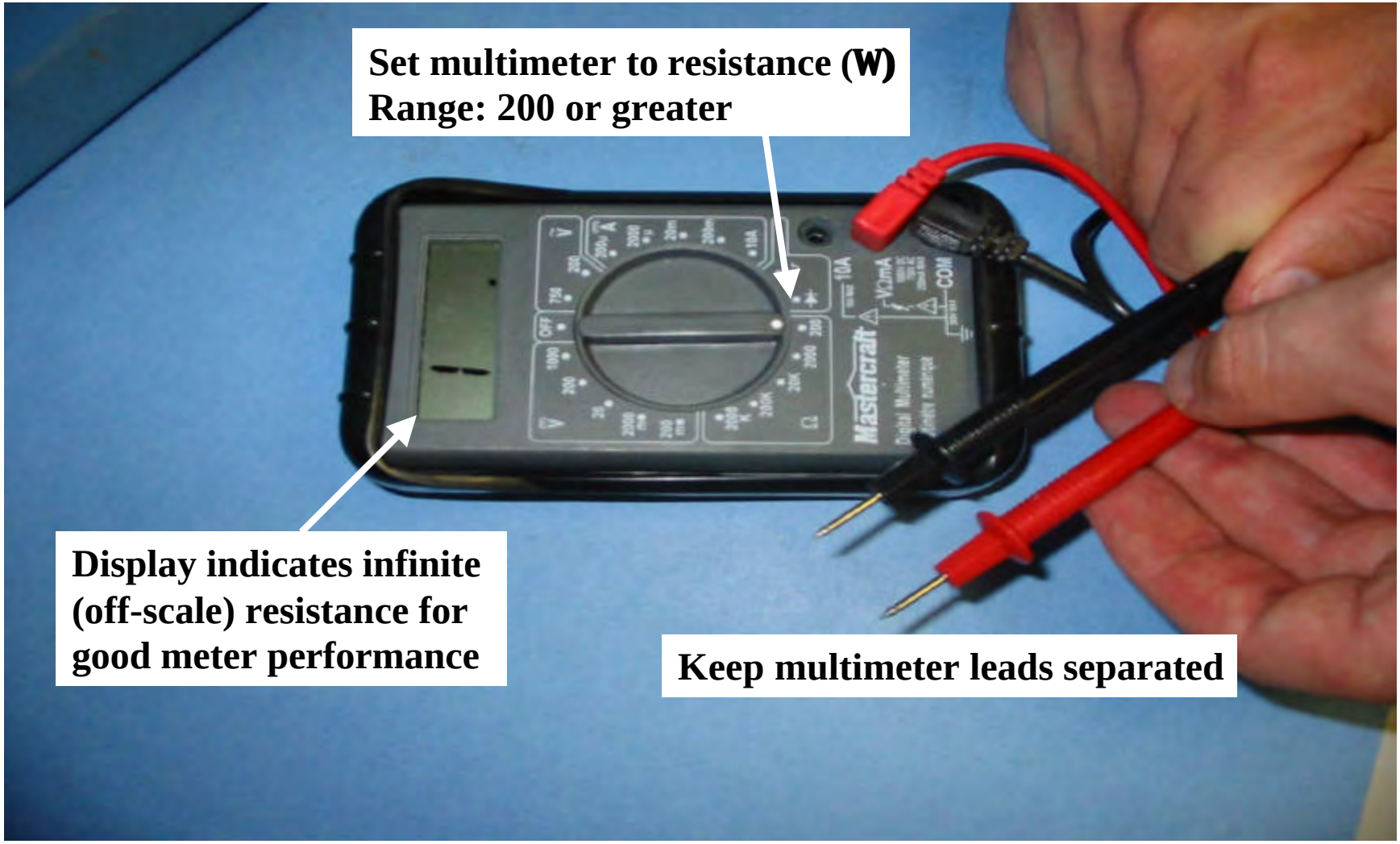
Pic.4 Testing Power Cable Voltage
(should indicate greater than 12.00 V DC for good battery and cable)



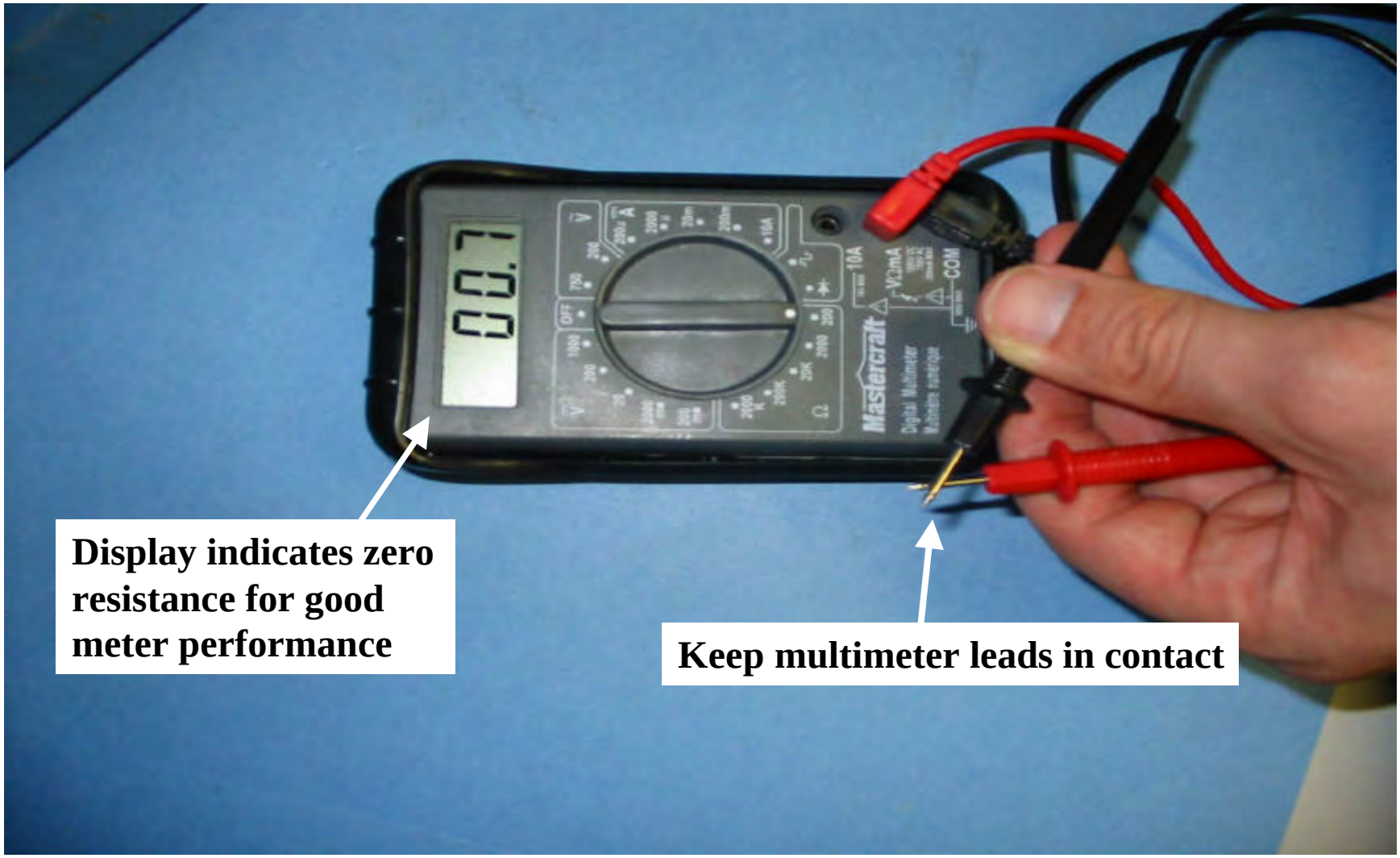
Pic.5 **Testing Power output from MPCI or MAGI using data cable (should be greater than 48 V)** ***Note: MPCI/MAGI must have power 'on' and be connected to power supply.***



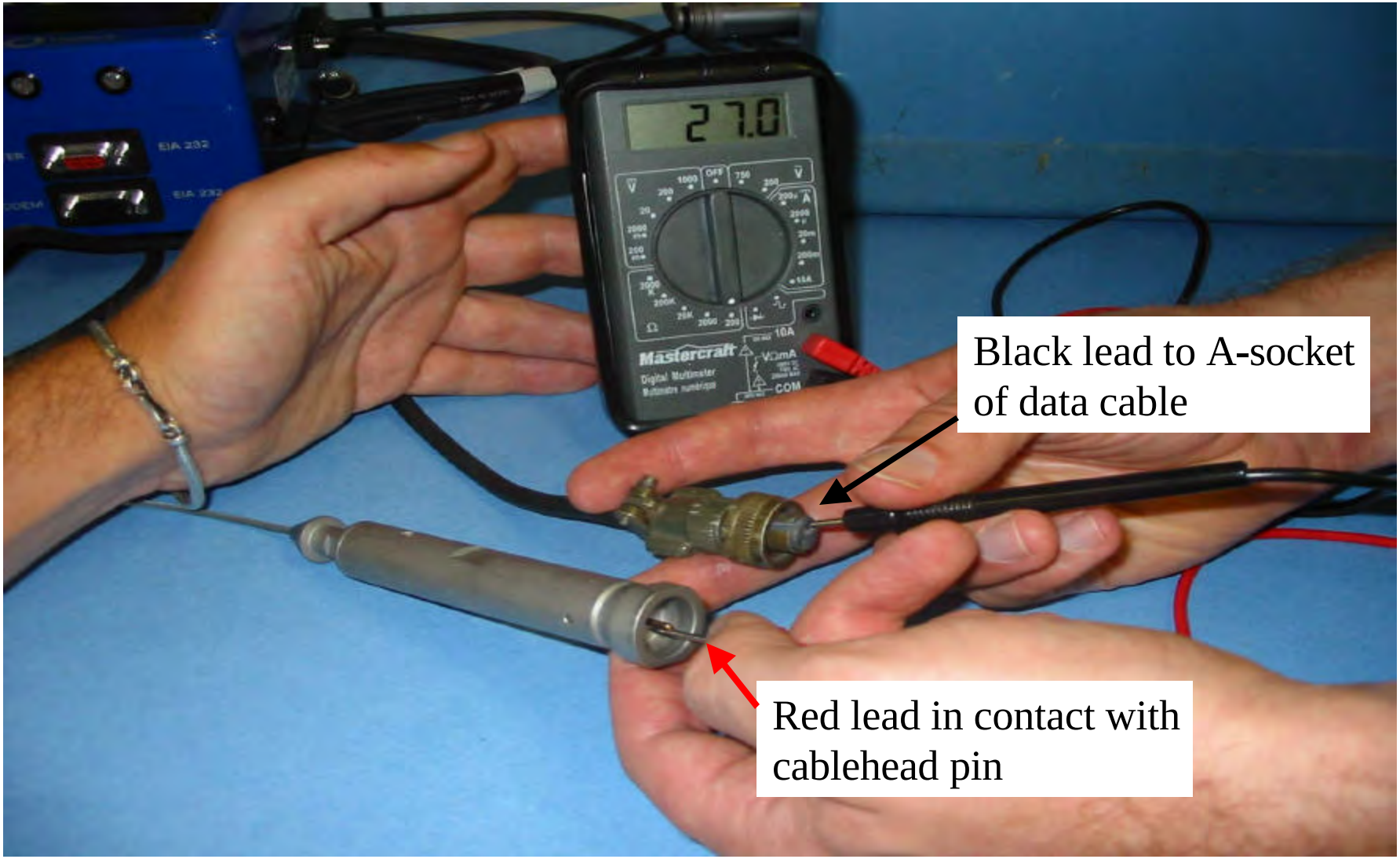
Pic.6 Checking power output at cablehead (should be greater than 48 V)
Note: MPCI/MAGI must have power 'on' and be connected to power supply.



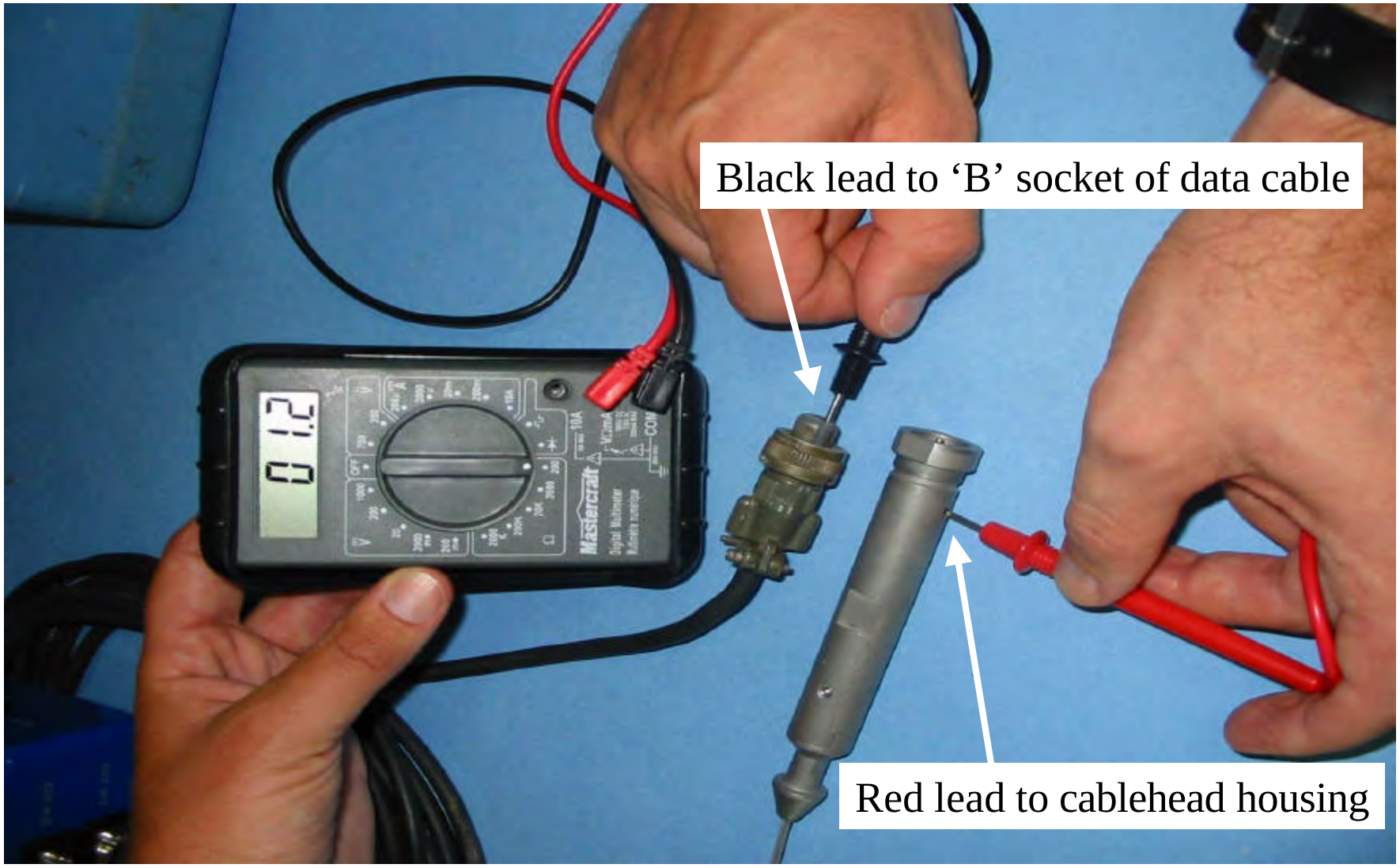
Pic.7 Test multimeter “open” resistence



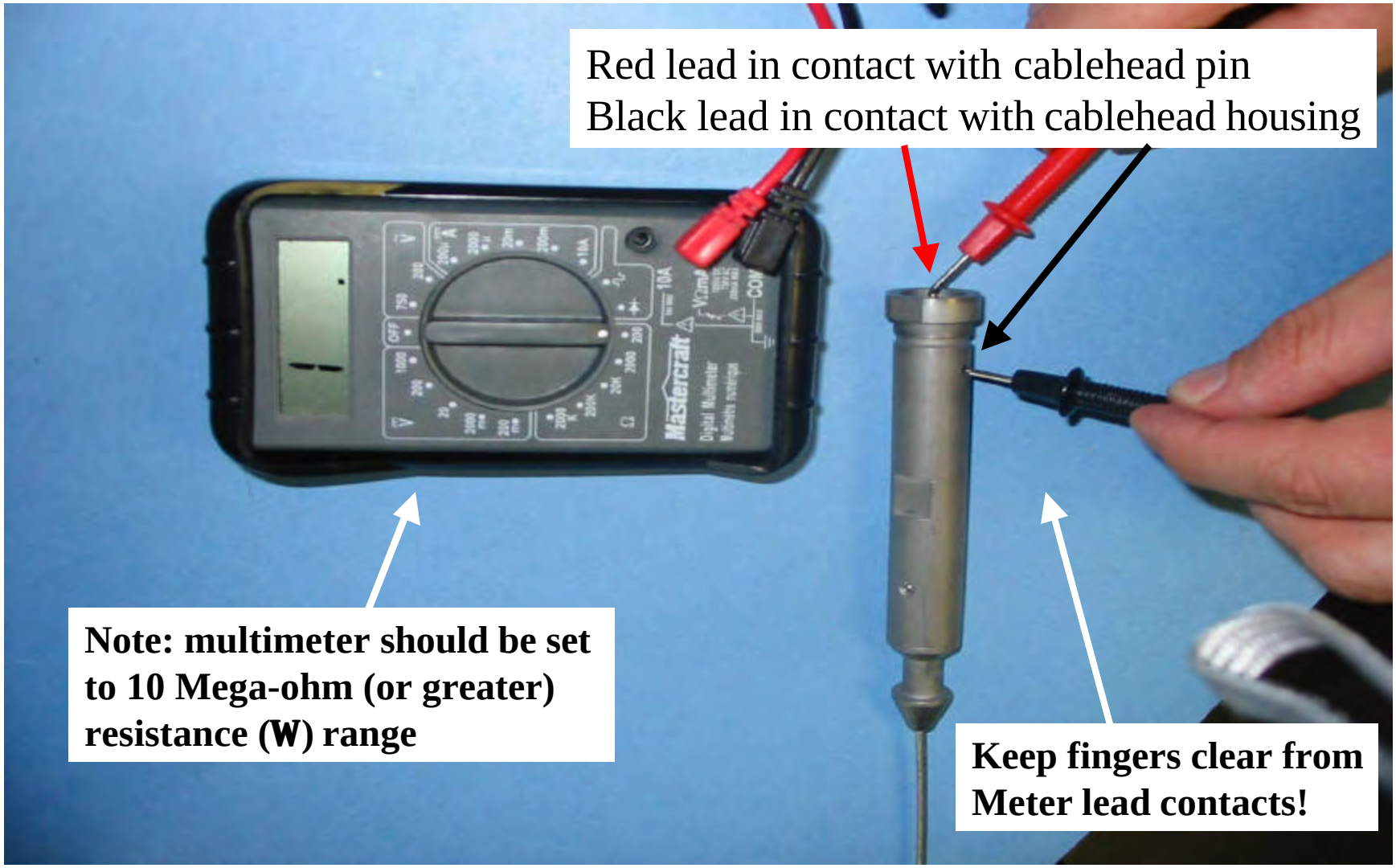
Pic.8 Test multimeter “closed” resistence



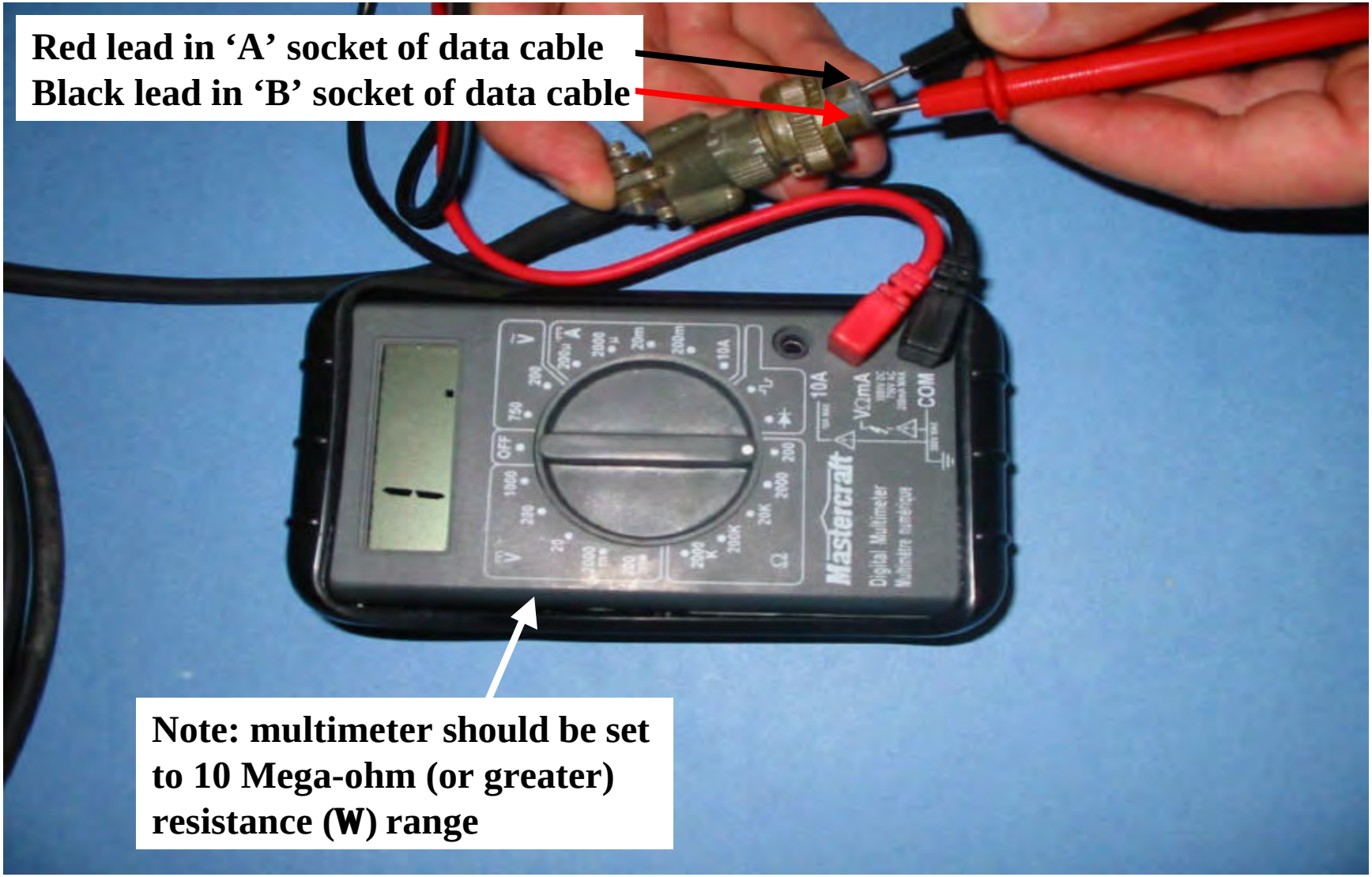
Pic.9 Test wireline ‘A-A’ resistance (approx. 27 W/1000 ft)



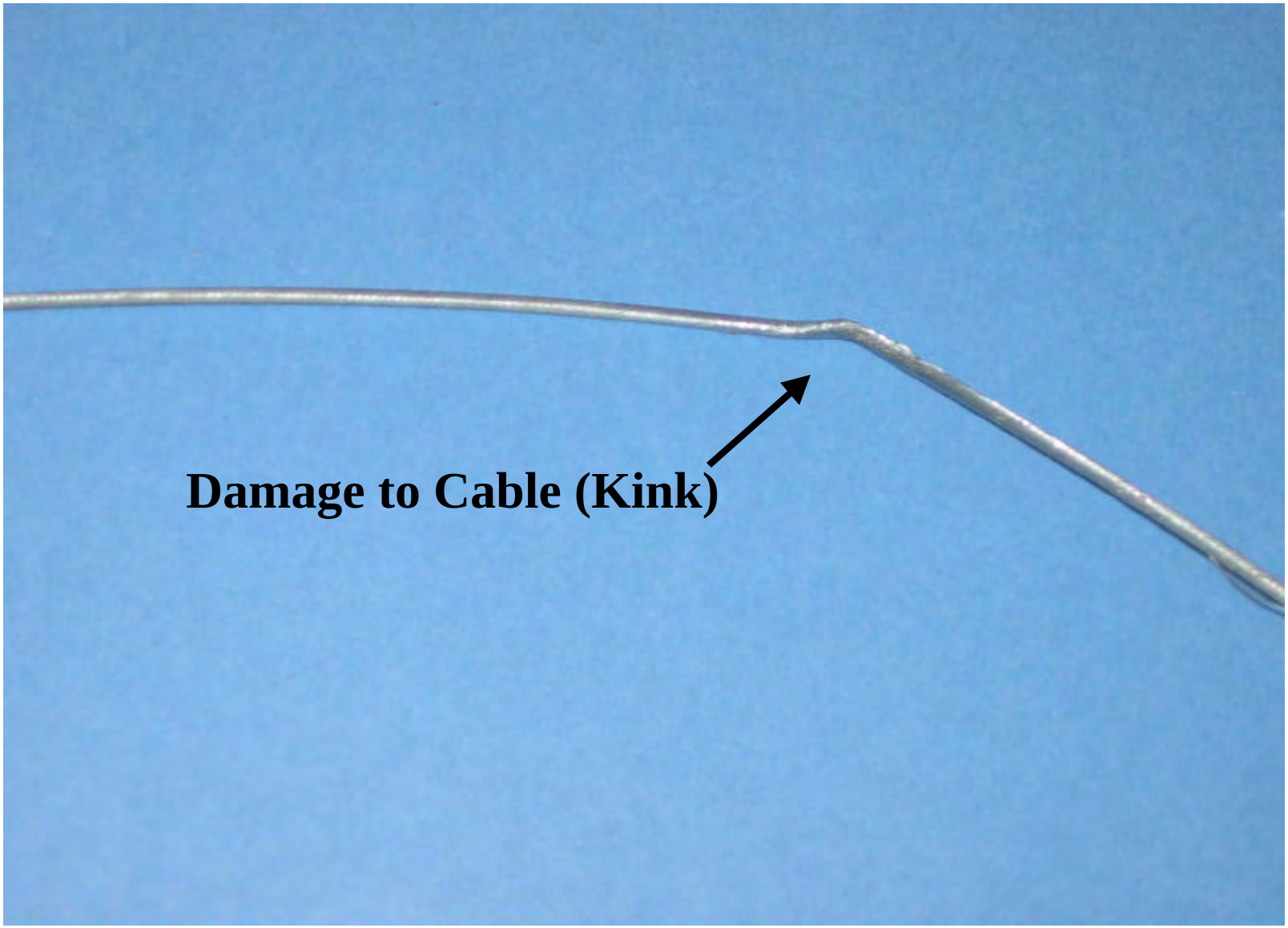
Pic.10 Test wireline ‘B-B’ resistance (should be less than ‘A-A’)



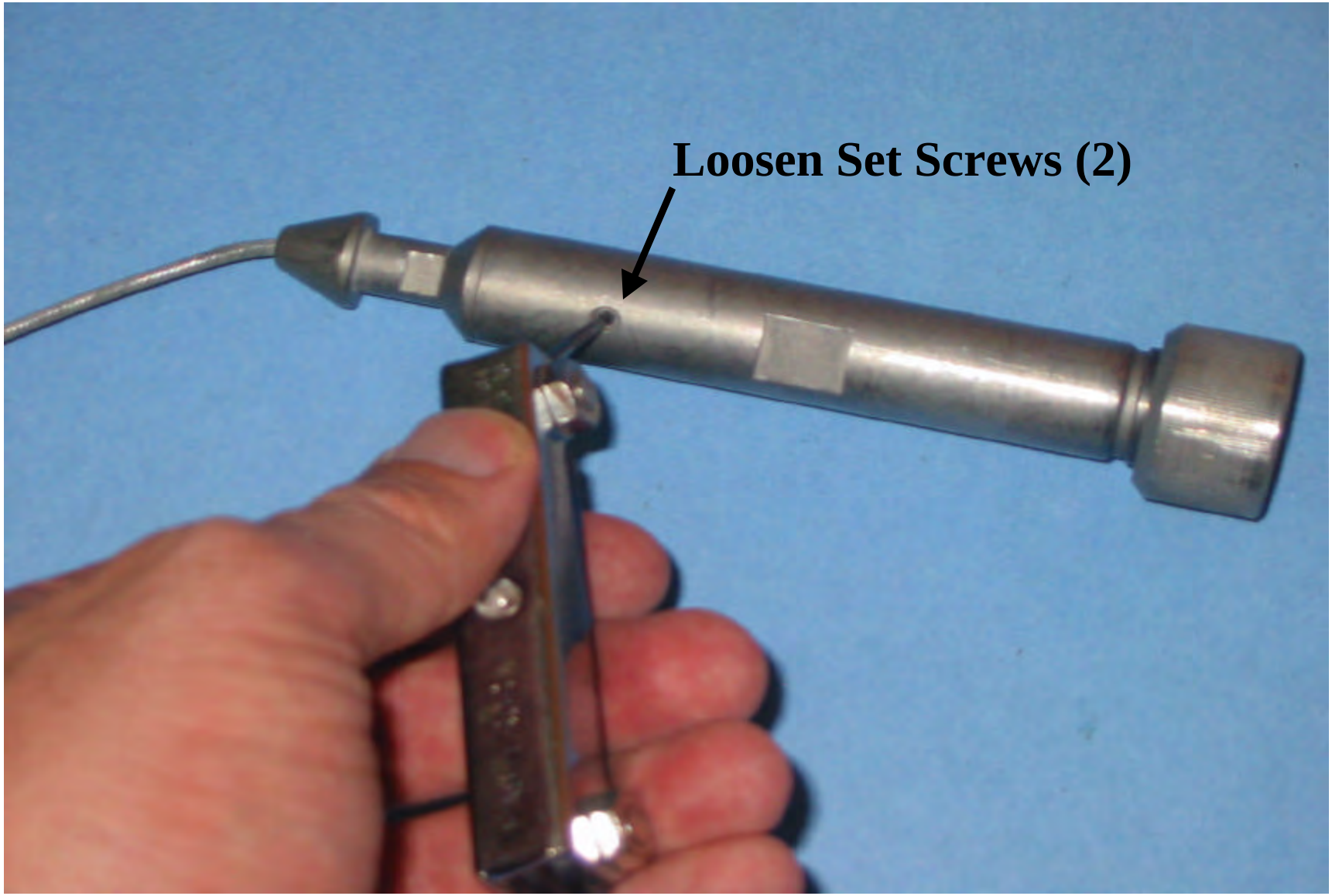
Pic.11 Test wireline 'A-B' resistance at cablehead (should be off-scale)



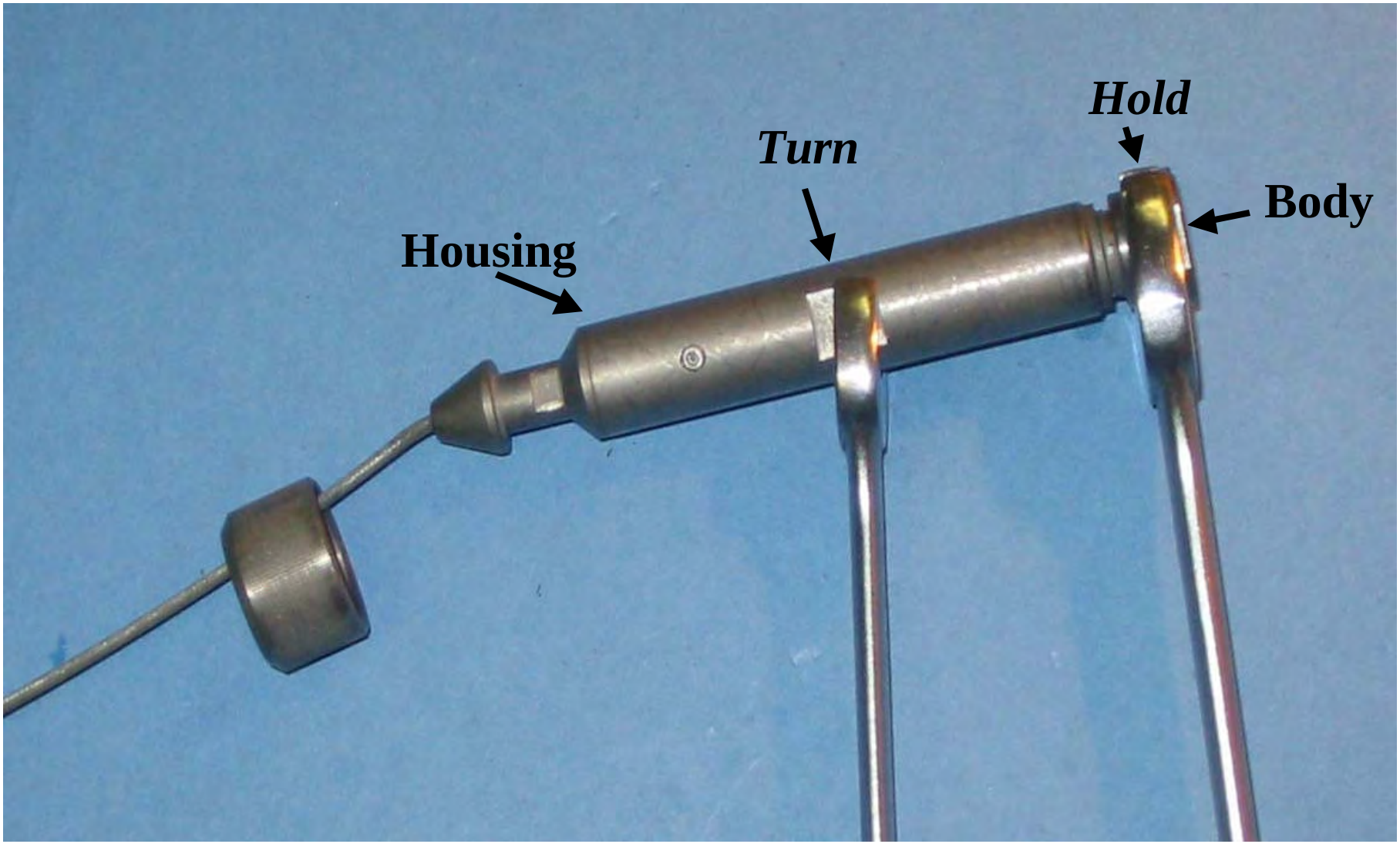
Pic.11 Test wireline ‘A-B’ resistance at data cable (should be off-scale)



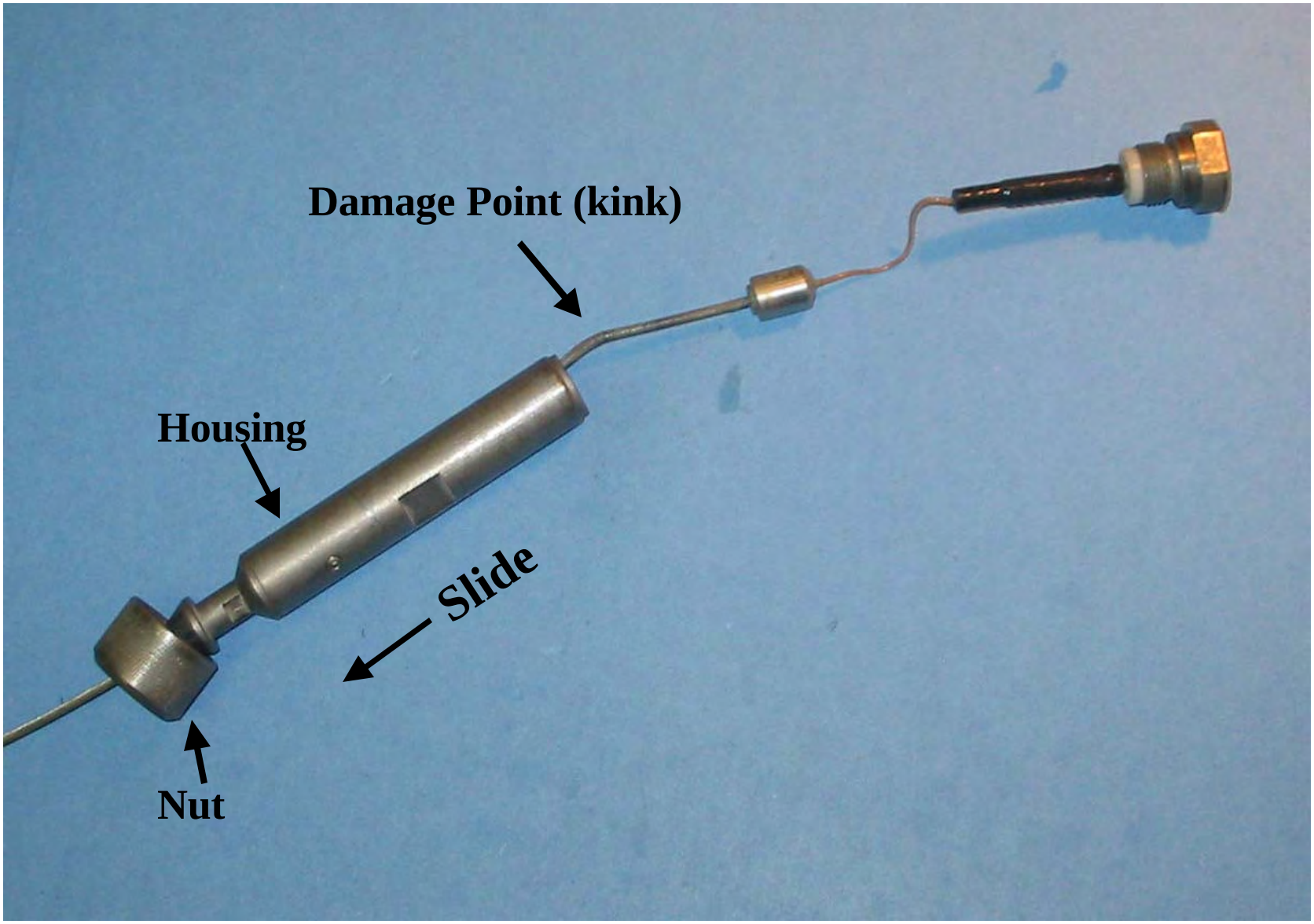
Pic.1 Identification of Cable Damage



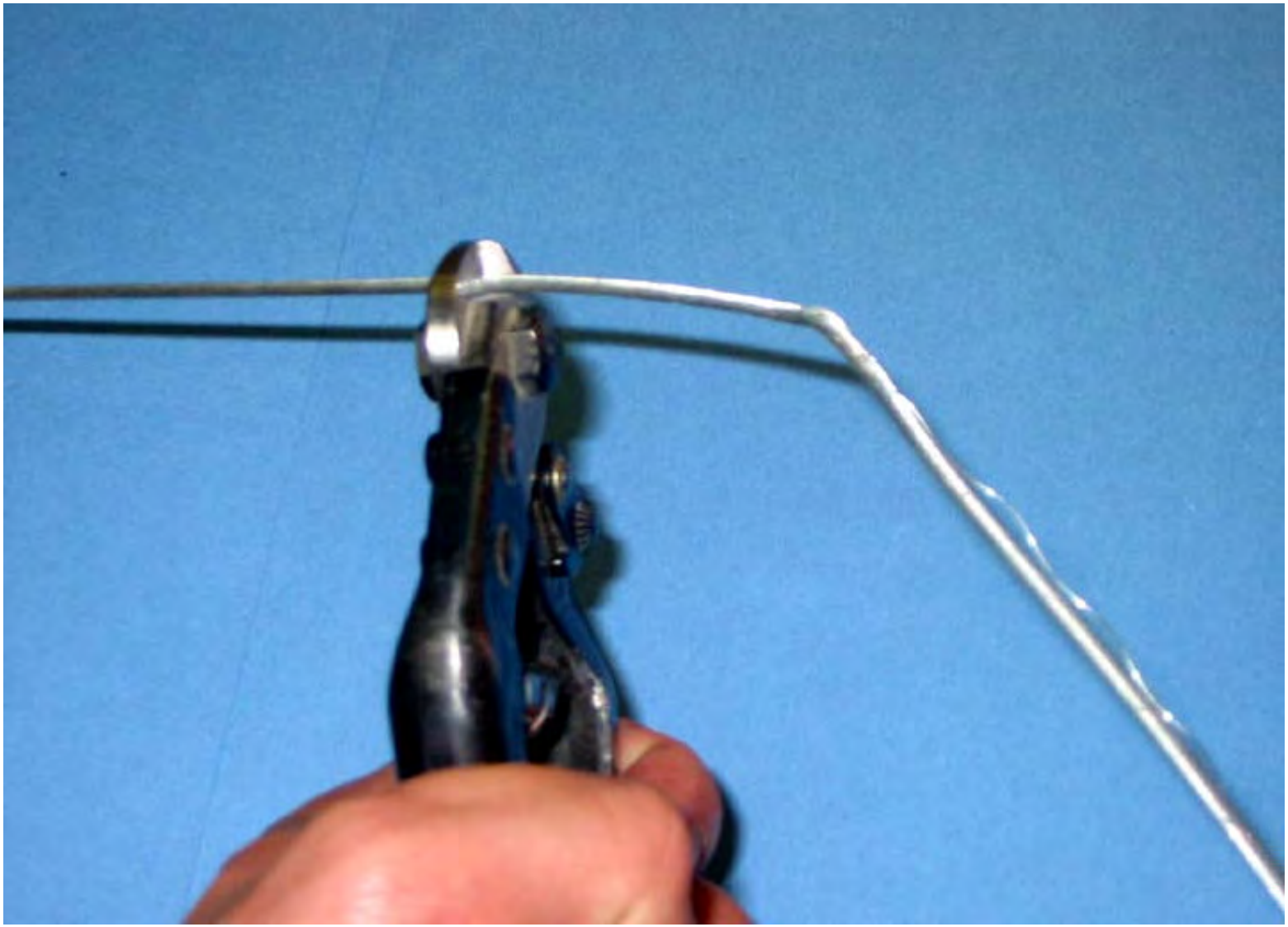
Pic.2 Cablehead Disassembly (1): Loosen set Screws



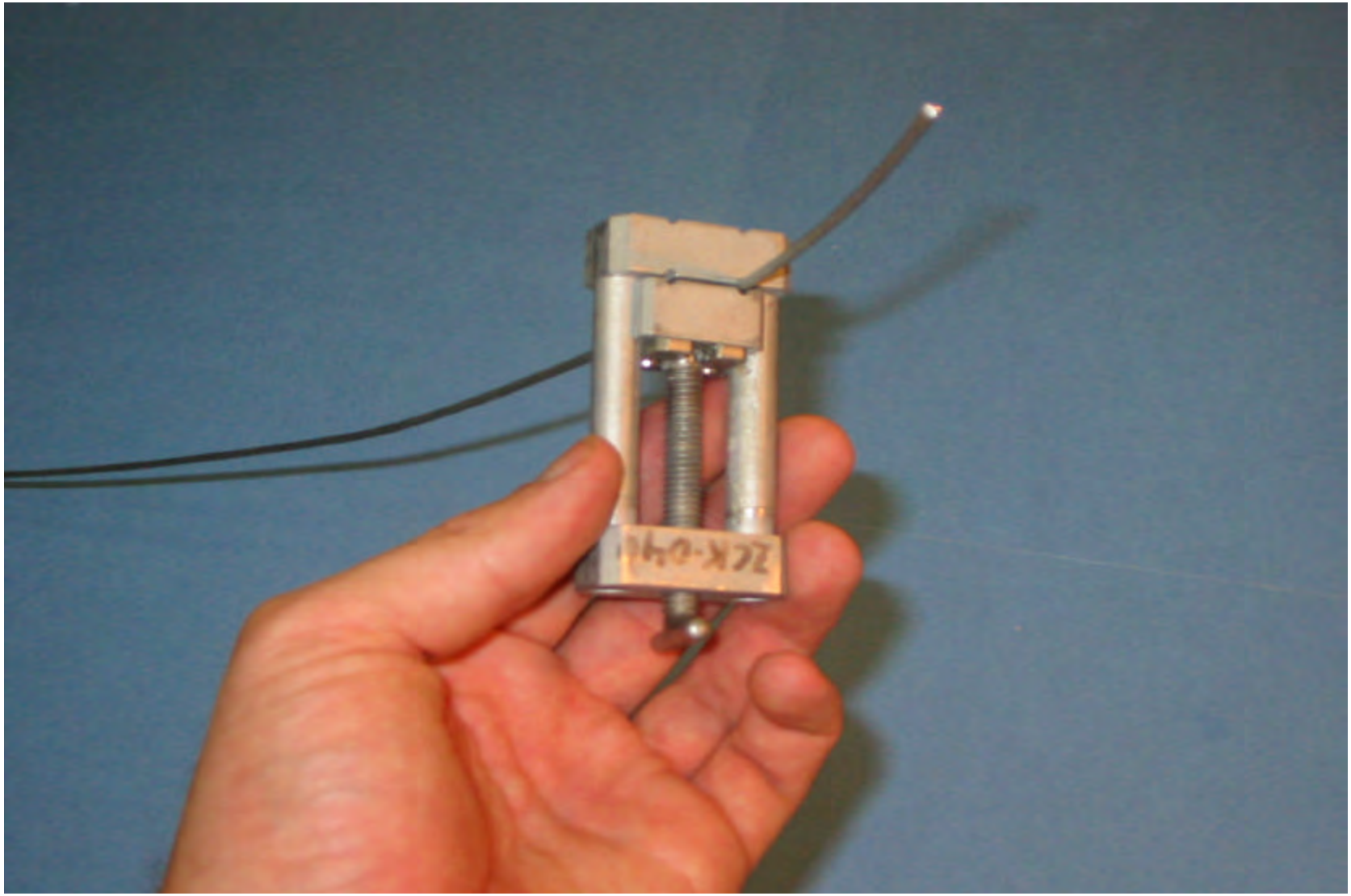
Pic.3 Cablehead Disassembly(2): Unscrew Housing From Body



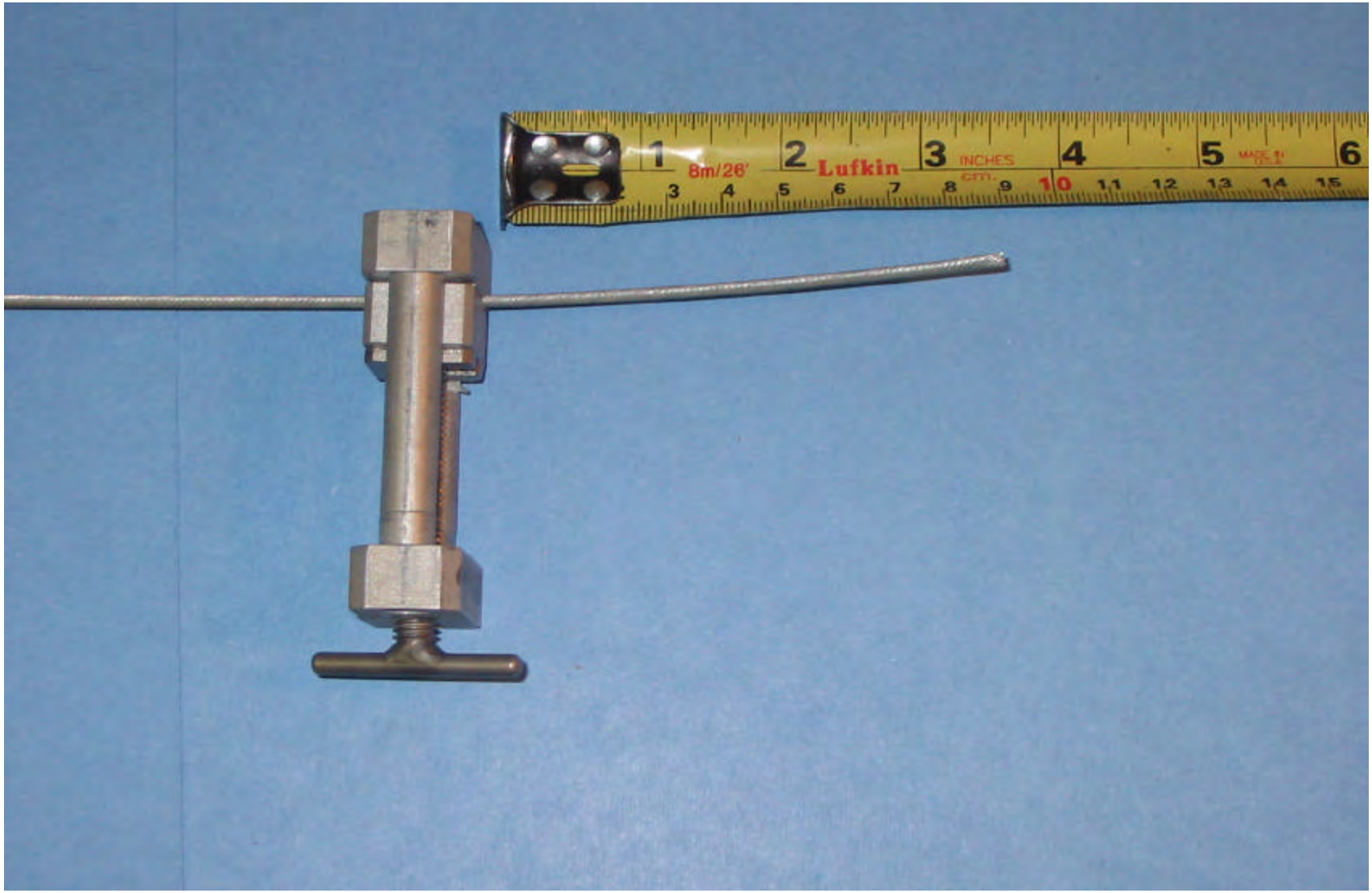
Pic.4 Cablehead Disassembly(3):
Slide Housing and Cablehead Nut Past Damage Point



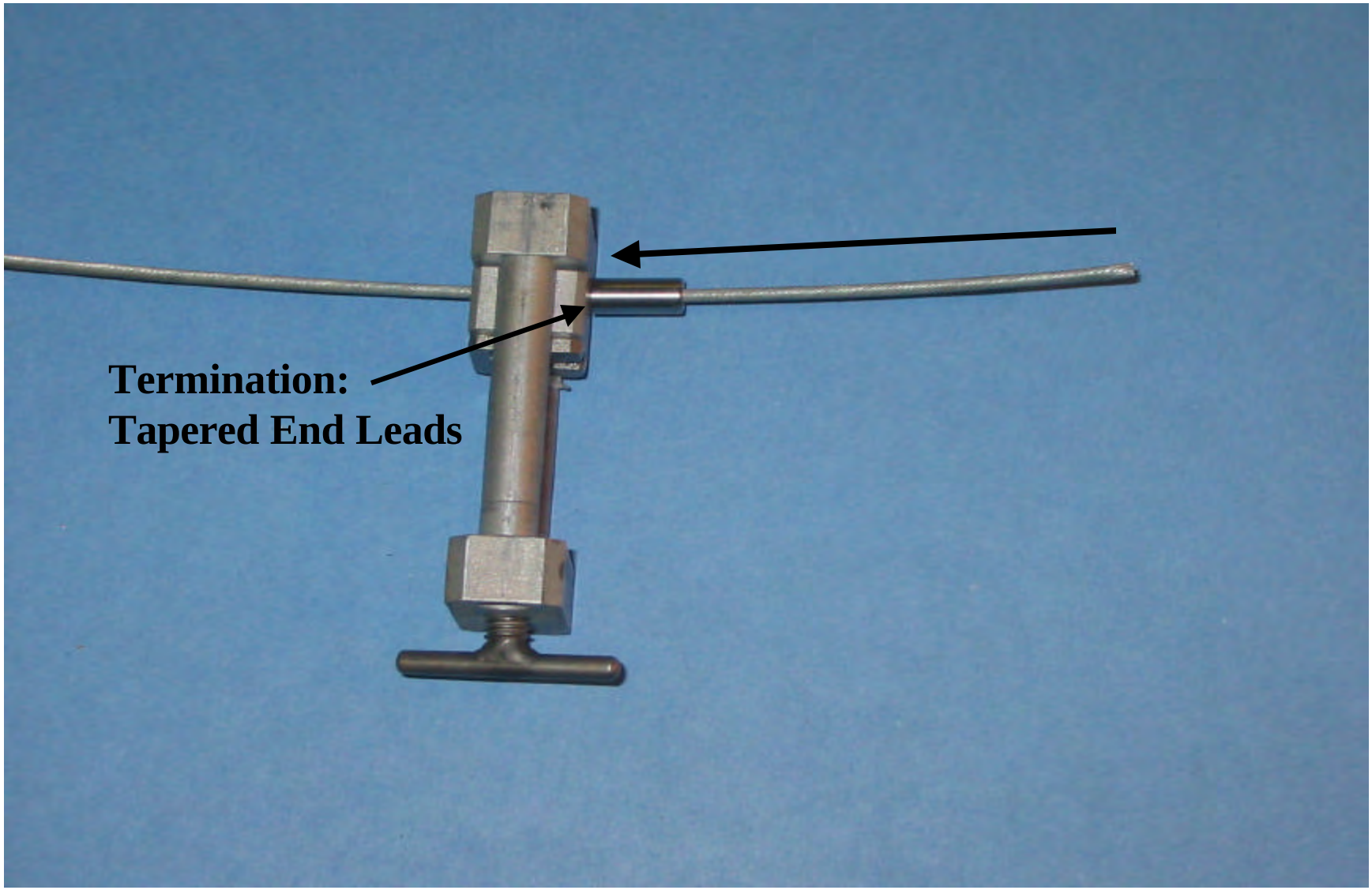
Pic.5 Cut Cable above Damage Point



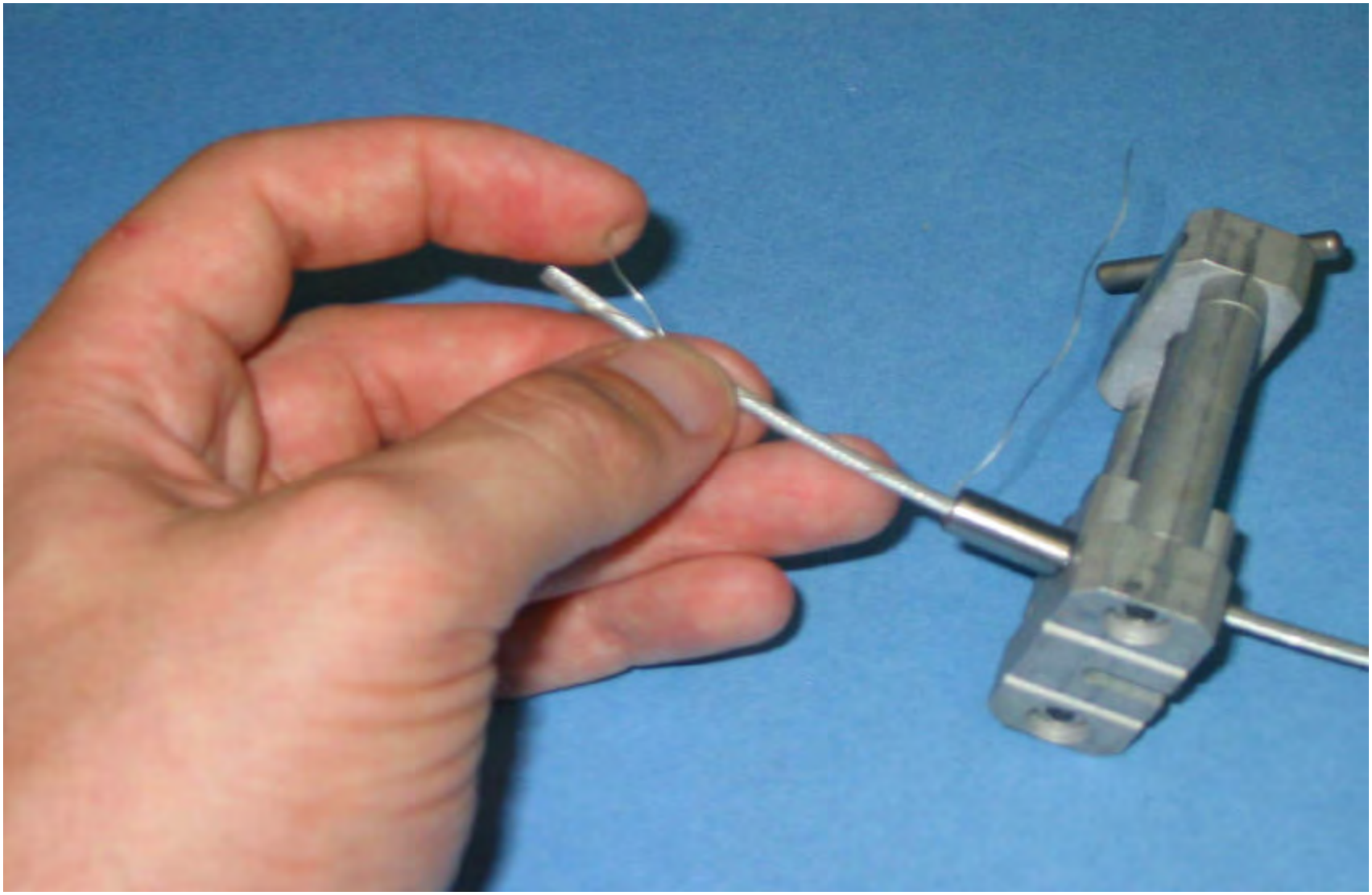
Pic.6a Clamp Cable in Termination Jig



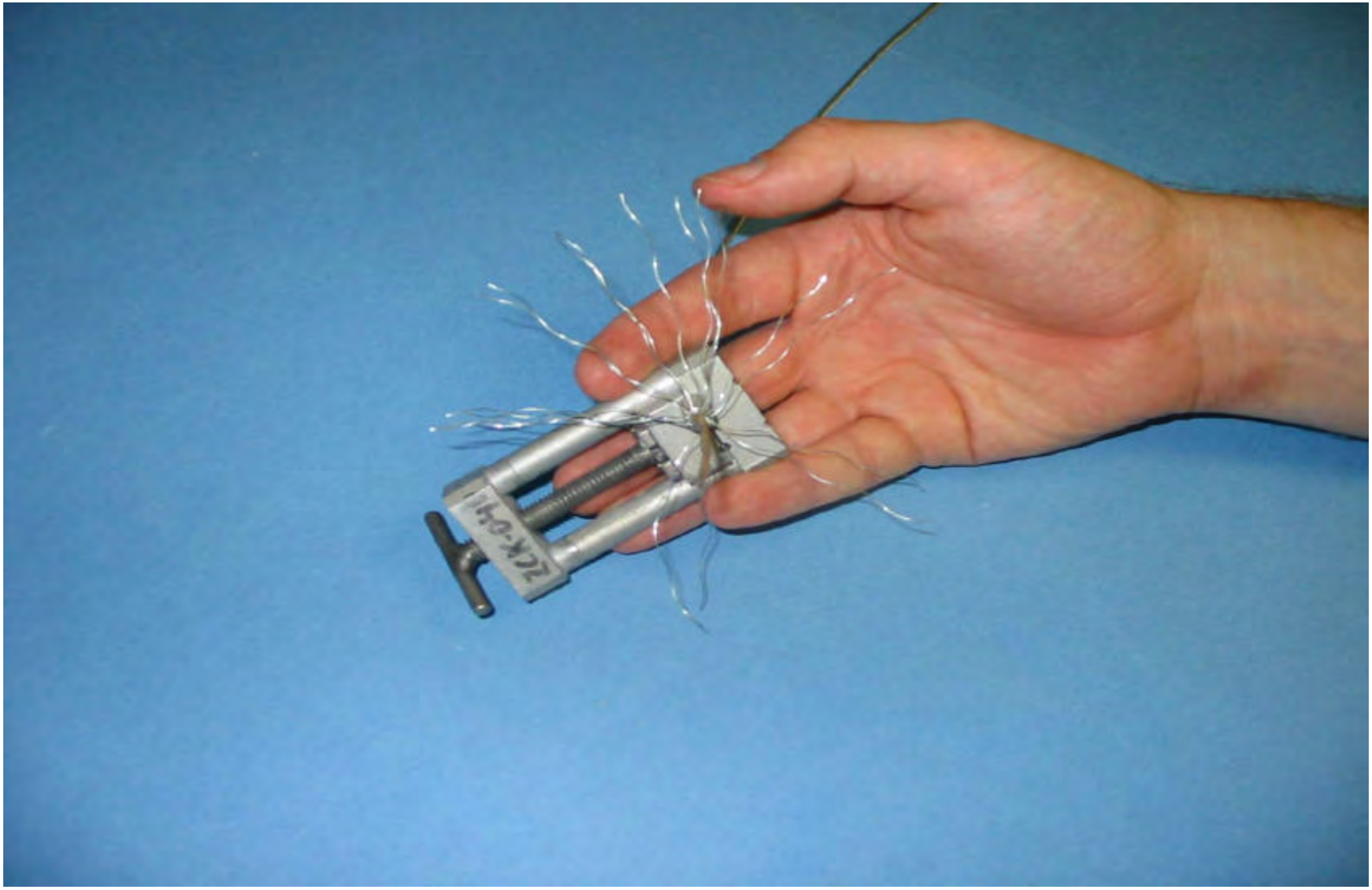
Pic.6b Leave 3.5 inches Cable Exposed



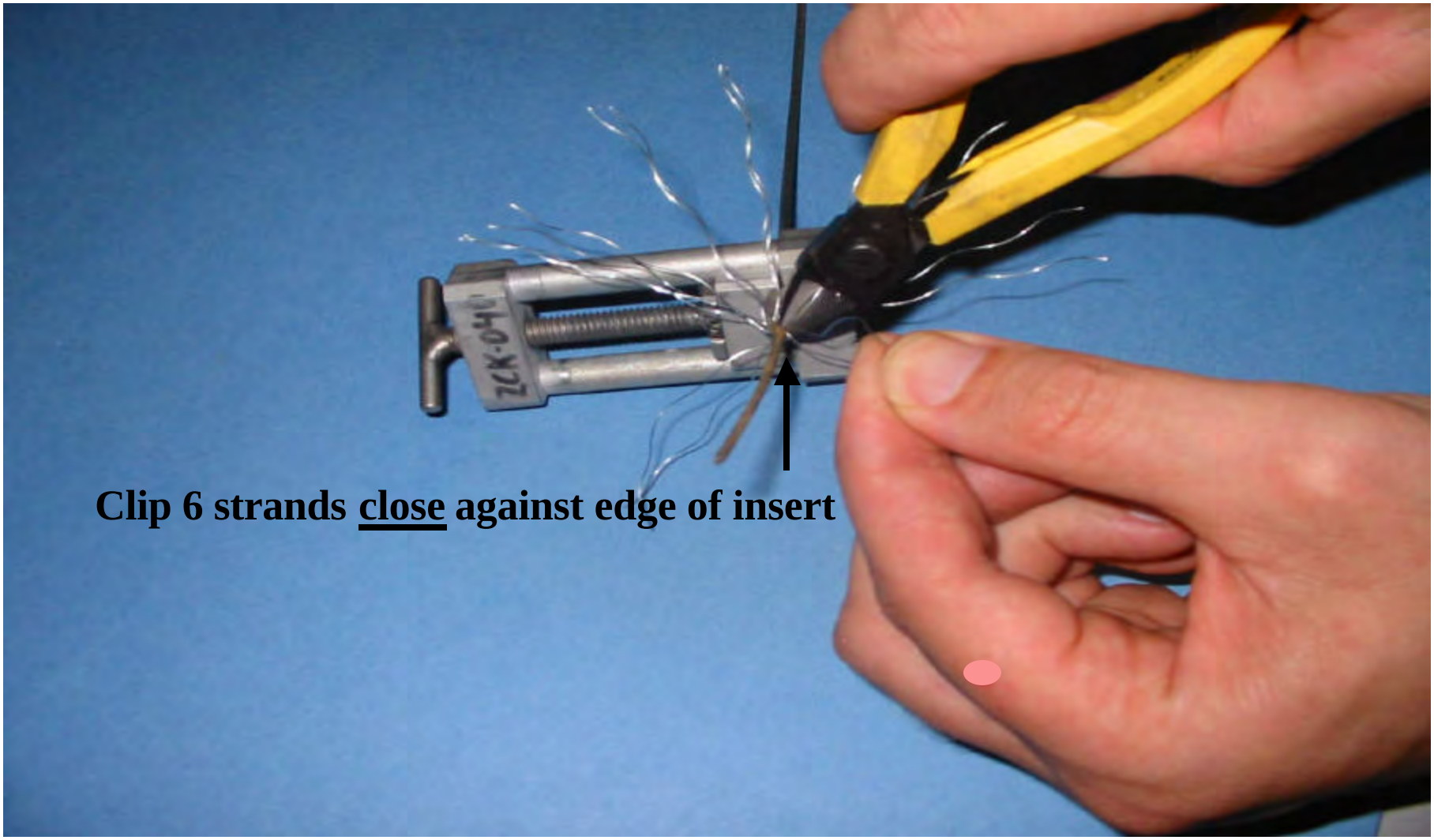
Pic.6c Slide Termination Insert Over Cable



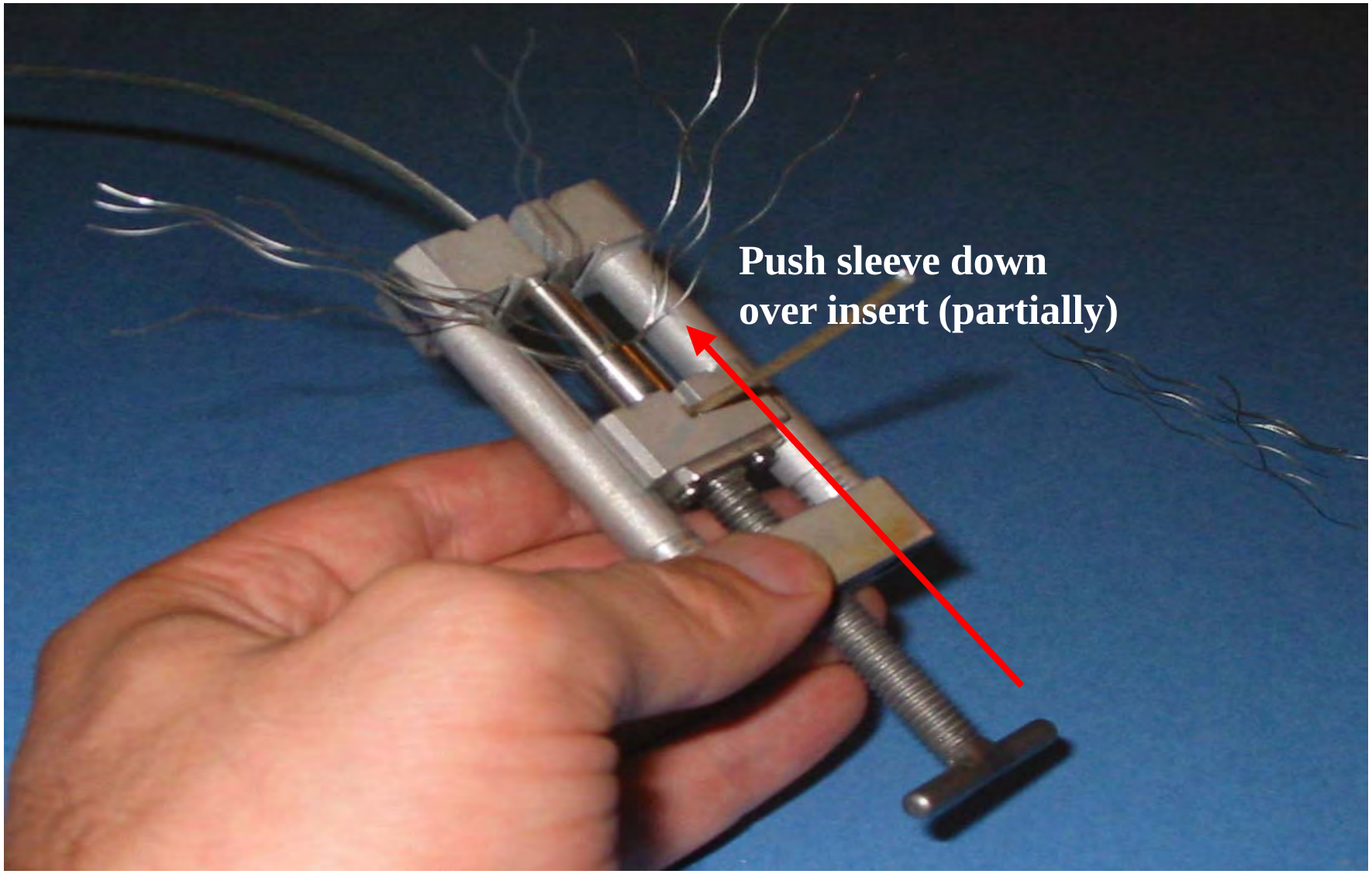
Pic.7a Unwind Outer-layer Strands (start)



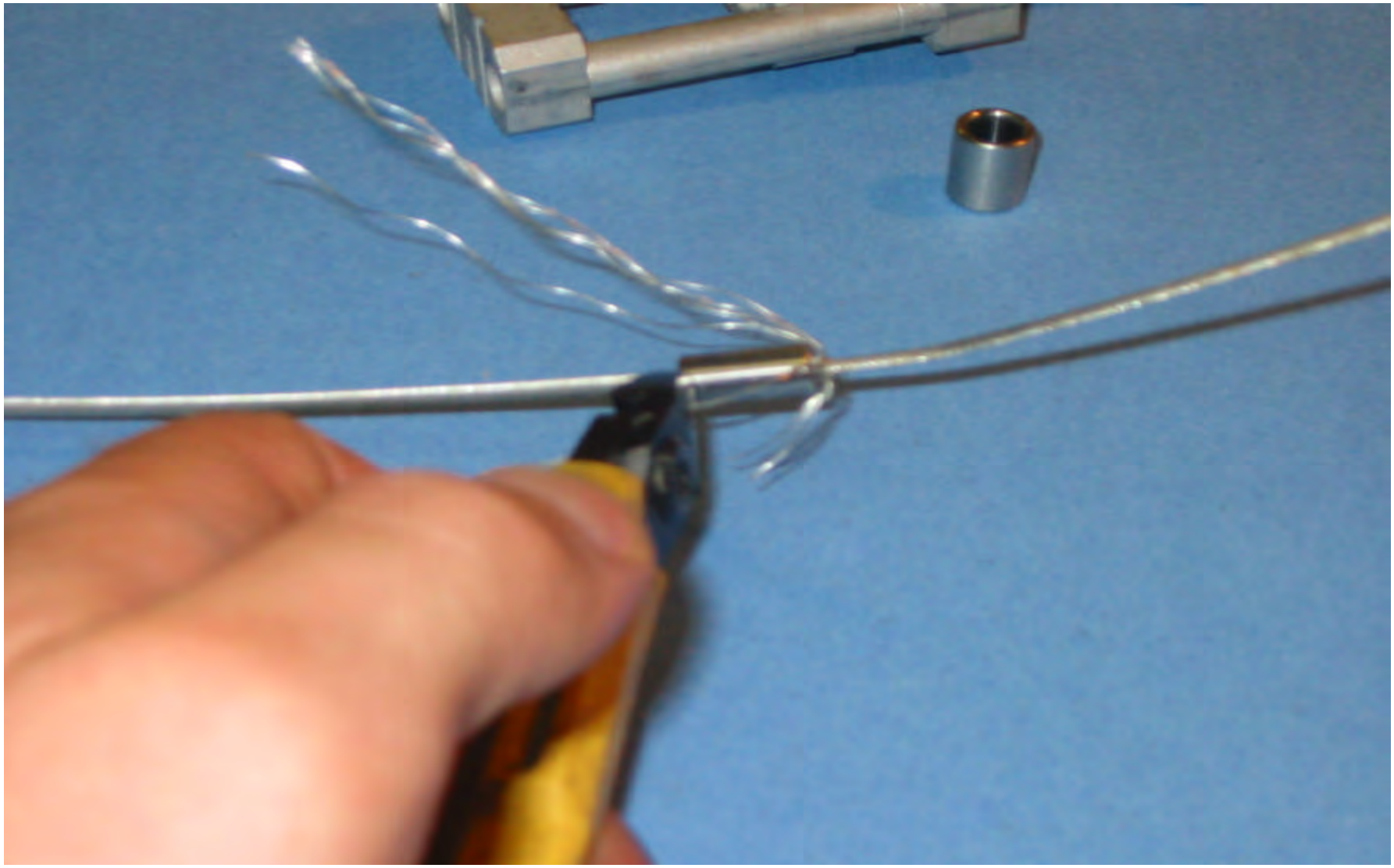
Pic.7b Unwind Outer Layer Strands (finish)



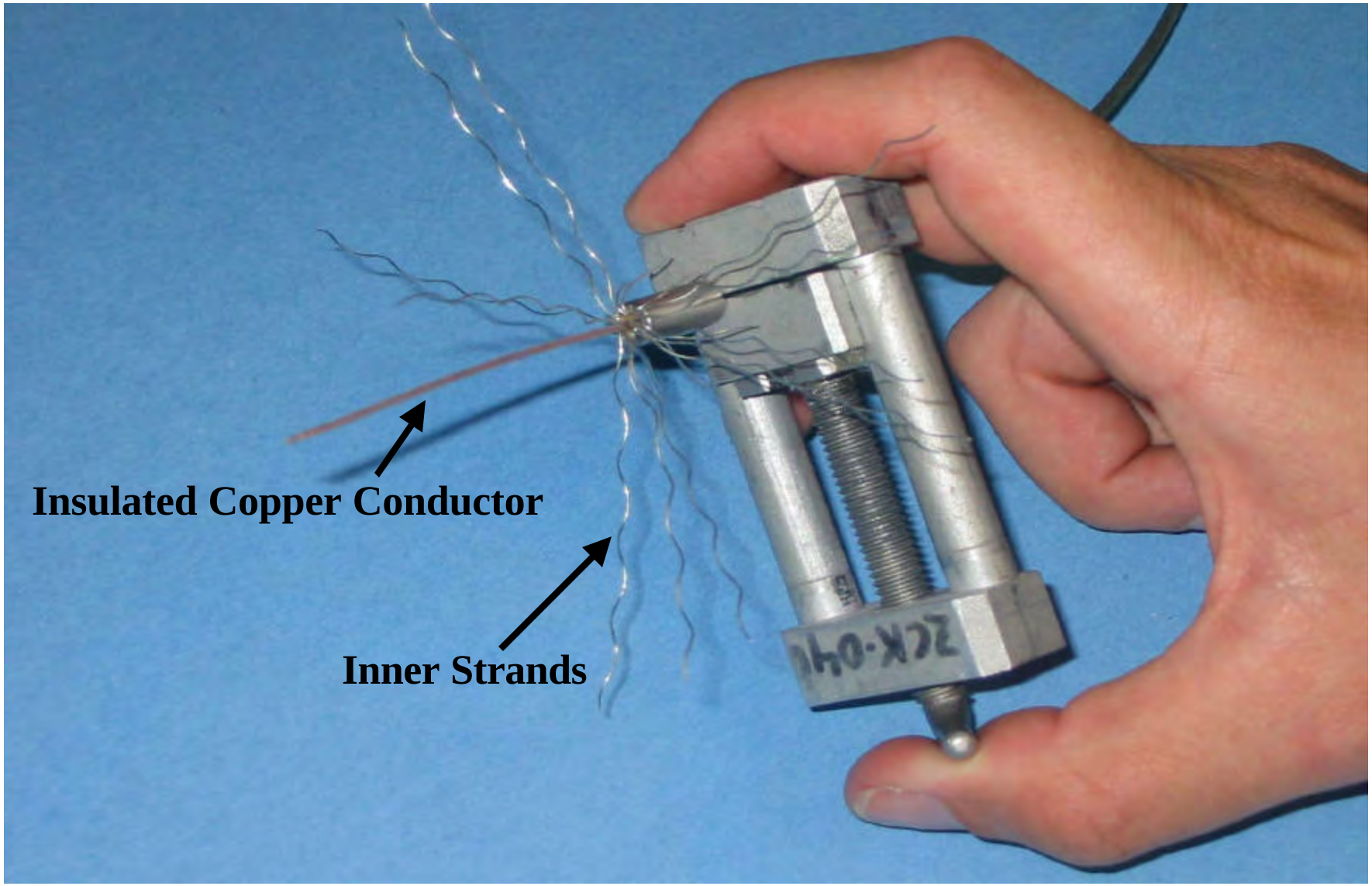
Pic.8 Clipping Outer Wire Strands (6 strands out of 18)



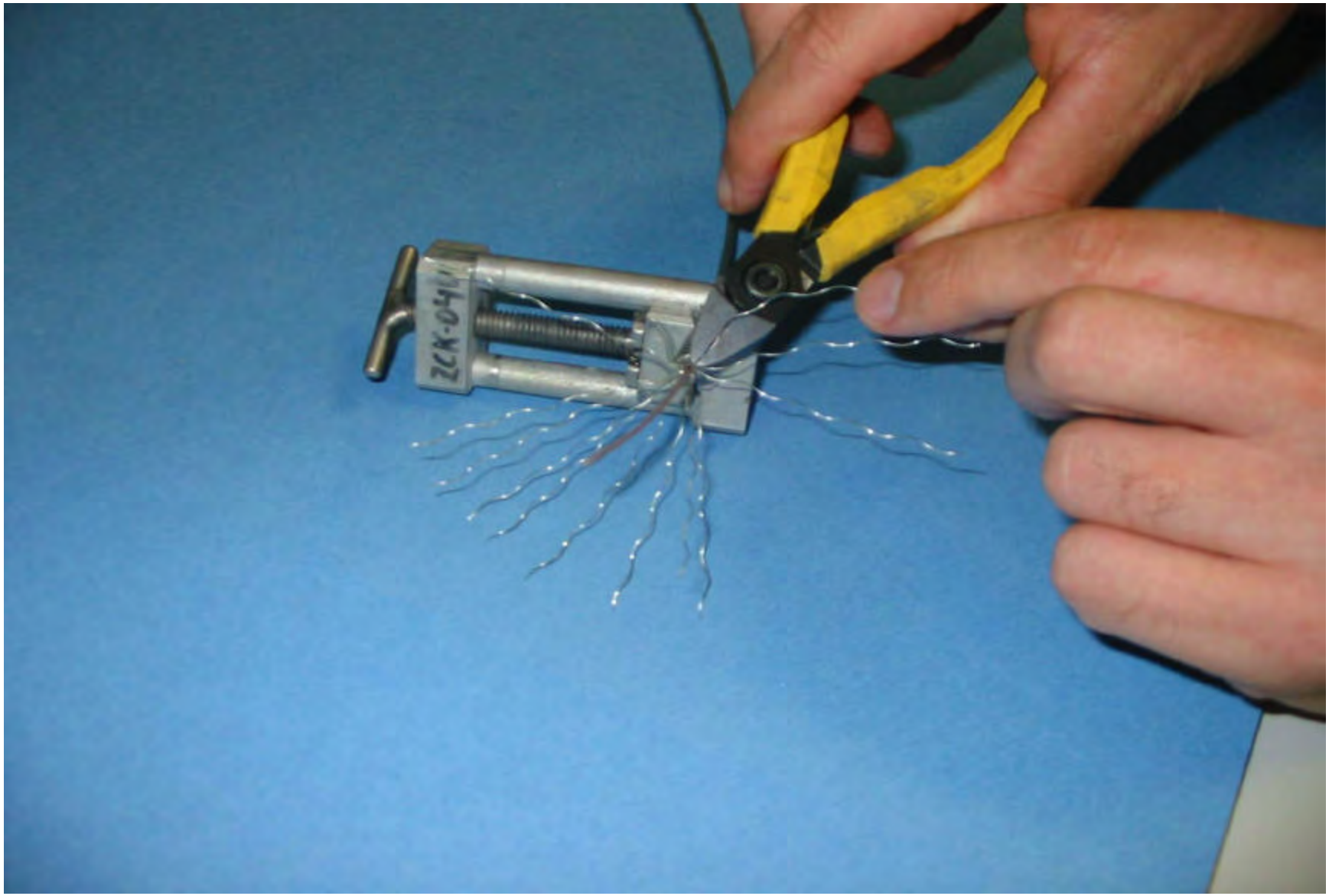
Pic.9 Partially Push Sleeve Down on Insert Using Jig (enough to bend strands down along insert)



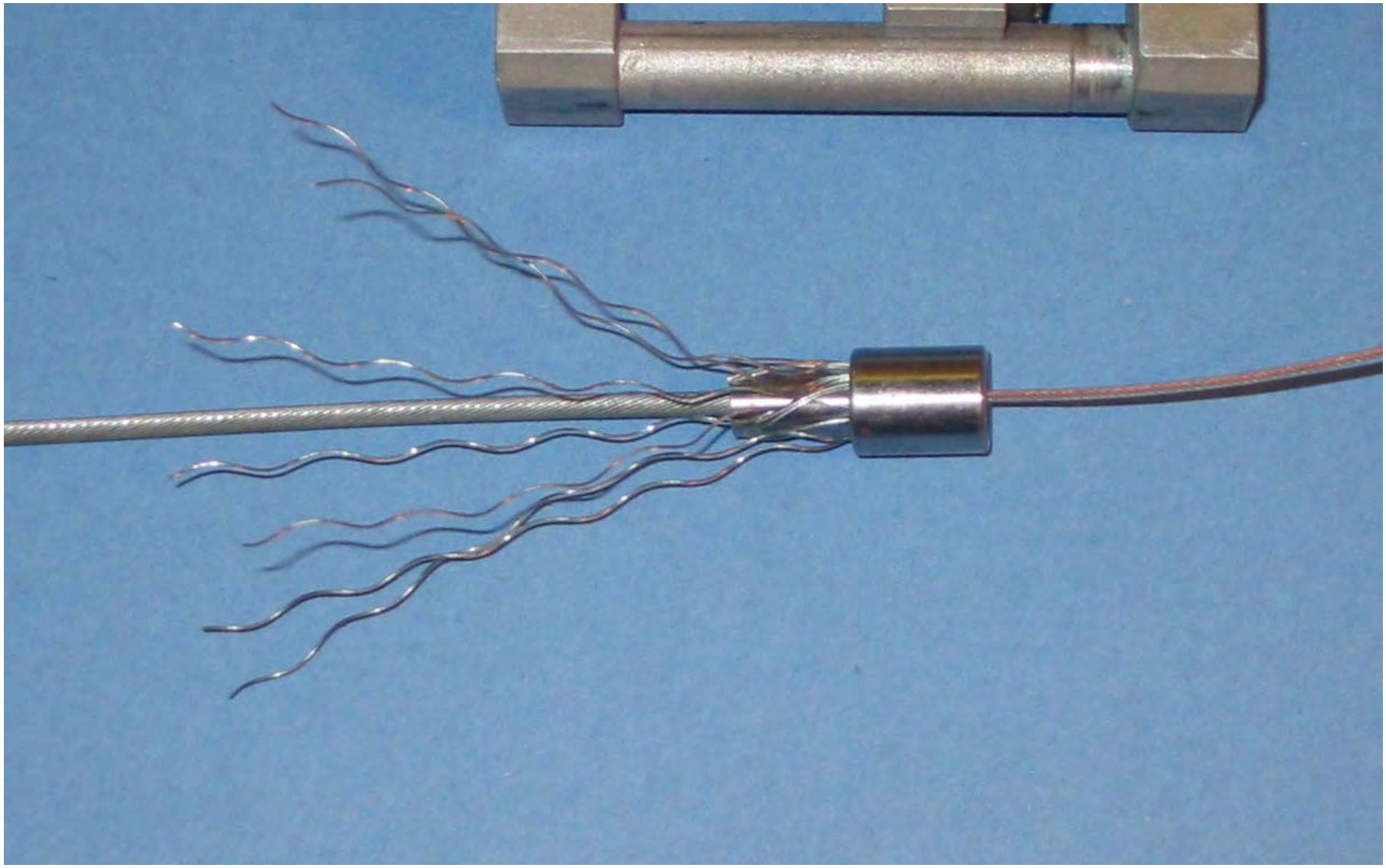
Pic.10 Trim Outer Wire Strands to Base of Insert.



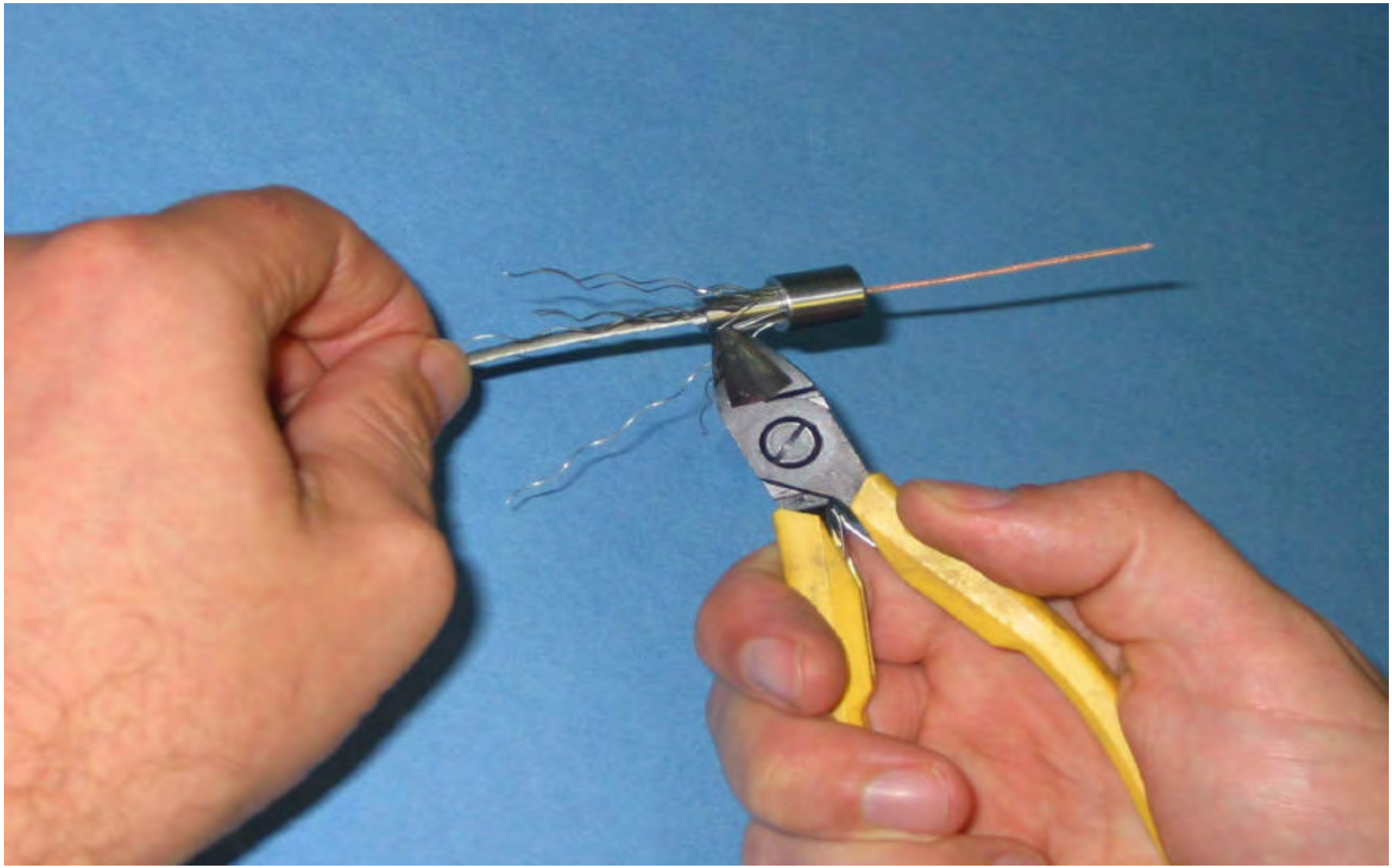
Pic.11 Unwind inner-layer strands of armor (exposing the insulated conductor wire)



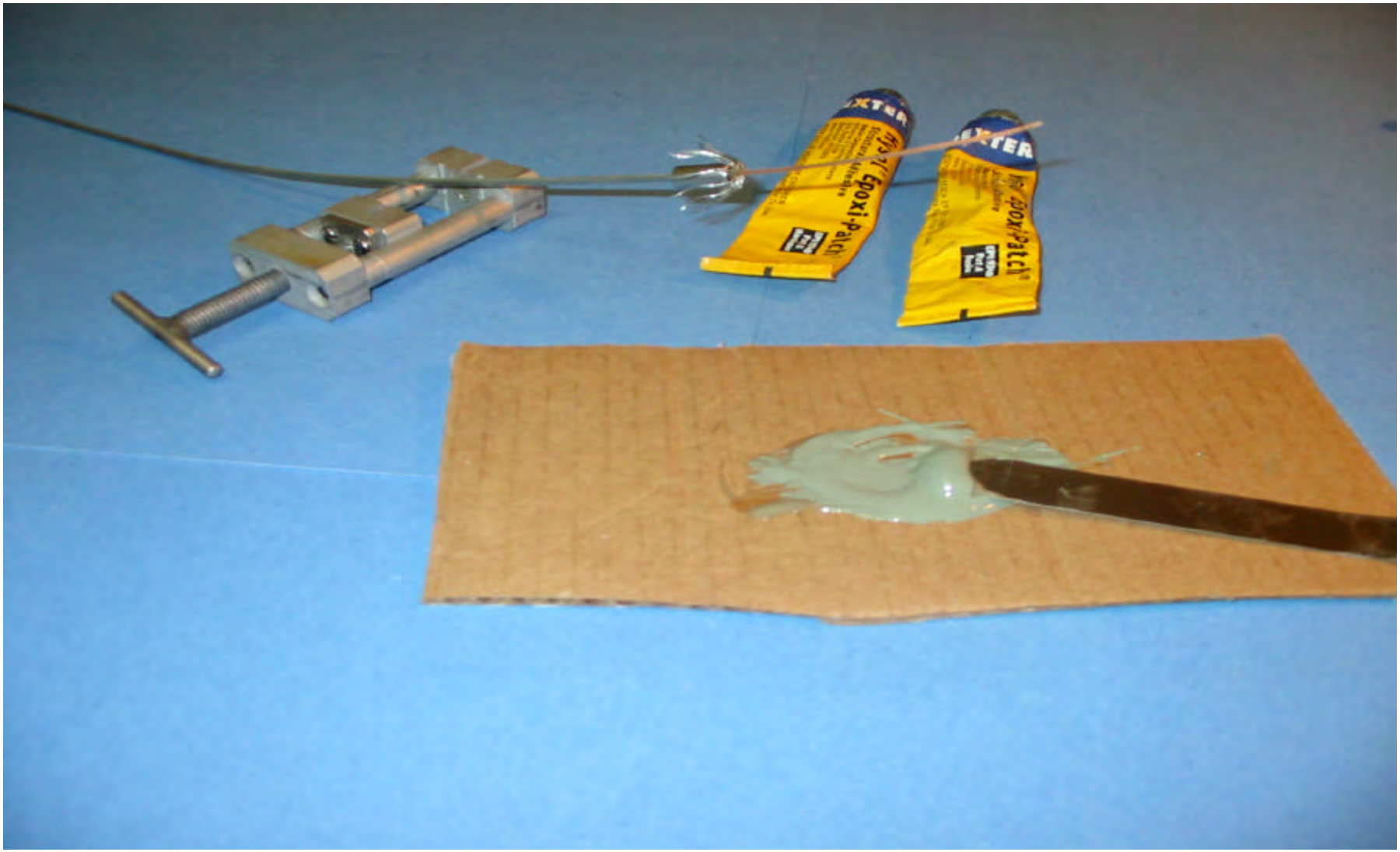
Pic.12 Clip 5 of the 12 inner armor strands close to the top of the insert



Pic.13 Bend down Remaining Inner Wire Strands (Use jig and termination sleeve)



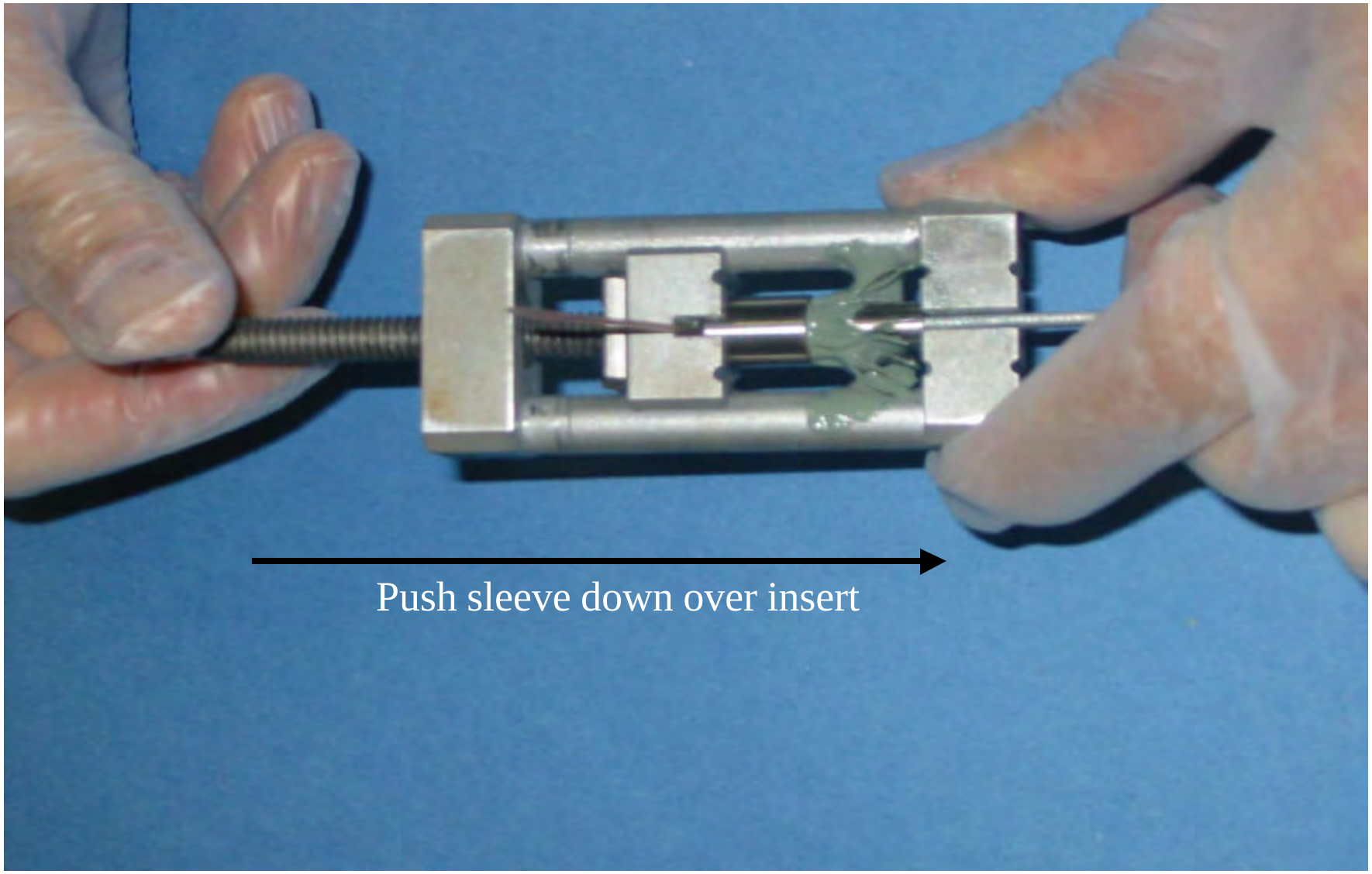
Pic.13 Trim Inner Wire Strands to Base of Insert



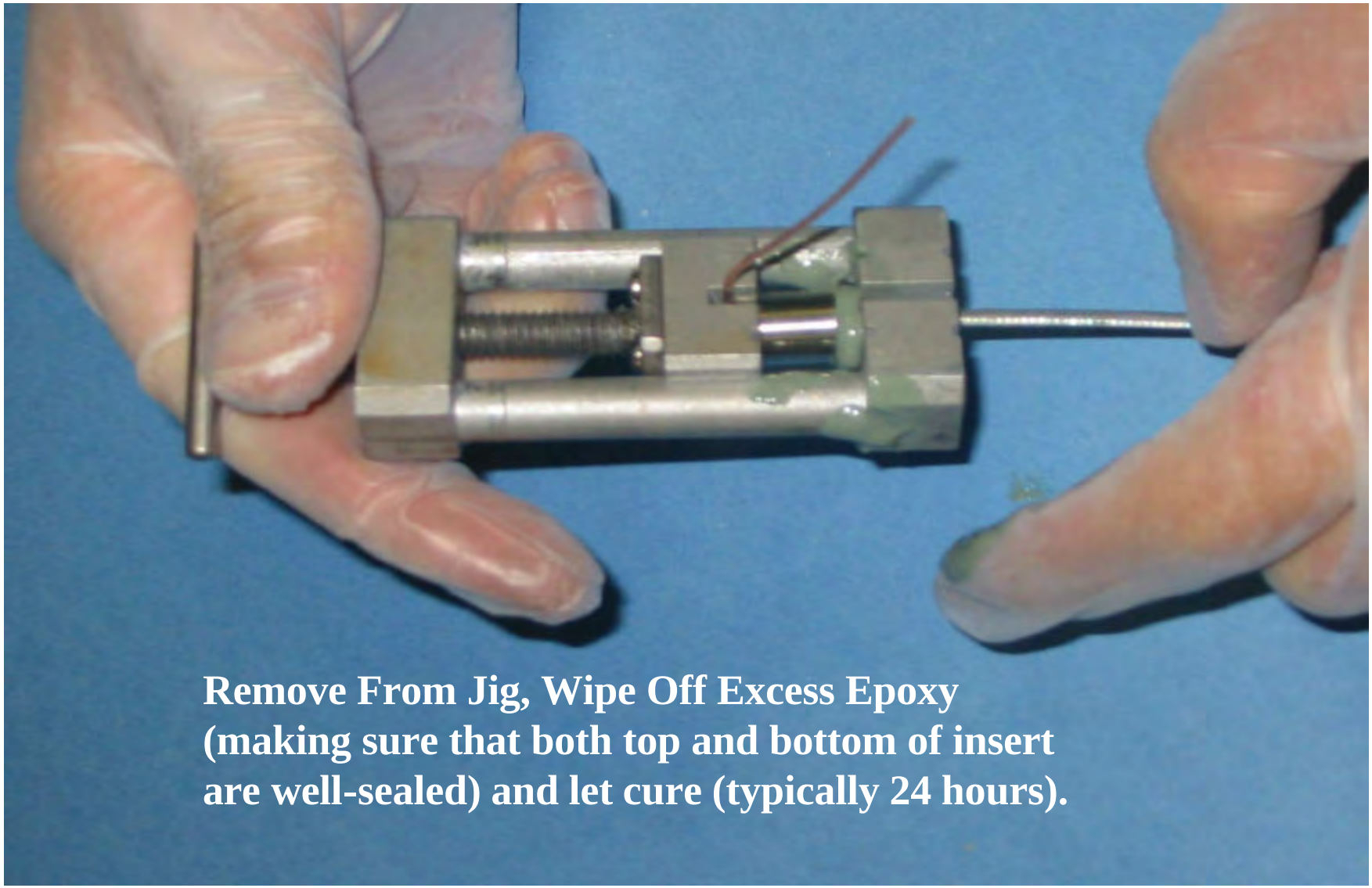
Pic.14 Mix epoxy



Pic.15 Apply epoxy. Cover the trimmed armor strands with epoxy



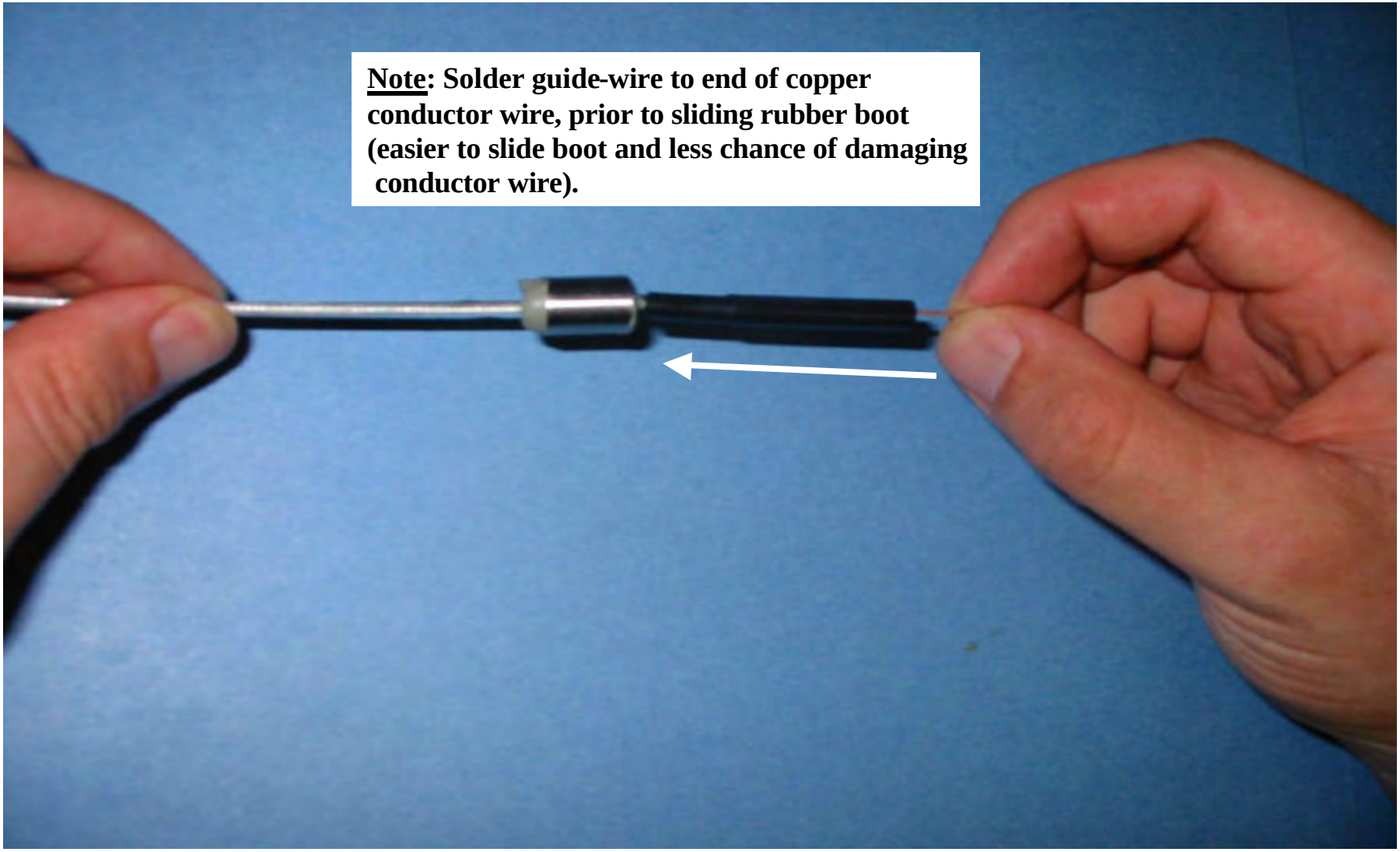
Pic.16 Using the termination jig, push the termination sleeve completely down over the insert



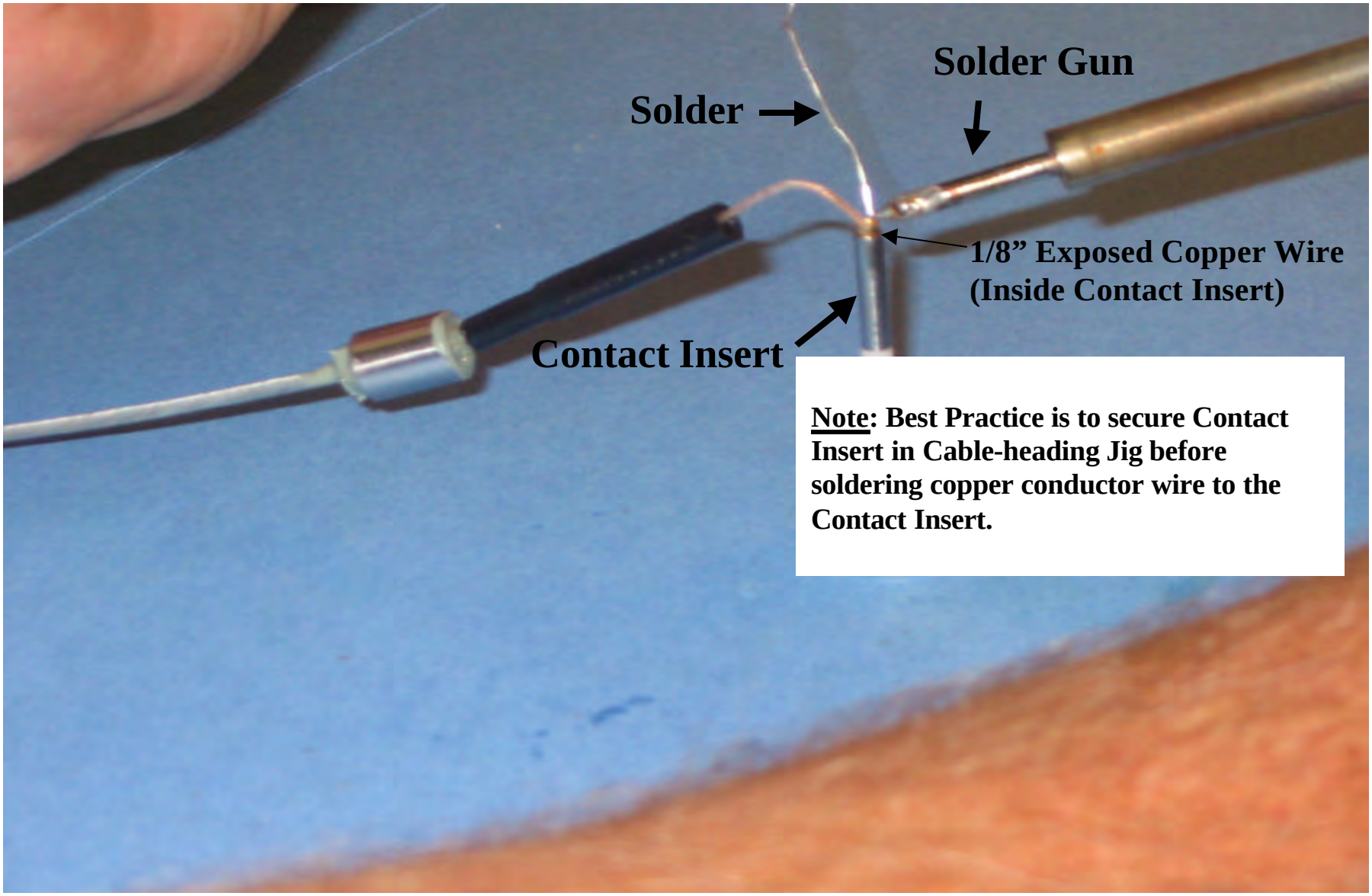
Pic.17 Termination Sleeve completely pushed down over insert



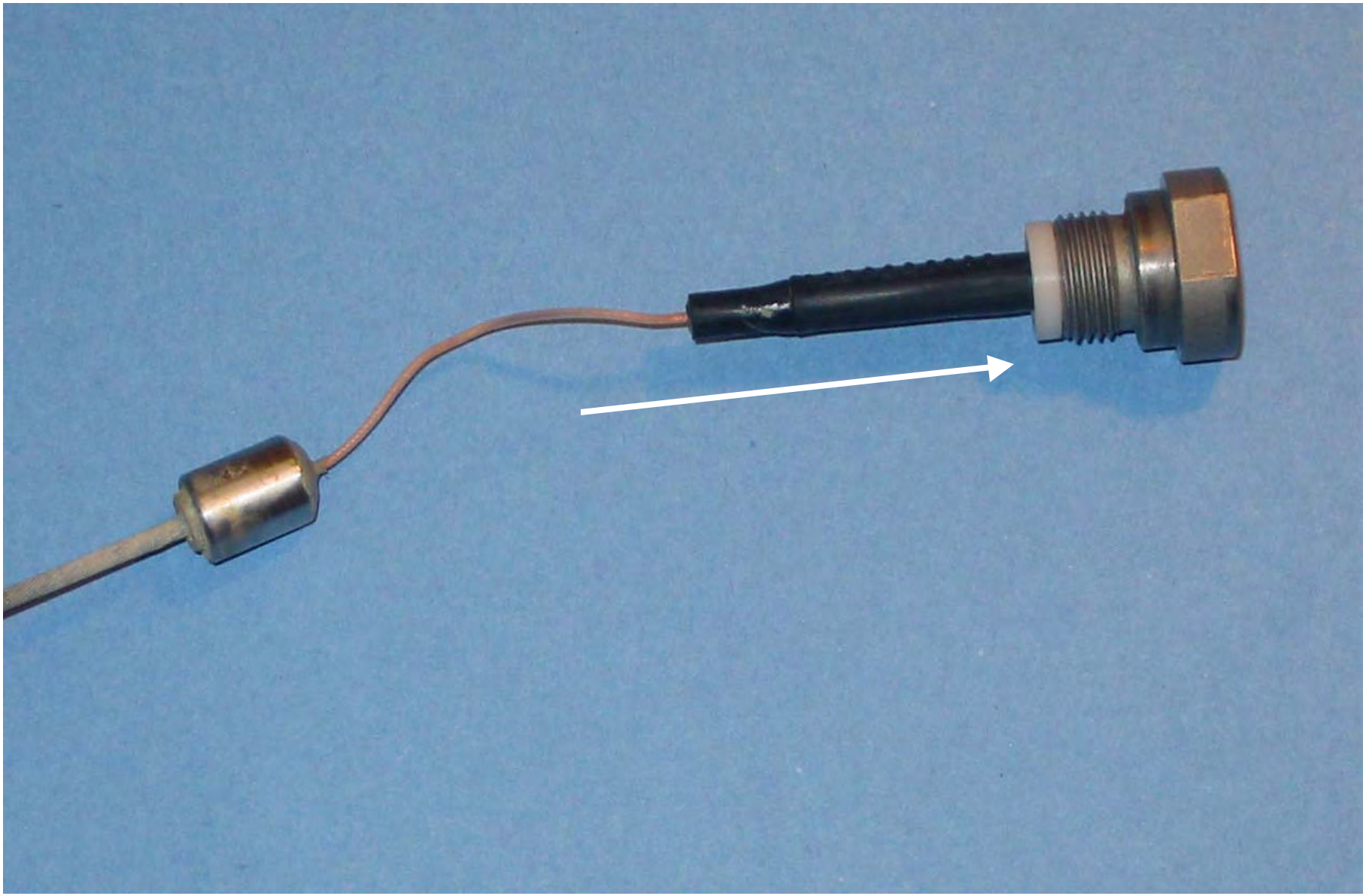
Pic.18 Apply silicon lubricant to the insulated conductor wire



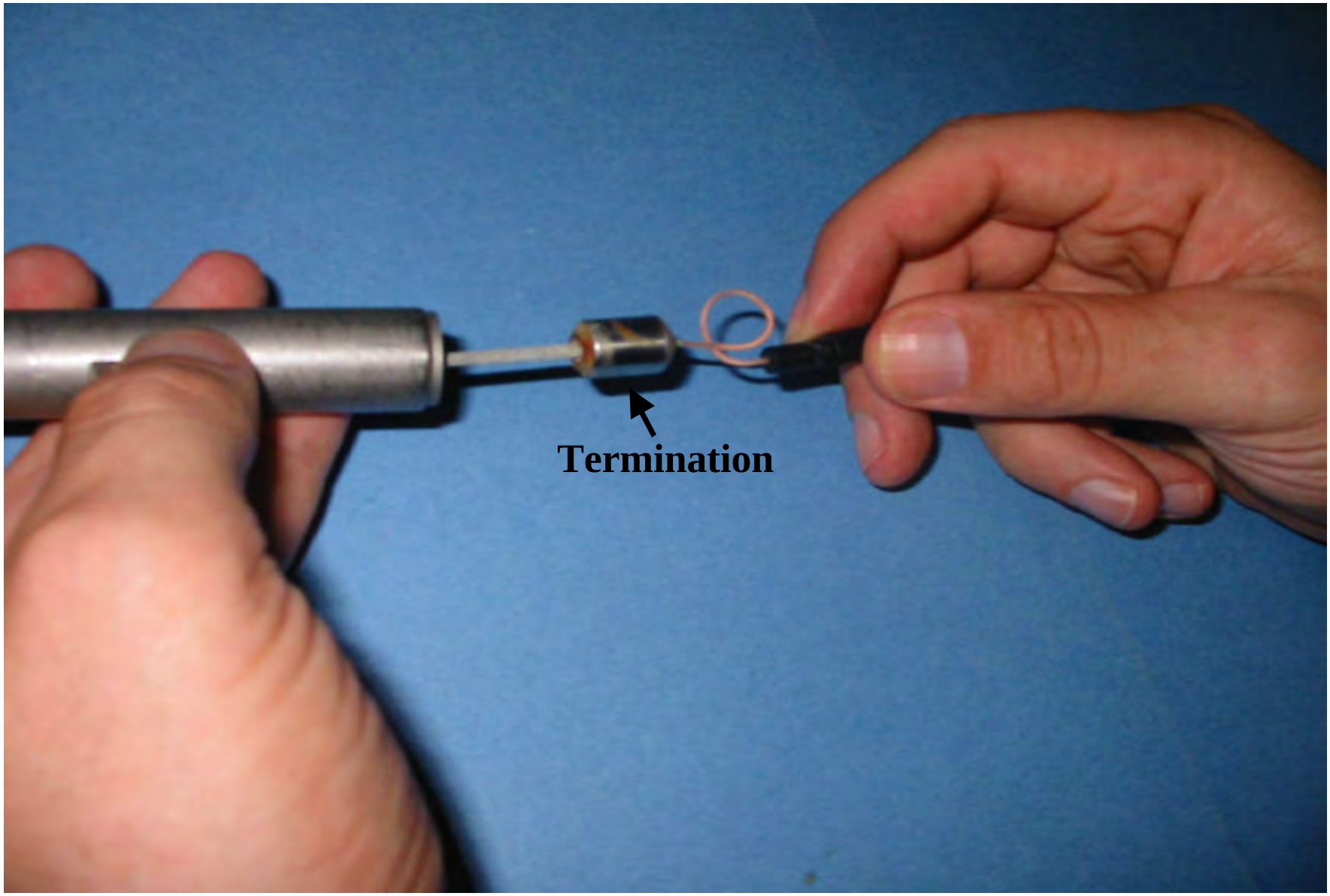
Pic.20 Slide the rubber boot towards the cablehead termination (final position)



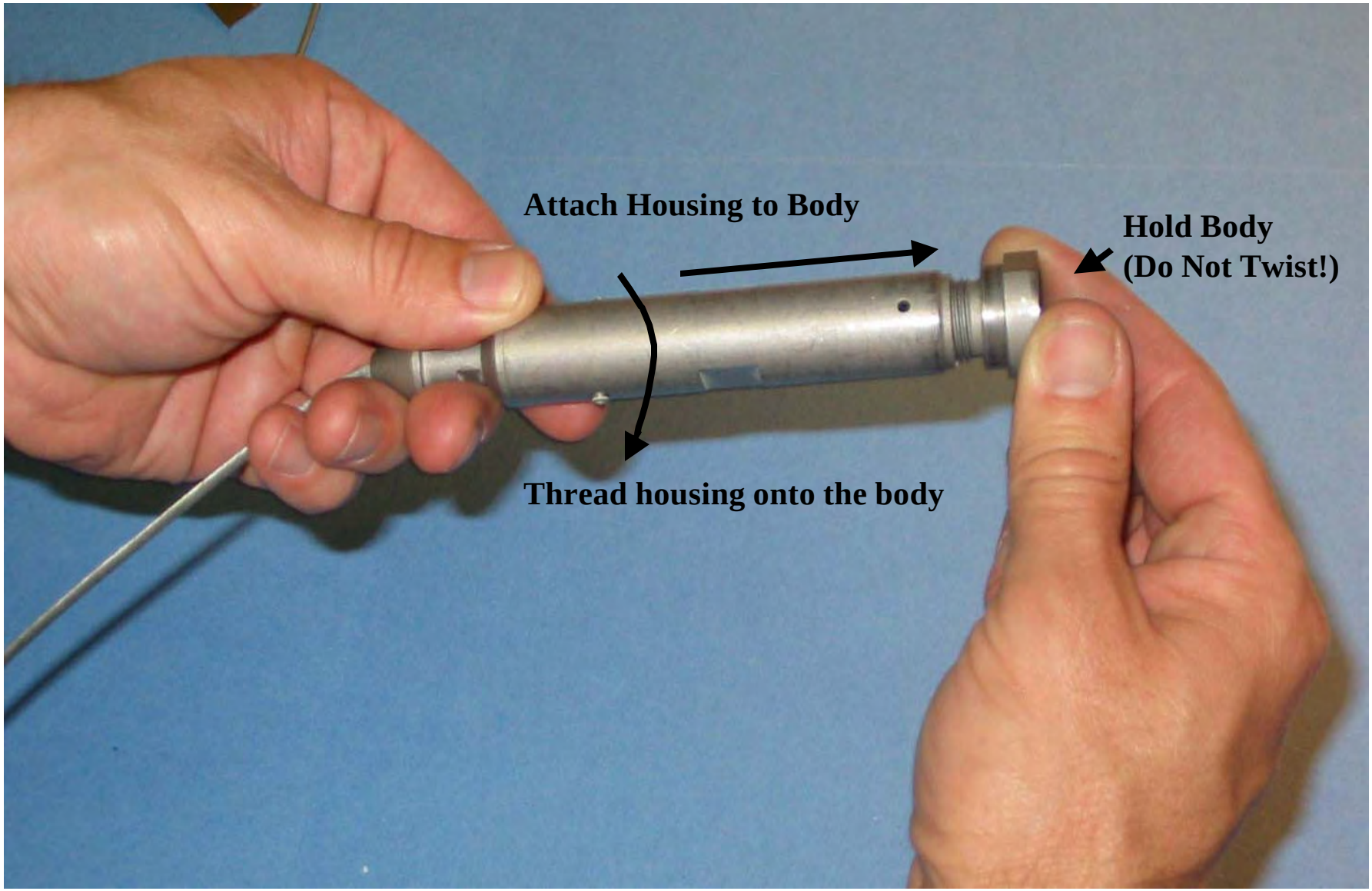
Pic.21 Solder 1/8 inch exposed copper wire (use wire strippers) into contact insert



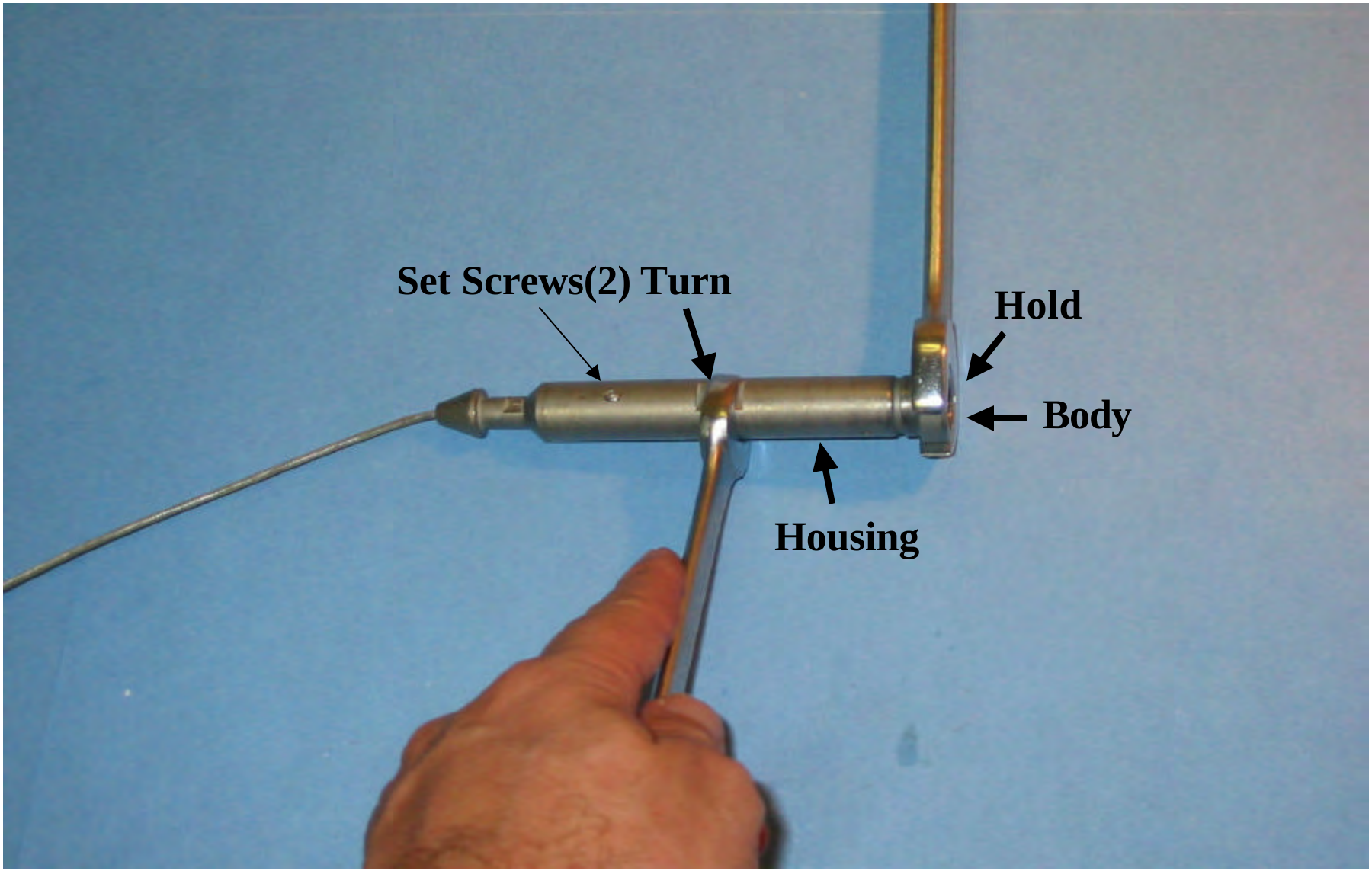
Pic.22 Slide the rubber boot down over the contact insert (when the solder has cooled)



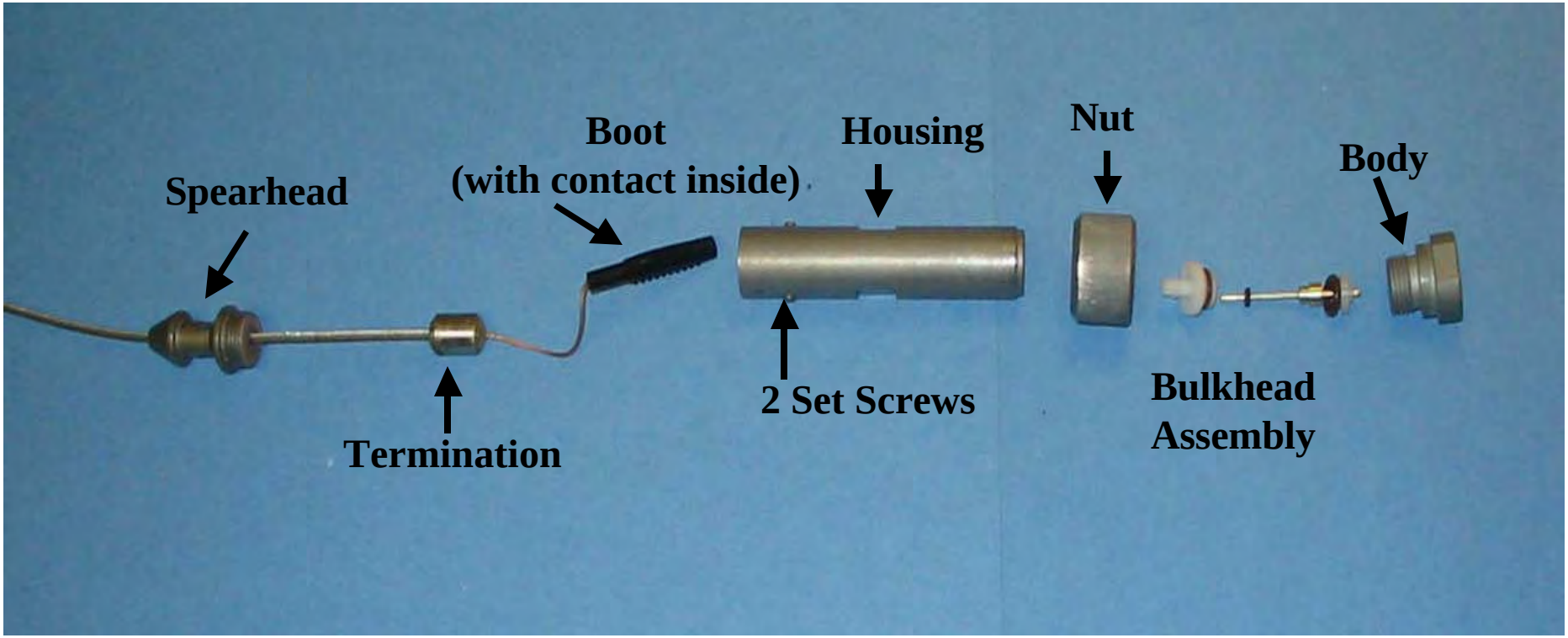
Pic.23 Create a loop in the conductor wire before sliding the cablehead housing down over the termination



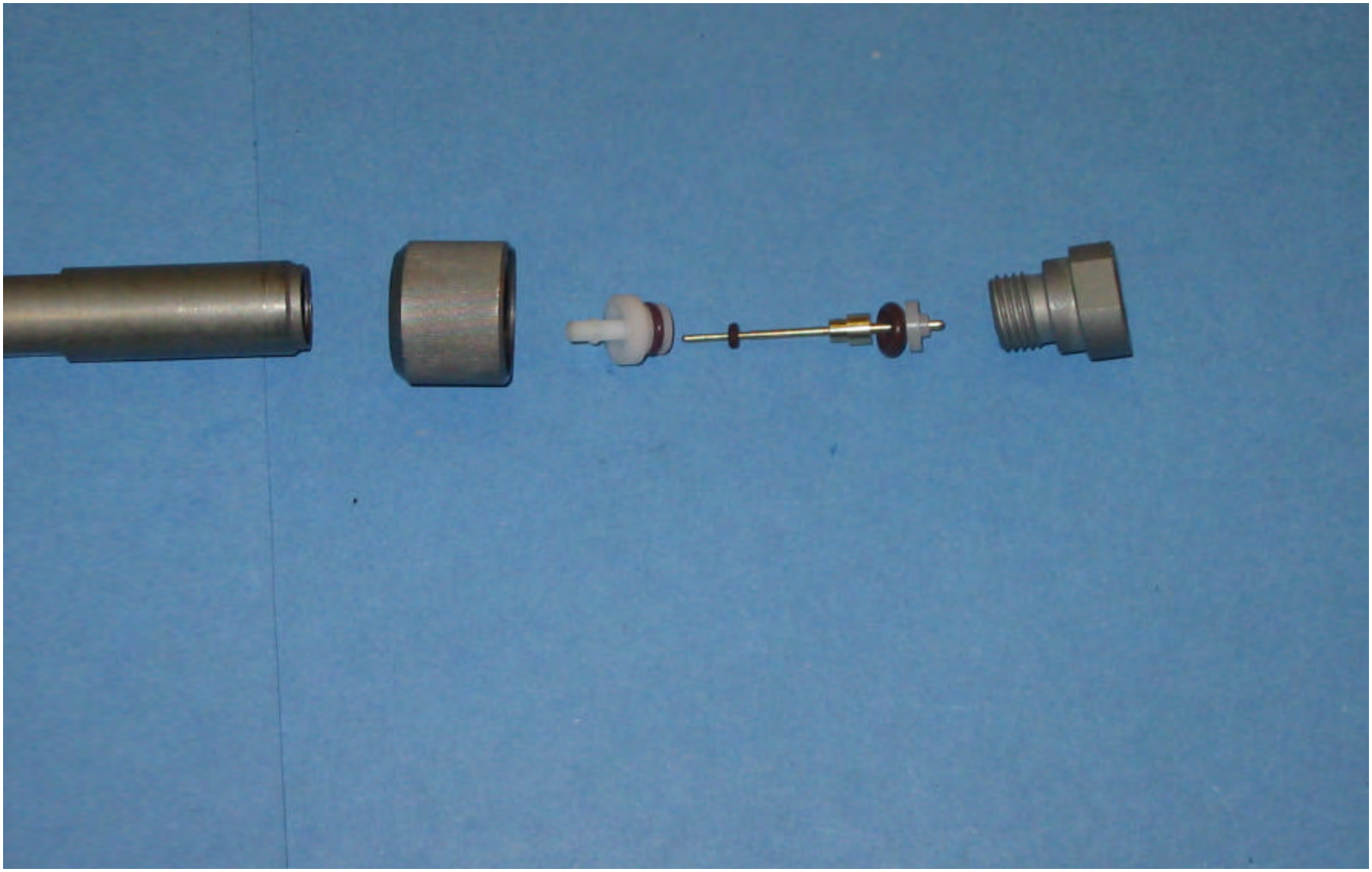
Pic.24 Thread the cablehead housing onto the body
(Do not twist the body! –this can damage the conductor wire)



Pic.25 Tighten the housing to the body
Tighten the set screws to complete re-assembly of the cablehead



Pic.26 Exploded view of cablehead assembly



Pic.27 Exploded view of bulkhead assembly

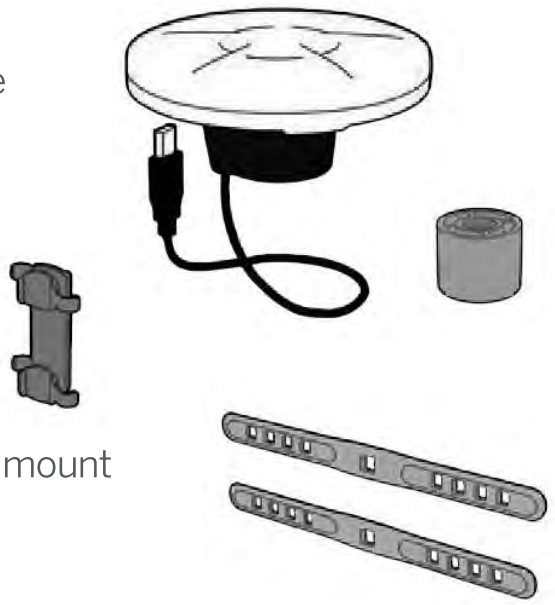
Trimble Catalyst DA2

GNSS RECEIVER

This guide provides an overview of important features and instructions to set up and operate the Trimble® Catalyst™ DA2 GNSS receiver and use it with a subscription to the Trimble Catalyst GNSS service. The receiver uses Bluetooth® technology to connect to a mobile device.

IN THE BOX

- Trimble Catalyst DA2 GNSS receiver, with USB power cable and push-fit mount
- Plastic bracket for battery mount
- Rubber straps (x2) for battery mount



- 5⁄8” x 11 threaded pole cap adapter (for push-fit mount)
- Quick Start Guide
- Trimble Hardware Warranty Card

NOTE -The DA2 GNSS receiver requires power from a standard USB power pack, purchased separately.

SAFETY AND COMPLIANCE

Before you use the Trimble Catalyst DA2 GNSS receiver, refer to the safety documentation and compliance information at:

geospatial.trimble.com/DA2-Compliance

ATTACHING THE RECEIVER TO A SURVEYING POLE

The DA2 receiver has a convenient push-fit mount for simple attachment to any 1 ¼" diameter pole. A ⅝" x 11 thread adaptor for convenient installation/removal on standard mapping and surveying accessories is also included in the box.

NOTE - Additional mounting accessories are available from Trimble or third party accessory vendors. Contact your Trimble distribution partner for details. Optional Trimble accessories include:

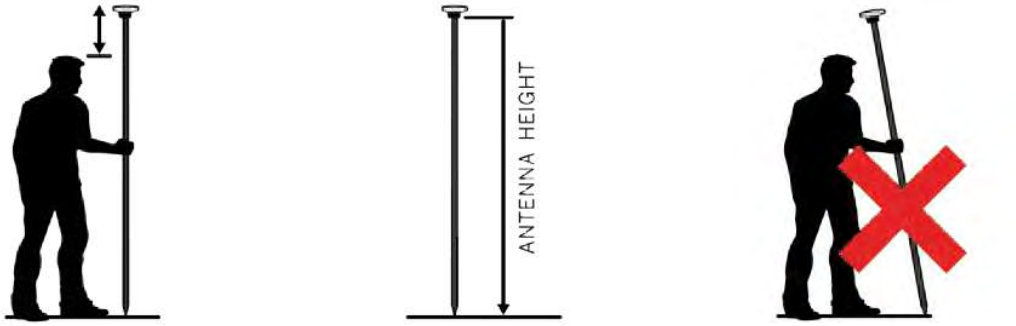
- A DA2 mounting accessory kit that includes:
  - Short ¼" push-fit thread adapter for camera tripods and monopoles
  - Tall and short ⅝" x 11 lock-fit thread adapter for vehicle or high-vibration use
  - Replacement push-fit mounting kit
- Aluminium and carbon-fiber survey poles and accessories

For consistent and accurate results

- If using the receiver on a pole, ensure that it is flat and secure on the pole.
- If using the push-fit ⅝" x 11 thread adapter, ensure that the yellow plastic of the thread adapter is completely concealed in the push-fit mount.



- When you are ready to work, always position the receiver vertically above the point on the ground being surveyed or mapped.
- When setting the receiver height offset in the field application (if supported), measure from the bottom of the push-fit pole mount to the ground.
- When tracking satellites, try to always hold the receiver above head-height, level to the sky, and as vertical as possible to ensure best performance.



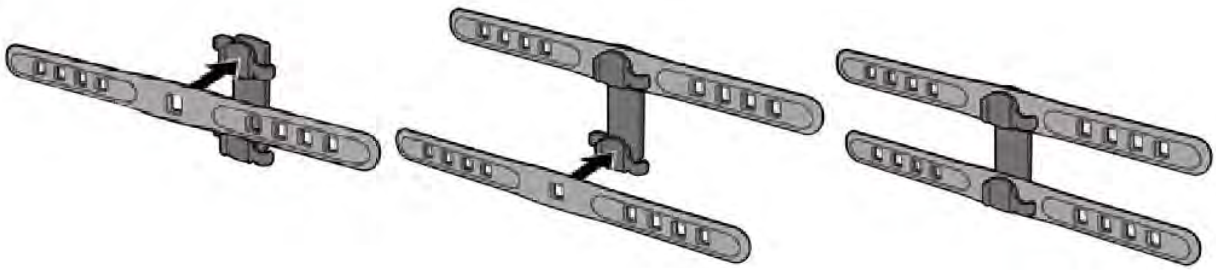
ASSEMBLING THE BATTERY MOUNT

The DA2 receiver is powered by USB. You can attach a standard off-the-shelf single-cell USB power pack to a survey rod using the supplied battery mounting bracket and rubber straps.

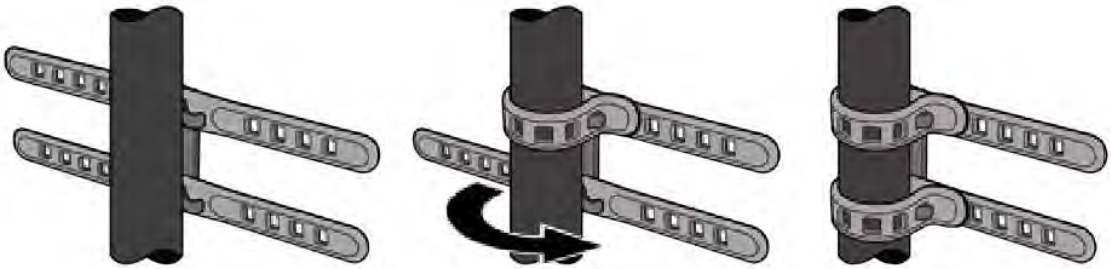
The supplied battery mount is designed to fit a variety of range pole and USB battery pack sizes.

To assemble the battery mount

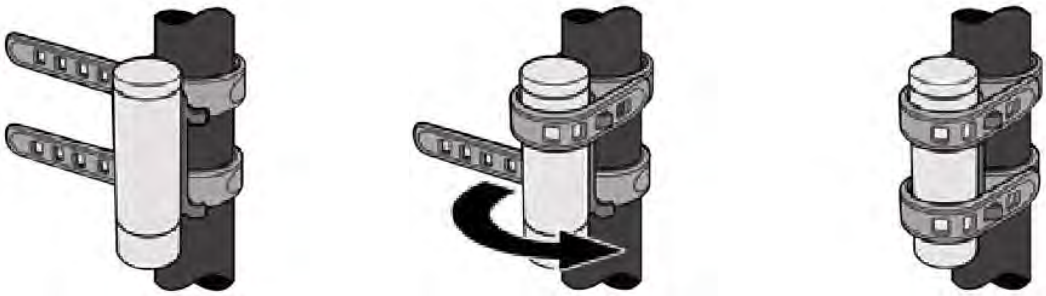
1. Stretch the two rubber straps over the plastic bracket.



2. To attach the battery mount on a range pole, wrap the rubber straps around the pole and secure using the fastening clips.

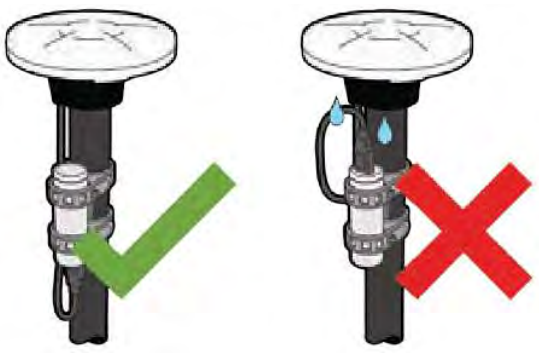


3. Attach a battery pack to the bracket using the clips on the other side.



For maximum rain-resistance, mount the battery with the USB socket facing towards the ground.

Use the supplied USB cable to connect the receiver to the USB battery pack.



TURNING THE RECEIVER ON

Activate the USB battery pack and press the button on the bottom of the DA2 receiver to turn it on.

LED status

- Flashing blue = receiver is discoverable and ready to pair/connect.
- Solid blue = receiver is connected to your field app (on Android), or your device (on iOS),
- Red = Fault. Turn off the receiver, then turn it on again. If the fault indicator persists, contact your Trimble distributor.
- Yellow = receiver software update is in progress

TURNING THE RECEIVER OFF

Briefly press the power button or unplug the power cable.

If the receiver is not connected to a device, it will go to sleep automatically after about 20 minutes.

CONNECTING TO THE DA2 RECEIVER

The DA2 receiver uses Bluetooth to communicate with a phone or tablet device and software.

Connecting on Android

Connect directly to the DA2 receiver using any supported Trimble field app. Third party apps connect to the DA2 receiver using the Trimble Mobile Manager app, available from the Google Play Store.

Connecting on iPhone and iPad

Connect to the DA2 receiver under **Settings** / **Bluetooth**. Search for your DA2 serial number in the devices list, and tap on it to connect. Configure DA2 using your Trimble field app, or the Trimble Mobile Manager app, available from the Apple App Store.





CONFIGURING THE DA2 RECEIVER

Follow the instructions in your field app to configure the DA2 receiver real-time GNSS corrections and output settings.

RESETTING THE DA2 RECEIVER

Resetting the DA2 receiver will force the receiver to forget any previously connected Bluetooth devices. Press and hold the button on the receiver until the light turns off. The receiver will reset itself and turn off. Press the button again to restart it.

SUBSCRIBE TO THE CATALYST GNSS SERVICE

The DA2 receiver is designed for use with the Trimble Catalyst GNSS service. Purchase a subscription to the service from a Trimble Catalyst distribution partner. To find your nearest distributor, go to catalyst.trimble.com.

USING THE RECEIVER WITH A CATALYST GNSS SUBSCRIPTION

To use the Catalyst GNSS service on your phone or tablet, download the Trimble Mobile Manager app. This app manages your access to the Catalyst service, gives you access to configuration settings for the DA2 receiver, and enables other applications on your device to access and use the Catalyst GNSS receiver service.

1. Download the Trimble Mobile Manager app from the Apple App Store or Google Play and install it on your device.

2. Sign in with your Trimble ID to download your Catalyst subscription license.

3. Follow the instructions in Trimble Mobile Manager to configure Catalyst GNSS settings.

4. Share Catalyst GNSS positions directly from Trimble Mobile Manager, or if you are using a Catalyst enabled field app, connect to the DA2 receiver directly from your field app.

For more instructions, refer to the user documentation for your field app.

SERVICING AND CARE

The USB power cable and mounting features are the only serviceable / removable parts of the receiver. Do not attempt to disassemble the receiver. To clean the receiver, wipe clean with a moist cloth.

MORE INFORMATION

For more information about using the receiver and the Trimble Catalyst service, or for documentation in other languages, support and troubleshooting information, go to catalyst.trimble.com.

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Attachment A: Standard Operating Procedure (SOP) #2

Passive Diffusion Bag (PDB) Sampling Protocol

1.0 Obtain PDB Sampler Hardware

- The hardware for each well in the sampling program will be custom-made by the PDB manufacturer (EON Products, Inc.) or by field sampling personnel, prior to the initiation of the field program.
- Each hardware kit is labeled for each well, and should closely match the dimensions submitted to the kit manufacturer.
- Open the hardware kit bag and carefully unwind the first few feet of cable or rope, to expose the first PDB station (colored zip ties or metal clips) from which the PDB samplers will hang.

2.0 Install PDB Sampler Hardware (Page 6, USGS, 2001)

- Unseal the appropriate PDB sampler hardware kit (match label to well name) and carefully retrieve hardware.
- Clip the first (bottom) PDB sampler onto the top and bottom PDB station using the available zip ties.
- Record time and bag position in the well.
- If this well is to be profiled, continue attaching PDB samplers to remaining PDB stations for this monitoring well.
- Otherwise, if this well is not scheduled to be profiled and has not yet been profiled, continue unwinding the hardware kit until the uppermost set of plastic disks is exposed and then attach the second PDB sampler.
- Once a well has been profiled and a specific depth has been selected from which to monitor groundwater quality, only one PDB sampler will be installed on the hardware kit – the depth interval will be noted on the field instruction form.
- Once the necessary PDB samplers have been installed, carefully lower the hardware kit until the stainless steel weight touches the well bottom.
- Confirm that the top clip (marker) roughly equals the top of casing and adjust as necessary to ensure a snug fit (slightly taught line) when the well cap is closed.
- Attach the end of the hardware line to the well head hanging device – make sure that the PDB sampler kit does not sag when well cap is closed.
- Secure the well.

3.0 Sample Naming/Recording

- Sample numbers will be generated as specified in the QAPP.
- Field personnel must include a depth for each sampler on the chain-of-custody.

- Record the relative position of each bag – they will be numbered in the order they will be retrieved (i.e., top → #1... #2... #n... → bottom) – in other words, the first PDB sampler to be installed will have the highest number and the last PDB sampler will have the lowest number.

4.0 PDB Sampler Retrieval (Page 9, USGS, 2001)

- Collect the appropriate number of VOA vials for the required number of VOC samples.
- Measure and record the corrected depth to water from the top of casing to ensure PDB are completely submerged below the water level.
- Note the time and begin reeling the PDB sampler hardware line.
- Field personnel must include a depth for each sampler on the chain-of-custody in the form of station number as recorded during bag placement.
- Important - the contents of each bag must be transferred to the VOA vials immediately after PDBs are removed from the well and before addressing any other sampling-related issues to avoid losing volatile compounds to atmosphere. Once the first bag leaves the water, the time limit starts at the same time for all exposed bags. All samples shall be contained in the VOA vials within 15 minutes of the PDB leaving the water.
- Extract the PDB sampler(s) from the well, remove the sampler cap and carefully empty the contents into VOA vials (preferably set up in a bottle holder), taking care not to over agitate the bag or water.
- Apply completed label to each VOA vial to ensure that they are not confused later.
- Repeat until all PDB samplers have been removed and contents transferred.
- QC duplicate samples consist of two separate sets of VOA vials filled from the same diffusion sampler.
- Store all filled VOA vials in Ziploc bags inside a properly cooled container.
- Follow above guidelines to re-install new PDB samplers as scheduled (profile or single-bag scenario).
- Dispose of all used passive diffusion sample bags and components appropriately as either IDW or recyclable material.
- Decontaminate all reusable equipment with clean water and ALCONOX.

5.0 User's Guide for Polyethylene-based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

(See following pages)

USGS
science for a changing world

USER'S GUIDE FOR POLYETHYLENE-BASED PASSIVE DIFFUSION BAG SAMPLERS TO OBTAIN VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN WELLS

PART 1: DEPLOYMENT, RECOVERY, DATA INTERPRETATION, AND QUALITY CONTROL AND ASSURANCE

Water-Resources Investigations Report 01-4060

Prepared in cooperation with the

U.S. AIR FORCE
U.S. NAVAL FACILITIES ENGINEERING COMMAND
U.S. ENVIRONMENTAL PROTECTION AGENCY
FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE
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User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

U.S. Geological Survey

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Columbia, South Carolina
2001

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Additional information about water resources in South Carolina is available on the World Wide Web at **http://sc.water.usgs.gov**

Report can be downloaded from **http://www.itrcweb.org** and **http://www.frtr.gov**

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Conversion Factors, Vertical Datum, Acronyms, and Abbreviations

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
foot per day (ft/d)	0.3048	meter per day
foot squared per day (ft^2/d)	0.09294	meter squared per day
gallon per minute (gal/min)	0.06308	liter per second
gallon per day (gal/d)	0.003785	cubic meter per day
inch per year (in/yr)	25.4	millimeter per year
	Volume	
gallon (gal)	3.785	liter

Temperature is given in degrees Celsius (°C), which can converted to degrees Fahrenheit (°F) by the following equation: °F = 9/5 (°C) + 32

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration in water is expressed in metric units as milligrams per liter (mg/L) or micrograms per liter (µg/L).

Additional Abbreviations	
EDB	1,2-Dibromomethane
AFCEE	Air Force Center for Environmental Excellence
*c*DCE	*cis*-1,2-Dibromoethene
ft^3/d	cubic feet per day
ft^3/mg	cubic feet per milligram
°C	degrees Celsius
g	gram
ITRC	Interstate Technology Regulatory Cooperation
LDPE	low-density polyethylene
L	liter
µg	microgram
µm	micrometer
µL	microliter
mg	milligram
mL	milliliter
mL/min	milliliter per minute
MTBE	Methyl-*tert*-butyl ether
NAVFAC	Naval Facilities Engineering Command
NAPL	non-aqueous phase liquid
PDB	passive diffusion bag
PCE	Tetrachloroethene
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOA	Volatile organic analysis
VOC	Volatile organic compound

User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

EXECUTIVE SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining concentrations of a variety of volatile organic compounds (VOCs) in ground water at monitoring wells. The suggested application of the method is for long-term monitoring of VOCs in ground-water wells at well-characterized sites.

The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-bore-hole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then a multiple deployment of PDB samplers within a well may be more appropriate for sampling the well.

A typical PDB sampler consists of a low-density polyethylene (LDPE) lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon of the well by attachment to a weighted line or fixed pipe.

The amount of time that the sampler should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for the environmental disturbance caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 degrees Celsius (°C). A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications; therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified time for sampler recovery after initial equilibration. PDB samplers routinely have been left in ground waters having concentrations of greater than 500 parts per million (ppm) of trichloroethene for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations, however. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparison to a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery consists of removing the samplers from the well and immediately transferring the enclosed water to 40-milliliter sampling vials for analysis. The resulting concentrations represent an integration of chemical changes over the most recent portion of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound).

The method has both advantages and limitations when compared to other sampling methods. Advantages include the potential for PDB samplers to eliminate or substantially reduce the amount of purge water associated with sampling. The samplers are relatively inexpensive and easy to deploy and recover. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells, and there is a minimum amount of field equipment required. The samplers also have the potential to delineate contaminant stratification in the formation across the open or screened intervals of monitoring wells where vertical hydraulic gradients are not present. In addition, the samplers integrate concentrations over time, which may range between about 48 to 166 hours depending on the compound of interest. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material, or that there is a detrimental effect on the VOC sample from the PDB material.

Water-filled polyethylene PDB samplers are not appropriate for all compounds. The samplers are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene. These factors include the molecular size and shape and the hydrophobic nature of the compound. Unpublished laboratory test data of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

VOC concentrations in PDB samplers represent concentrations in the vicinity of the sampler within the well screen or open interval. This may be a limitation for PDB samplers and some other types of sampling, such as low-flow sampling, if the ground-water contamination is above or below the screen or not in the sample intervals providing water movement to the PDB samplers. If there is a vertical hydraulic gradient in the well, then the concentrations in the sampler may represent the concentrations in the water flowing vertically past the sampler rather than in the formation directly adjacent to the sampler. Vertically spaced multiple PDB samplers may be needed in chemically stratified wells or where flow patterns through the screen change as a result of ground-water pumping or seasonal water-level fluctuations.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches to determine the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of passive diffusion sampler applicability and interpretation of the data is

suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB sampler field applications.

INTRODUCTION

The use of PDB samplers for collecting ground-water samples from wells offers a cost-effective approach to long-term monitoring of VOCs at well-characterized sites (Vroblesky and Hyde, 1997; Gefell and others, 1999). The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-borehole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then deployment of multiple PDB samplers within a well may be more appropriate for sampling the well.

The samplers consist of deionized water enclosed in a LDPE sleeve (fig. 1) and are deployed adjacent to a target horizon within a screened or open interval of a well. The suggested application is for long-term monitoring of VOCs in ground-water wells. Where the screened interval is greater than 10 feet (ft), the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is important that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. For many VOCs of environmental interest (table 1), the VOC concentration in water within the sampler approaches the VOC concentration in water outside of the PDB sampler over an equilibration period. The resulting concentrations represent an integration of chemical changes over the most recent part of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound being sampled). The approach is inexpensive and has the potential to eliminate or substantially reduce the amount of purge water removed from the well.

A variety of PDB samplers have been utilized in well applications (fig. 1). Although the samplers vary in specific construction details, a typical PDB sampler consists of a 1- to 2-ft-long LDPE tube closed at both ends and containing laboratory-grade deionized water (fig. 1). The typical diameter for PDB samplers used in a 2-inch-diameter well is approximately 1.2 inches; however, other dimensions may be used to match the well diameter. Equilibration times may be longer for larger diameter PDB samplers. On the outside of the PDB sampler, a low-density polyethylene-mesh sometimes is used for protection against abrasion in open boreholes and as a means of attachment at the prescribed depth. The PDB sampler can be positioned at the target horizon by attachment to a weighted line or by attachment to a fixed pipe.

PDB samplers for use in wells are available commercially. Authorized distributors as of March 2001 are Columbia Analytical Services (800-695-7222; www@caslab.com) and Eon Products (800-474-2490; www.eonpro.com). A current list of vendors and PDB-sampler construction details can be obtained from the U.S. Geological Survey Technology Transfer Enterprise Office, Mail Stop 211, National Center, 12201 Sunrise Valley Drive, Reston, Virginia 20192 (telephone 703-648-4344; fax 703-648-4408). PDB samplers employ patented technology (U.S. patent number 5,804,743), and therefore, require that the user purchase commercially produced samplers from a licensed manufacturer or purchase a nonexclusive license for sampler construction from the U.S. Geological Survey Technology Enterprise Office at the above address.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches for determining the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of PDB sampler applicability and interpretation of the data is suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB-sampler field applications.



Figure 1. Typical water-filled passive diffusion bag samplers used in wells, including (A) diffusion bag with polyethylene mesh, (B) diffusion bag without mesh, and (C) bag and mesh attached to bailer bottom.

Table 1. Compounds tested under laboratory conditions for use with passive diffusion bag samplers
[From Vroblesky and Campbell, 2001]

Tested compounds showing good correlation (average differences in concentration of 11 percent or less between diffusion-sampler water and test-vessel water) in laboratory tests			
Benzene	2 Chlorovinyl ether	*cis*-1,2-Dichloroethene	1,1,1-Trichloroethane
Bromodichloromethane	Dibromochloromethane	*trans*-1,2-Dichloroethene	1,1,2-Trichloroethane
Bromoform	Dibromomethane	1,2-Dichloropropane	Trichloroethene
Chlorobenzene	1,2-Dichlorobenzene	*cis*-Dichloropropene	Trichlorofluoromethane
Carbon tetrachloride	1,3-Dichlorobenzene	1,2-Dibromoethane	1,2,3-Trichloropropane
Chloroethane	1,4-Dichlorobenzene	*trans*-1,3-Dichloropropene	1,1,2,2-Tetrachloroethane
Chloroform	Dichlorodifluoromethane	Ethyl benzene	Tetrachloroethene
Chloromethane	1,2-Dichloroethane	Naphthalene	Vinyl chloride
	1,1-Dichloroethene	Toluene	Total xylenes
Tested compounds showing poor correlation (average differences in concentration greater than 20 percent between diffusion-sampler water and test-vessel water) in laboratory tests			
Acetone*	Methyl-*tert*-butyl ether	Styrene	

*T.M Sivavec and S.S. Baghel, General Electric Company, written commun., 2000

Summary of Passive Diffusion Bag Sampler Advantages and Limitations

Advantages

1. PDB samplers have the potential to eliminate or substantially reduce the amount of purge water associated with sampling.

2. PDB samplers are inexpensive.

3. The samplers are easy to deploy and recover.

4. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells.

5. A minimal amount of field equipment is required.

6. Sampler recovery is rapid. Because of the small amount of time and equipment required for the sampling event, the method is practical for use where access is a problem or where discretion is desirable (that is, residential communities, business districts, or busy streets where vehicle traffic control is a concern).

7. Multiple PDB samplers, distributed vertically along the screened or open interval, may be used in conjunction with borehole flow meter testing to gain insight on the movement of contaminants into and out of the well screen or open interval or to locate the zone of highest concentration in the well. Analytical costs when using multiple PDB samplers sometimes can be reduced by selecting a limited number of the samplers for laboratory analysis based on screening by using field gas chromatography at the time of sample collection.

8. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material or that there is a detrimental effect from the PDB material on the VOC sample.

Limitations

1. PDB samplers integrate concentrations over time. This may be a limitation if the goal of sampling is to collect a representative sample at a point in time in an aquifer where VOC-concentrations substantially change more rapidly than the samplers equilibrate. Laboratory results obtained indicate that a variety of compounds equilibrated within 48 hours at 21 °C (Vroblesky and Campbell, 2001). Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane may require between 93 and 166 hours to equilibrate at 10 °C (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). The initial equilibration under field conditions may be longer to allow well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment.

2. Water-filled polyethylene PDB samplers are not appropriate for all compounds. For example, although methyl-*tert*-butyl ether and acetone (Vroblesky, 2000; Paul Hare, General Electric Company, oral commun., 2000) and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene membrane. These factors include the molecular size and shape and the hydrophobic nature of the compound. Compounds having a cross-sectional diameter of about 10 angstroms or larger (such as humic acids) do not pass through the polyethylene because the largest (transient) pores in polyethylene do not exceed about 10 angstroms in diameter (Flynn and Yalkowsky, 1972; Hwang and Kammermeyer, 1975; Comyn, 1985). The samplers are not appropriate for hydrophilic polar molecules, such as inorganic ions. A detailed discussion of the relation between hydrophobicity and compound transport through polyethylene can be found in Gale (1998). Unpublished laboratory test data (D.A. Vroblesky, U.S. Geological Survey, written commun., 1998) of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

3. PDB samplers rely on the free movement of water through the well screen. In situations where ground water flows horizontally through the well screen, the VOC concentrations in the open interval of the well probably are representative of the aquifer water in the adjacent formation (Gillham and others, 1985; Robin and Gillham, 1987; Kearl and others, 1992; Powell and Puls, 1993; Vroblesky and Hyde, 1997). In these situations, the VOC concentration of the water in contact with the PDB samplers, and therefore, the water within the diffusion samplers, probably represents local conditions in the adjacent aquifer. However, if the well screen is less permeable than the aquifer or the sandpack, then under ambient conditions, flowlines may be diverted around the screen. Such a situation may arise from inadequate well development or from iron bacterial fouling of the well screen. In this case, the VOC concentrations in the PDB samplers may not represent concentrations in

the formation water because of inadequate exchange across the well screen. PDB samplers have not yet been adequately tested to determine their response under such conditions.

4. VOC concentrations in PDB samplers represent ground-water concentrations in the vicinity of the screened or open well interval that move to the sampler under ambient flow conditions. This is a limitation if the ground-water contamination lies above or below the well screen or open interval, and requires the operation of a pump to conduct contaminants into the well for sampling.

5. In cases where the well screen or open interval transects zones of differing hydraulic head and variable contaminant concentrations, VOC concentrations obtained using a PDB sampler may not reflect the concentrations in the aquifer directly adjacent to the sampler because of vertical transport in the well. However, a vertical array of PDB samplers, used in conjunction with borehole flow meter testing, can provide insight on the movement of contaminants into or out of the well. This information then can be used to help determine if the use of PDB samplers is appropriate for the well, and to select the optimal vertical location(s) for the sampler deployment.

6. In wells with screens or open intervals with stratified chemical concentrations, the use of a single PDB sampler set at an arbitrary (by convention) depth may not provide accurate concentration values for the most contaminated zone. However, multiple PDB samplers distributed vertically along the screened or open interval, in conjunction with pump sampling (as appropriate), can be used to locate zone(s) of highest concentration in the well. Multiple PDB samplers also may be needed to track the zone of maximum concentration in wells where flow patterns through the screened interval change as a result of ground-water pumping or seasonal water-table fluctuations.

PASSIVE DIFFUSION BAG SAMPLER DEPLOYMENT

A variety of approaches can be used to deploy the PDB samplers in wells. A typical deployment approach, described in this section, is to attach the PDB samplers to a weighted line. It also is acceptable to attach the weights directly to the PDB sampler if the attachment point is of sufficient strength to support the weight. The weights attached to the bottom of the line are stainless steel and can be reused, but must be thoroughly decontaminated with a detergent before the first use or before using in a different well. Rope, such as 90 pound, 3/16 inch braided polyester, can be used as the line for single-use applications if it is of sufficient strength to support the weight and sampler, is nonbuoyant, and is subject to minimal stretch; however, the rope should not be reused because of the high potential for cross contamination. Stainless-steel or Teflon-coated stainless-steel wire is preferable. The weighted lines should not be reused in different wells to prevent carryover of contaminants. A possible exception is coated stainless-steel wire, which can be reused after sufficient decontamination. An alternative deployment approach, not discussed in this section, is to attach the PDB samplers to a fixed pipe in the well (Vroblesky and Peters, 2000, p. 3; also included in Part 2 of this publication). The PDB samplers should not contact non-aqueous phase liquid (NAPL) during deployment or retrieval to prevent cross contamination. An approach that can be utilized to deploy diffusion samplers through a layer of floating NAPL is described in the field test at Naval Station North Island, California (Vroblesky and Peters, 2000, p. 3-4; also included in Part 2 of this publication).

If the PDB sampler is to be compared with a conventional pumping approach to sampling, then it is suggested that both the pump and the PDB sampler be deployed at the same time, with the sampler attached near (such as directly below) the pump inlet. This approach eliminates potential concentration differences between the two methods that may result from well disturbance during equipment removal and deployment at the time of sampling. An alternative method is to deploy the PDB samplers independently of the pumps and recover the samplers immediately prior to placing the pump down the well.

PDB samplers are available either prefilled (field ready) with laboratory-grade deionized water or unfilled. The unfilled samplers are equipped with a plug and funnel to allow for field filling and sample recovery. To fill these samplers, remove the plug from the sampler bottom, insert the short funnel into the sampler, and pour laboratory-grade deionized water into the sampler. The sampler should be filled until water rises and stands at least half way into the funnel. Remove excess bubbles from the sampler. Remove the funnel and reattach the plug. A small air bubble from the plug is of no concern.

The following steps should be used for deploying PDB samplers in wells:

1. Measure the well depth and compare the measured depth with the reported depth to the bottom of the well screen from well-construction records. This is to check on whether sediment has accumulated in the bottom of the well, whether there is a nonscreened section of pipe (sediment sump) below the well screen, and on the accuracy of well-construction records. If there is an uncertainty regarding length or placement of the well screen, then an independent method, such as video imaging of the well bore, is strongly suggested.

2. Attach a stainless-steel weight to the end of the line. Sufficient weight should be added to counterbalance the buoyancy of the PDB samplers. This is particularly important when multiple PDB samplers are deployed. One approach, discussed in the following paragraphs, is to have the weight resting on the bottom of the well, with the line taut above the weight. Alternatively, the PDB sampler and weight may be suspended above the bottom, but caution should be exercised to ensure that the sampler does not shift location. Such shifting can result from stretching or slipping of the line or, if multiple samplers are attached end-to-end rather than to a weighted line, stretching of the samplers.

3. Calculate the distance from the bottom of the well, or top of the sediment in the well, up to the point where the PDB sampler is to be placed. A variety of approaches can be used to attach the PDB sampler to the weight or weighted line at the target horizon. The field-fillable type of PDB sampler is equipped with a hanger assembly and weight that can be slid over the sampler body until it rests securely near the bottom of the sampler. When this approach is used with multiple PDB samplers down the same borehole, the weight should only be attached to the lowermost sampler. An additional option is to use coated stainless-steel wire as a weighted line, making loops at appropriate points to attach the upper and lower ends of PDB samplers. Where the PDB sampler position varies between sampling events, movable clamps with rings can be used. When using rope as a weighted line, a simple approach is to tie knots or attach clasps at the appropriate depths. Nylon cable ties or stainless-steel clips inserted through the knots can be used to attach the PDB samplers. An approach using rope as a weighted line with knots tied at the appropriate sampler-attachment points is discussed below.

(a) For 5-ft-long or shorter well screens, the center point of the PDB sampler should be the vertical midpoint of the saturated well-screen length. For example, if the well screen is at a depth of 55 to 60 ft below the top of casing, and the measured depth of the well is 59 ft, then the bottom of the well probably has filled with sediment. In this case, the midpoint of the sampler between the attachment points on the line will be midway between 55 and 59 ft, or at 57 ft. Thus, for a 1.5-ft-long sampler, the attachment points on a weighted line should be tied at distances of 1.25 ft (2 ft – 0.75 ft) and 2.75 ft (2 ft + 0.75 ft) from the top of the sediment in the well, or the bottom of the well, making adjustments for the length of the attached weight. When the PDB sampler is attached to the line and installed in the well, the center of the sampler will be at 57-ft depth. If, however, independent evidence is available showing that the highest concentration of contaminants enters the well from a specific zone within the screened interval, then the PDB sampler should be positioned at that interval.

(b) For 5- to 10-ft-long well screens, it is advisable to utilize multiple PDB samplers vertically along the length of the well screen for at least the initial sampling (fig. 2). The purposes of the multiple PDB samplers are to determine whether contaminant stratification is present and to locate the zone of highest concentration. The midpoint of each sampler should be positioned at the midpoint of the interval to be sampled. For 1.5-ft-long samplers, at each sampling depth in the screened interval, make two attachment points on the weighted line at a distance of about 1.5 ft apart. The attachment points should be positioned along the weighted line at a distance from the bottom end of the weight such that the midpoint between the knots will be at the desired sampling depth along the well screen. Sampler intervals are variable, but a simple approach is to use the top knot/loop of one sampler interval as the bottom knot/loop for the overlying sampler interval.



Figure 2. Example of multiple PDB samplers prepared for deployment.

(c) PDB samplers should not be used in wells having screened or open intervals longer than 10 ft unless used in conjunction with borehole flow meters or other techniques to characterize vertical variability in hydraulic conductivity and contaminant distribution or used strictly for qualitative reconnaissance purposes. This is because of the increased potential for cross contamination of water-bearing zones and hydraulically driven mixing effects that may cause the contaminant stratification in the well to differ from the contaminant stratification in the adjacent aquifer material. If it is necessary to sample such wells, then multiple PDB samplers should be installed vertically across the screened or open interval to determine the zone of highest concentration and whether contaminant stratification is present.

4. The samplers should be attached to the weights or weighted line at the time of deployment. For samplers utilizing the hanger and weight assembly, the line can be attached directly to the top of the sampler. PDB samplers utilizing an outer protective mesh can be attached to a weighted line by using the following procedure:

(a) Insert cable ties through the attachment points in the weighted line.

(b) At each end of the PDB sampler, weave the ends of the cable ties or clamp through the LPDE mesh surrounding the sampler and tighten the cable ties. Thus, each end of the PDB sampler will be attached to a knot/loop in the weighted line by means of a cable tie or clamp. The cable ties or clamps should be positioned through the polyethylene mesh in a way that prevents the PDB sampler from sliding out of the mesh.

(c) Trim the excess from the cable tie before placing the sampler down the well. Caution should be exercised to prevent sharp edges on the trimmed cable ties that may puncture the LDPE.

5. When using PDB samplers without the protective outer mesh, the holes punched at the ends of the bag, outside the sealed portion, can be used to attach the samplers to the weighted line. Stainless-steel spring clips have been found to be more reliable than cable ties in this instance, but cable ties also work well.

6. Lower the weight and weighted line down the well until the weight rests on the bottom of the well and the line above the weight is taut. The PDB samplers should now be positioned at the expected depth. A check on the depth can be done by placing a knot or mark on the line at the correct distance from the top knot/loop of the PDB sampler to the top of the well casing and checking to make sure that the mark aligns with the lip of the casing after deployment.

7. Secure the assembly in this position. A suggested method is to attach the weighted line to a hook on the inside of the well cap. Reattach the well cap. The well should be sealed in such a way as to prevent surface-water invasion. This is particularly important in flush-mounted well vaults that are prone to flooding.

8. Allow the system to remain undisturbed as the PDB samplers equilibrate.

PASSIVE DIFFUSION BAG SAMPLER AND SAMPLE RECOVERY

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene (*c*DCE), tetrachlorethene (PCE), trichloroethene (TCE), toluene, naphthalene, 1,2-dibromoethane (EDB), and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C (Vroblesky and Campbell, 2001). A subsequent laboratory study of mixed VOCs at 10 °C showed that PCE and TCE were equilibrated by about 52 hours, but other compounds required longer equilibration times (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). Chloroethane, *c*DCE, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

Under field conditions, the samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. The results of borehole dilution studies show that wells can recover to 90 percent of the predisturbance conditions within minutes to several hours for permeable to highly permeable geologic formations, but may require 100 to 1,000 hours (4 to 40 days) in muds, very fine-grained loamy sands, and fractured rock, and may take even longer in fractured shales, recent loams, clays, and slightly fractured solid igneous rocks (Halevy and others, 1967).

In general, where the rate of ground-water movement past a diffusion sampler is high, equilibration times through various membranes commonly range from a few hours to a few days (Mayer, 1976; Harrington and others, 2000). One field investigation showed adequate equilibration of PDB samplers to aquifer trichloroethene (TCE) and carbon tetrachloride (CT) concentrations within 2 days in a highly permeable aquifer (Vroblesky and others, 1999). In other investigations, PDB samplers recovered after 14 days were found to be adequately equilibrated to chlorinated VOCs (Obrien & Gere Engineers, Inc., 1997a, 1997b; Hare, 2000); therefore, the equilibration period was less than or equal to 14 days for those field conditions. Because it appears that 2 weeks of equilibration probably is adequate for many applications, a minimum equilibration time of 2 weeks is suggested. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating field data, a side-by-side comparison with conventional sampling methodology is advisable to justify the field equilibration time.

In less permeable formations, longer equilibration times may be required. It is probable that water in the well bore eventually will equilibrate with the pore-water chemistry; however, if the rate of chemical change or volatilization loss in the well bore exceeds the rate of exchange between the pore water and the well-bore water, then the PDB samplers may under-

estimate pore-water concentrations. Guidelines for equilibration times and applicability of PDB samplers in low-permeability formations have not yet been established. Therefore, in such situations, a side-by-side comparison of PDB samplers and conventional sampling methodology is advisable to ensure that the PDB samplers do not underestimate concentrations obtained by the conventional method. A detailed discussion of diffusion rates relevant to diffusion sampler equilibrium in slow-moving ground-water systems can be found in Harrington and others (2000).

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity (Paul Hare, General Electric Company, oral commun., 2000). The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds may be reduced, but not stopped, across a heavily biofouled polyethylene membrane (Ellis and others, 1995; Huckins and others, 1996; Huckins and others, in press). If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing contaminant concentrations from the PDB sampler to concentrations from a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery of PDB samplers is accomplished by using the following approach:

1. Remove the PDB samplers from the well by using the attached line. The PDB samplers should not be exposed to heat or agitated.

2. Examine the surface of the PDB sampler for evidence of algae, iron or other coatings, and for tears in the membrane. Note the observations in a sampling field book. If there are tears in the membrane, the sample should be rejected. If there is evidence that the PDB sampler exhibits a coating, then this should be noted in the validated concentration data.

3. Detach and remove the PDB sampler from the weighted line. Remove the excess liquid from the exterior of the bag to minimize the potential for cross contamination.

4. A variety of approaches may be used to transfer the water from the PDB samplers to 40-mL volatile organic analysis (VOA) vials. One type of commercially available PDB sampler provides a discharge device that can be inserted into the sampler. If discharge devices are used, the diameter of the opening should be kept to less than about 0.15 inches to reduce volatilization loss. Two options are presently available to recover water from the sample using discharge devices. One option involves removing the hanger and weight assembly from the sampler, inverting the sampler so that the fill plug is pointed upward, and removing the plug. The water can be recovered by directly pouring in a manner that minimizes agitation or by pouring through a VOC-discharge accessory inserted in place of the plug. The second approach involves piercing the sampler near the bottom with a small-diameter discharge tube and allowing water to flow through the tube into the VOA vials. In each case, flow rates can be controlled by tilting or manipulating the sampler. Alternatively, the PDB sampler can be cut open at one end using scissors or other cutting devices which have been decontaminated between use for different wells. Water can then be transferred to 40-ml VOA vials by gently pouring in a manner that minimizes water agitation. Acceptable duplication has been obtained using each method. Preserve the samples according to the analytical method. The sampling vials should be stored at approximately 4 °C in accordance with standard sampling protocol. Laboratory testing suggests that there is no substantial change in the VOC concentrations in PDB samplers over the first several minutes after recovery; however, the water should be transferred from the water-filled samplers to the sample bottles immediately upon recovery.

5. A cost-effective alternative when using multiple PDB samplers in a single well is to field screen water from each sampler using gas chromatography. These results can be used to decide which of the multiple PDB samplers should be sent to an EPA-approved laboratory for standard analysis. Typically, at least the sample containing the highest concentration should be analyzed by a laboratory.

6. If a comparison is being made between concentrations obtained using PDB samplers and concentrations obtained using a conventional sampling approach, then the well should be sampled by the conventional approach soon after (preferably on the same day) recovery of the PDB sampler. The water samples obtained using PDB samplers should be sent in the same shipment, as the samples collected by the conventional approach for the respective wells. Utilizing the same laboratory may reduce analytical variability.

7. Any unused water from the PDB sampler and water used to decontaminate cutting devices should be disposed in accordance with local, state, and Federal regulations.

DETERMINING APPLICABILITY OF PASSIVE DIFFUSION BAG SAMPLERS AND INTERPRETATION OF DATA

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method during the same sampling event. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if both PDB and conventional sampling produce concentrations that agree within a range deemed acceptable by local, state, and Federal regulatory agencies and meet the site-specific data-quality objectives, then a PDB sampler may be approved for use in that well to monitor ambient VOC concentrations. If concentrations from the PDB sampler are higher than concentrations from the conventional method, it is probable that concentrations from the PDB sampler adequately represent ambient conditions because there usually is a greater potential for dilution from mixing during sampling using conventional methods than during sampling using PDB samplers.

If, however, the conventional method produces concentrations that are significantly higher than those obtained using the PDB sampler, then it is uncertain whether the PDB-sampler concentrations represent local ambient conditions. In this case, further testing can be done to determine whether contaminant stratification and/or intra-borehole flow is present. Multiple sampling devices can be used to determine the presence of contaminant stratification, and borehole flowmeters can be used to determine whether intra-borehole flow is present. When using flowmeters to measure vertical flow in screened boreholes, however, the data should be considered qualitative because of the potential for water movement through the sand pack. Borehole dilution tests (Halevy and others, 1967; Drost and others, 1968; Grisak and others, 1977; Palmer, 1993) can be used to determine whether water is freely exchanged between the aquifer and the well screen.

Once the source of the difference between the two methods is determined, a decision can be made regarding the well-specific utility of the PDB samplers. Tests may show that VOC concentrations from the PDB samplers adequately represent local ambient conditions within the screened interval despite the higher VOC concentration obtained from the conventional method. This may be because the pumped samples incorporated water containing higher concentrations either from other water-bearing zones induced along inadequate well seals or through fractured clay (Vroblesky and others, 2000), from other water-bearing zones not directly adjacent to the well screen as a result of well purging prior to sampling (Vroblesky and Petkewich; 2000), or from mixing of chemically stratified zones in the vicinity of the screened interval (Vroblesky and Peters, 2000).

The mixing of waters from chemically stratified zones adjacent to the screened interval during pumping probably is one of the more important sources of apparent differences between the results obtained from PDB sampling and conventional sampling because such stratification probably is common. Vertical stratification of VOCs over distances of a few feet has been observed in aquifer sediments by using multilevel sampling devices (Dean and others, 1999; Pitkin and others, 1999), and considerable variation in hydraulic conductivity and water chemistry has been observed in an aquifer in Cape Cod, Massachusetts, on the scale of centimeters (Wolf and others, 1991; Smith and others 1991; Hess and others, 1992). Multiple PDB samplers have been used to show a change in TCE concentration of 1,130 (µg/L over a 6-ft vertical screened interval in Minnesota (Vroblesky and Petkewich, 2000). Tests using PDB samplers in screened intervals containing VOC stratification showed that the PDB-sampler data appeared to be point-specific, whereas the pumped sample integrated water over a larger interval (Vroblesky and Peters, 2000).

The decision on whether to use PDB samplers in such situations depends on the data-quality objectives for the particular site. If the goal is to determine and monitor higher concentrations or to examine contaminant stratification within the screened interval, then the PDB samplers may meet this objective. If the goal is to determine the average concentrations for the entire screened interval, then a pumped sample or an average from multiple diffusion samplers may be appropriate.

As an aid in the decision-making process, the following section examines the influences that hydraulic and chemical heterogeneity of an aquifer can have on sample quality in long-screened wells. Because VOC concentrations from PDB samplers commonly are compared to VOC concentrations from other sampling methodologies, the second section examines the differences in sample quality between these methodologies in situations of hydraulic and chemical heterogeneity.

Influences of Hydraulic and Chemical Heterogeneity on Sample Quality in Long-Screened Wells

Sampling biases and chemical variability in long-screened wells, which can be loosely defined as wells having significant physical and chemical heterogeneity within the screened interval and in the adjacent aquifer (Reilly and Leblanc, 1998), have been the subject of numerous investigations. Sources of chemical variability in such wells include non-uniform flow into wells (Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Chiang and others, 1995; Church and Granato, 1996; Reilly and LeBlanc, 1998), lithologic heterogeneity (Reilly and others, 1989; Robbins, 1989; Martin-Hayden and others, 1991; Gibs and others, 1993; Reilly and Gibs, 1993), and in-well mixing. In a well open across a chemically or hydraulically heterogeneous section of the aquifer, differences in the sampling methodology can produce significant differences in the sampling results.

Long-screened wells have the potential to redistribute chemical constituents in the aquifer where there are vertical hydraulic gradients within the screened interval. Water can move into the well from one horizon and exit the well at a different horizon (Church and Granato, 1996; Reilly and LeBlanc 1998). If there is vertical flow in the screened or open interval, and the zone of low hydraulic head (outflow from the well) is within the contaminated horizon, then the PDB samplers (or any standard sampling methodology) can underestimate or not detect the contamination. The reason is that, in this case, the contaminated horizon does not contribute water to the well under static conditions. Instead, water from other horizons with higher hydraulic head will invade the contaminated horizon by way of the well screen. Under pumped conditions, the majority of the extracted water will be from the most permeable interval, which may not be the contaminated zone. Even when pumping induces inflow from the contaminated interval, much of that inflow will be a reflection of the residual invaded water from other horizons. In this situation, a substantial amount of purging would be required before water representative of the aquifer could be obtained (Jones and Lerner, 1995). Such sampling is not likely to reflect a significant contribution from the contaminated zone, and concentrations in the contaminated zone probably will be underestimated.

Similarly, if VOC-contaminated water is flowing into the well and is exiting the well at a different horizon, then VOCs will be present along the screened interval between the two horizons. In this case, VOC concentrations in the screened interval may be representative of aquifer concentrations at the inflow horizon, but may not be representative of aquifer concentrations near the outflow horizon.

In areas where vertical stratification of VOC concentrations is anticipated, using multiple PDB samplers may more fully characterize the contaminated horizon than using a single PDB sampler. This is particularly true in wells having screens 10 ft or longer; however, significant VOC stratification has been observed over intervals of less than 5 ft (Vroblesky and Peters, 2000). Because of the increased probability of vertical concentration or hydraulic gradients within the open interval of long-screened (greater than 10 ft) wells, it is advisable to determine the zones of inflow and outflow within the screened or open interval of these wells using borehole flowmeter analysis (Hess, 1982; 1984; 1986; 1990; Young and others, 1998).

Comparison of Passive Diffusion Bag Sampling Methodology to Conventional Methodologies

Traditional sampling methodologies, such as the purge-and-sample (or conventional purging method), low-flow or low-volume sampling, and using straddle packers and multilevel samplers, produce VOC

concentrations that may differ from VOC concentrations obtained from PDB samplers because the methodologies sometimes are influenced in different ways by aquifer hydraulic and chemical heterogeneity. This section examines potential sources of concentration differences between traditional methodologies and the PDB methodology.

The purge-and-sample approach to ground-water monitoring differs from the diffusion-sampler approach primarily because the area of the screened or open interval that contributes water to the purged sample typically is greater than for the PDB sampler, and the potential for mixing of stratified layers is higher. When pumping three or more casing volumes of water prior to collecting a sample, chemical concentrations in the discharging water typically change as the well is pumped (Keely and Boateng, 1987; Cohen and Rabold, 1988; Martin-Hayden and others, 1991; Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Barcelona and others, 1994; Martin-Hayden, 2000), due to mixing during pumping and other factors, such as the removal of stagnant water in the casing and changing patterns of inflow and outflow under ambient and pumping conditions (Church and Granato, 1996). The induction of lateral chemical heterogeneity during pumping also may produce variations in the sampled concentrations. The amount of mixing during purging can be highly variable (Barber and Davis, 1987; Church and Granato, 1996; Reilly and LeBlanc, 1998; Martin-Hayden, 2000), and may result in concentrations that are not locally representative (Reilly and Gibs, 1993). Substantial vertical hydraulic gradients, even in shallow homogeneous aquifers, have been observed to bias sampling using conventional purging because the majority of the pumped water may come from a particular horizon not related to the contaminated zone and because the intra-well flow that intruded the aquifer may not be adequately removed during purging (Hutchins and Acree, 2000). Thus, differences may be observed between concentrations obtained from a pumped sample and from a PDB sample in a chemically stratified interval if the pumped sample represents an integration of water collected from multiple horizons and the PDB sampler represents water collected from a single horizon.

Low-flow purging and sampling (Barcelona and others, 1994; Shanklin and others, 1995) disturbs the local ground water less than conventional purge-and-sample methods. Thus, samples obtained by PDB samplers are likely to be more similar to samples obtained by using low-flow purging than to those obtained by using conventional purge-and-sample methods. Even under low-flow conditions, however, purging still can integrate water within the radius of pumping influence, potentially resulting in a deviation from VOC concentrations obtained by PDB sampling. One investigation found that in low hydraulic conductivity formations, low-flow sampling methodology caused excessive drawdown, which dewatered the screened interval, increased local ground-water velocities, and caused unwanted colloid and soil transport into the ground-water samples (Sevee and others, 2000). The authors suggest that in such cases, a more appropriate sampling methodology may be to collect a slug or passive sample from the well screen under the assumption that the water in the well screen is in equilibrium with the surrounding aquifer.

Isolating a particular contributing fracture zone with straddle packers in an uncased borehole allows depth-discrete samples to be collected from the target horizon (Hsieh and others, 1993; Kaminsky and Wylie, 1995). Strategically placed straddle packers often can minimize or eliminate the impact of vertical gradients in the sampled interval. However, even within a packed interval isolating inflowing fracture zones, deviations between VOC concentrations in water from PDB samplers and water sampled by conventional methods still may occur if the conventional method mixes chemically stratified water outside the borehole or if the packed interval straddles chemically heterogeneous zones.

The use of multilevel PDB samplers and other types of multilevel samplers (Ronen and others, 1987; Kaplan and others, 1991; Schirmer and others, 1995; Gefell and others, 1999; Jones and others, 1999) potentially can delineate some of the chemical stratification. Diffusion sampling and other sampling methodologies, however, can be influenced by vertical hydraulic gradients within the well screen or the sand pack. When vertical hydraulic gradients are present within the well, water contacting the PDB sampler may not be from a horizon adjacent to the PDB sampler. Rather, the water may represent a mixing of water from other contributing intervals within the borehole. In a screened well, even multilevel samplers with baffles to limit vertical flow in the well cannot prevent influences from

vertical flow in the gravel pack outside the well screen. Such vertical flow can result from small vertical differences in head with depth. A field test conducted by Church and Granato (1996) found that vertical head differences ranging from undetectable to 0.49 ft were sufficient to cause substantial flows (as much as 0.5 liters/minute) in the well bore.

QUALITY CONTROL AND ASSURANCE

The sources of variability and bias introduced during sample collection can affect the interpretation of the results. To reduce data variability caused during sampling, a series of quality-control samples should be utilized.

Replicate samples are important for the quality control of diffusion-sampler data. Sample replicates provide information needed to estimate the precision of concentration values determined from the combined sample-processing and analytical method and to evaluate the consistency of quantifying target VOCs. A replicate sample for water-filled diffusion samplers consists of two separate sets of VOC vials filled from the same diffusion sampler. Each set of VOC vials should be analyzed for comparison. Approximately 10 percent of the samplers should be replicated.

The length of the PDB sampler can be adjusted to accommodate the data-quality objectives for the sampling event. The length can be increased if additional volume is required for collection of replicate and matrix spike/matrix spike duplicate samples.

Trip blanks are used to determine whether external VOCs are contaminating the sample due to bottle handling and/or analytical processes not associated with field processing. Trip blanks are water-filled VOA vials prepared offsite, stored and transported with the other bottles used for collecting the environmental sample, and then submitted for analysis with the environmental sample. Consideration also should be given to the collection of a predeployment PDB trip blank to determine if the PDB samplers are exposed to extraneous VOCs prior to deployment. The predeployment trip blank should be a PDB sampler that is stored and transported with the field PDB samplers from the time of sampler construction to the time of deployment in the wells. An aliquot of the predeployment blank water should be collected from the PDB sampler in a VOA vial and submitted for analysis at the time of sampler deployment.

Water used to construct the diffusion samplers should be analyzed to determine the presence of background VOCs. Although many VOCs accidentally introduced into the diffusion-sampler water probably will reequilibrate with surrounding water once the diffusion samplers are deployed, some VOCs may become trapped within the diffusion-sampler water. For example, acetone, which is a common laboratory contaminant, does not easily move through the polyethylene diffusion samplers (Paul Hare, General Electric Company, oral commun., 1999). Thus, acetone inadvertently introduced into the diffusion-sample water during sampler construction may persist in the samplers, resulting in a false positive for acetone after sampler recovery and analysis.

SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining a variety of VOCs in ground water at monitoring wells. The suggested application for PDB samplers is for long-term monitoring of VOCs in ground-water wells at well-characterized sites. Where the screened interval is greater than 10 ft, the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is suggested that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. A typical PDB sampler consists of a 1- to 2-ft-long low-density polyethylene lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon by attachment to a weighted line or fixed pipe.

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. Concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an

aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C. A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications. Therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When deploying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery after initial equilibration. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers were left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. In some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing sampler results to a conventional sampling method concentrations before continuing to use PDB samplers for long-term deployment in that well.

PDB methodology is suitable for a broad variety of VOCs, including chlorinated aliphatic compounds and petroleum hydrocarbons. The samplers, however, are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. The samplers should not be used to sample for phthalates because of the potential for the LDPE to contribute phthalates to the water sample.

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if the two approaches produce concentrations that agree within a range deemed acceptable by the local, state, and Federal regulatory agencies, then use of a PDB sampler in that well will provide VOC concentrations consistent with the historical record. If concentrations from the PDB sampler are higher than concentrations from the conventional method, then it is probable that the concentrations from the PDB sampler are an adequate representation of ambient conditions. If, however, the conventional method produces concentrations that are substantially higher than the concentrations found by using the PDB sampler, then the PDB sampler may or may not adequately represent local ambient conditions. In this case, the difference may be due to a variety of factors, including mixing or translocation due to hydraulic and chemical heterogeneity of the aquifer within the screened or open interval of the well and the relative permeability of the well screen.

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USER MANUAL
ITEM# 626973-01REF
REVISION H



ProDIGITAL User Manual

PROFESSIONAL SERIES DIGITAL HANDHELD METERS

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Effort has been made to make the information in this manual complete, accurate, and current.

The manufacturer shall not be held responsible for errors or omissions in this manual.

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Thank you for purchasing a YSI Professional Series Digital handheld meter. This manual covers setup, operation, and functionality of the ProDIGITAL handhelds which include the ProDSS, ProSwap and ProSolo.

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- Waterproof (IP-67) case
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Safety Information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all precautionary statements. Failure to do so could result in serious injury to the operator or damage to the equipment. Do not use or install this equipment in any manner other than that specified in this manual.

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Precautionary Symbols

NOTE: *Information that requires special emphasis*

NOTICE: Indicates a situation which, if not avoided, may cause damage to the instrument

⚠ **CAUTION:** Indicates a potentially hazardous situation that may result in minor or moderate injury

⚠ **WARNING:** Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury

Product Components

Carefully unpack the instrument and accessories and inspect for damage. If any parts or materials are damaged, contact YSI Customer Service at 800-897-4151 (+1 937 767-7241) or the authorized YSI distributor from whom the instrument was purchased.

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When viewing this document as an Adobe™ PDF, hovering your cursor over certain phrases will bring up the finger-point icon. Clicking elements of the Table of Contents, website URLs, or references to certain sections will take you automatically to those locations.

1. Introduction

1.1 Battery Use and Battery Life

ProSeries Digital handhelds use a rechargeable lithium-ion (Li-Ion) battery pack as a power source. The battery comes pre-installed in the handheld and ships at less than 50% full capacity. Battery life depends on use, enabled parameters, LCD brightness, and GPS use.

A new battery, that has been fully charged, is expected to last for the following durations at 25°C, with Sampling set to Auto, Backlight set to Auto, and GPS enabled:

- ProDIGITAL handheld only - 48 hours
- ProDSS with fully loaded 4-port cable assembly and 25% LCD brightness - 20 hours

To increase battery life, enable manual sampling mode (Sampling). Manual sampling mode powers the sensor(s) on to take a measurement and then powers down to conserve battery life.

As with all lithium-ion batteires, battery life will decline over time and use. This decay should be expected. For the long-term health of the battery, a larger discharge is better than a small dishcarge between recharges.

1.2 Charging the Battery Pack

A USB cable is included with the handheld to charge the instrument battery pack and connect the instrument to a PC. The battery pack can be charged from the AC power adapter, directly from a computer USB connection or from an external, portable USB battery pack (sold separately, see Accessories).

Plug the USB connector into the AC power adapter, computer USB connector or external USB battery pack, then plug the micro USB connector into the handheld (Figure 1).

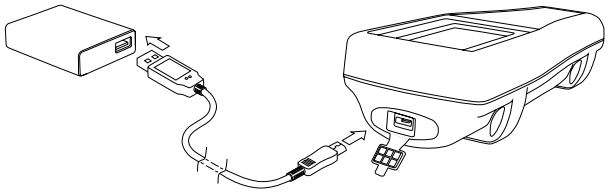


Figure 1 Connecting the handheld to AC power supply

⚠ **WARNING:** Charge the battery pack in an open area away from flammable materials, liquids, and surfaces. Do not charge or handle a battery pack that is hot to the touch. Failure to follow the safety warnings and precautions can result in personal injury and/or instrument damage not covered under warranty. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions.

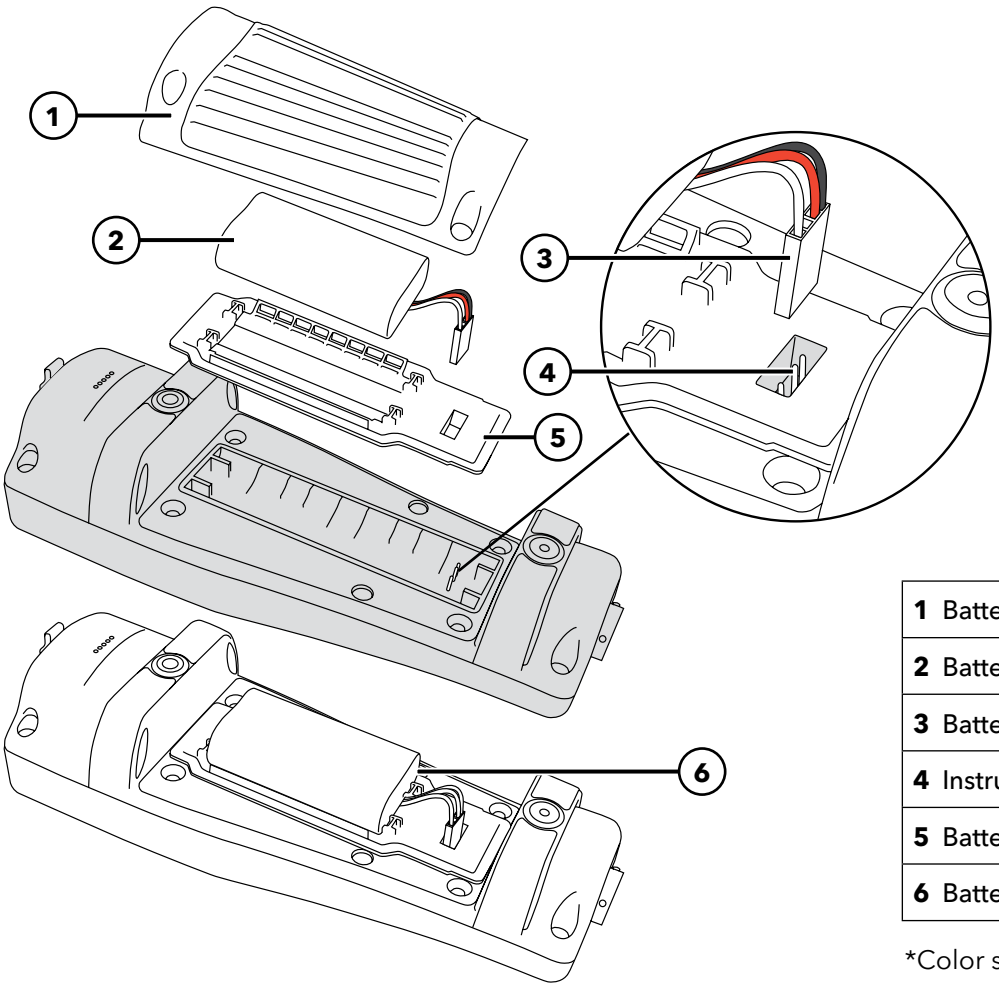
For the handheld to recognize that it is using AC power, you must start charging the handheld while it is turned on. After the instrument recognizes it is being charged, it can be turned off to finish charging.

AC Charging	DC Charging
9 hr	14 hr

1.3 Battery Replacement

1. Remove the battery pack cover by unscrewing (counter-clockwise) the four screws with a flat or Phillips head screwdriver (Figure 2). The retaining screws are captured into the battery pack cover and are not removable.
2. If replacing an existing battery pack, remove the Li-Ion battery pack and rubber battery pack cradle. With two fingers, grasp the battery pack connector and pull the connector straight up to disconnect and remove. Properly dispose of the old battery pack (See Battery Disposal).
3. Inspect the replacement battery pack and battery pack cradle for damage. Contact YSI technical support if there is any damage.
4. Correctly align and seat the battery pack cradle and battery pack into the instrument.
5. Align the battery pack connector wire terminals with the three instrument pins, then connect the battery pack to the instrument. Make sure that the three wire terminal connectors and three instrument pins are correctly aligned before connecting the battery pack connector. Incorrect installation can damage the battery pack connectors or instrument pins.
6. Install the battery pack cover, then hand tighten the cover screws with a screwdriver. DO NOT use any power tools. Make sure that the cover sealing surface is correctly aligned and free of any contamination or damage.

NOTICE: The battery cover does NOT need to make a compressed seal. Overtightening the cover screws can damage the battery cover and the handheld.



1	Battery pack cover
2	Battery pack
3	Battery pack connector*
4	Instrument pin connectors
5	Battery pack cradle
6	Battery pack cradle installed

*Color shown for reference

Figure 2 Battery replacement

1.4 Connect the Handheld to the Cable Assembly

The cable connectors are keyed for positive mating and to prevent connector damage (Figure 3). The handheld retains its IP-67 waterproof rating when the cable is disconnected. However, the connectors are not wet-mateable and should be clean and dry before connecting.

Align the keys on the cable connector with the slots on the handheld connector. Push together firmly, then twist the outer ring clockwise until it locks into place.

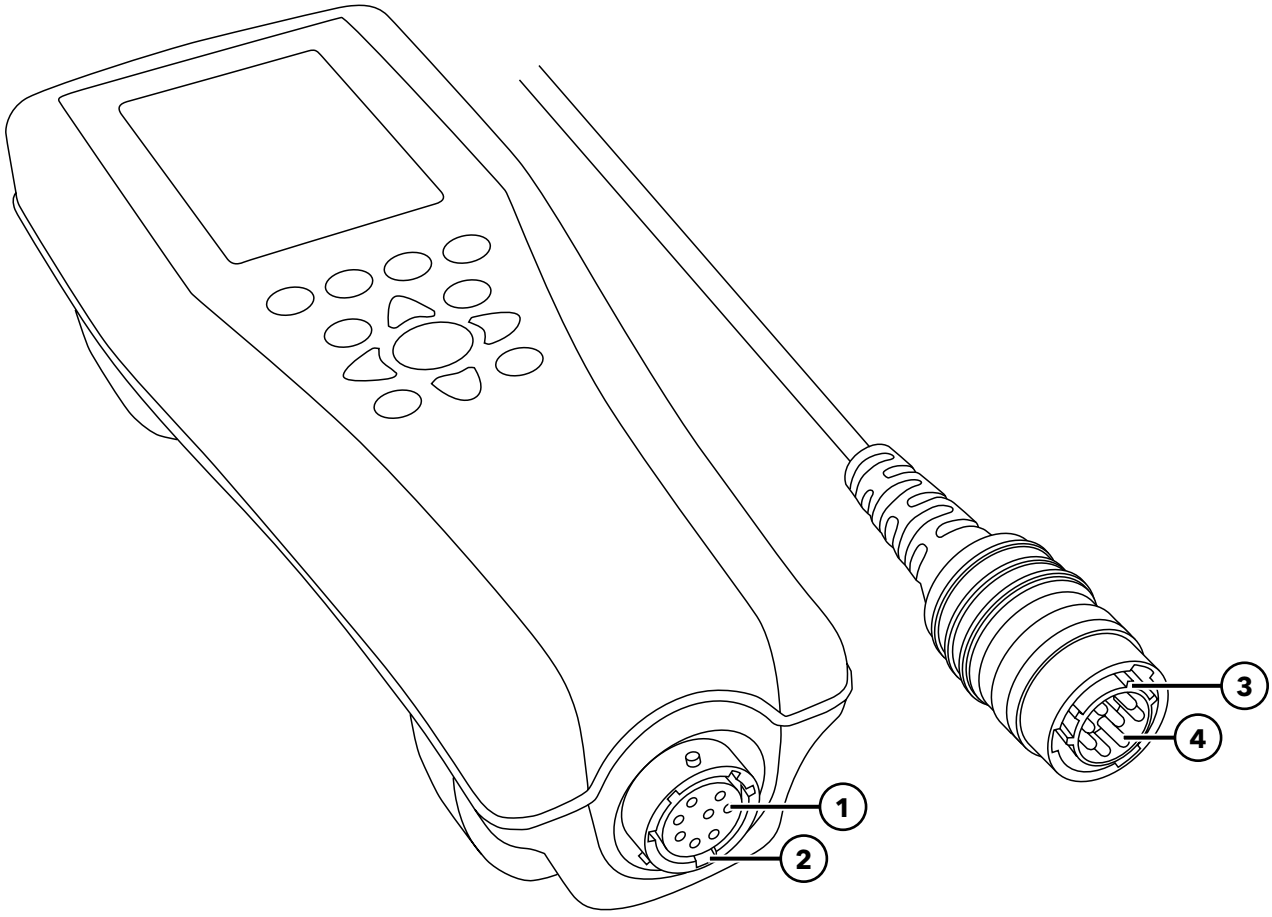


Figure 3 Keyed connectors

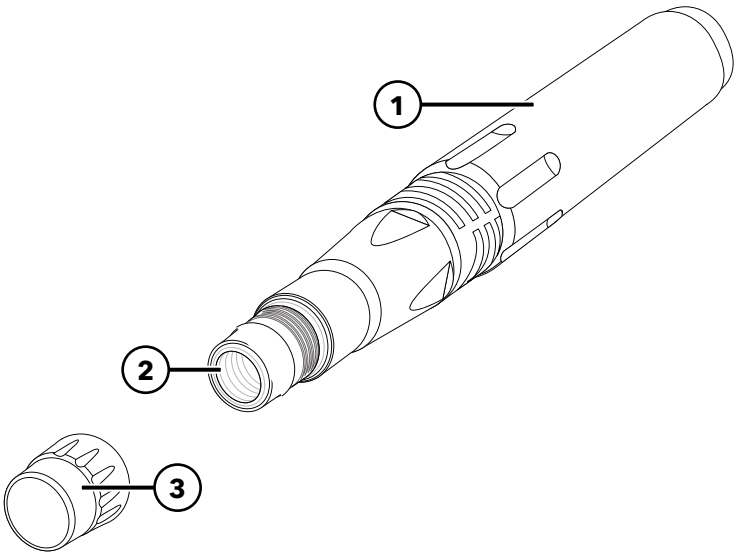
1 Handheld female connector	**3** Keyed area of connector
2 Slotted area of connector	**4** Cable male connector

1.5 Cable Assemblies with Integrated Sensors

Probe assemblies like the **ODO/CT**, **ODO/T**, and **ProOBOD** feature integral sensors — this means that these sensors cannot be removed from the probe and cable. Sensor caps on the ODO/CT and ODO/T are user-replaceable and need to be changed out about once per year.

NOTE: *Each ODO cable assembly and sensor cap includes an instruction sheet with important information unique and specific to each individual sensing cap. These are important because they include calibration coefficients needed for proper setup.*

NOTE: *A new cable/probe assembly already has a sensor cap installed and the sensor cap coefficients are preloaded into the probe at the factory.*



1	Probe
2	Sensor
3	Sensor Cap

Figure 4 ODO probe and cable assembly

Preparing the Probe and Sensor

1. Remove the metal probe guard from the probe by turning it counterclockwise.
2. Remove the red storage cap which, contains a moist sponge, from the end of the probe by pulling it straight off the sensor. Save this to use later for long-term storage.
3. Reinstall the probe guard by sliding it carefully over the sensor and then threading it onto the cable assembly with a clockwise rotation.

⚠ **CAUTION:** It is important to always store your sensor in a moist environment so the sensor cap does not dry out. A grey calibration/storage sleeve is shipped with your cable assembly for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

1.6 Cable Assemblies with 1 or 4 Ports

ProSwap 1-port cables support user-replaceable sensors. The single port is universal and will allow any ProDSS smart sensor to be connected. These cables include a built-in thermistor which eliminates the need to always connect a conductivity/temperature sensor.

ProDSS 4-port cables feature user-replaceable sensors. The ports on the bulkhead are universal, meaning that you can install any sensor into any port. A conductivity/temperature sensor must be installed for accurate measurement of all parameters except turbidity and TSS.

Bulkhead ports are numbered (Figure 5), so if multiple sensors of the same type are installed, the port number will be added to the Run screen display to clarify the measurement value of each sensor.

NOTICE: The bulkhead ports and sensor connectors are not wet-mateable. Make sure that the sensor connectors and bulkhead ports are clean and dry before sensor installation.

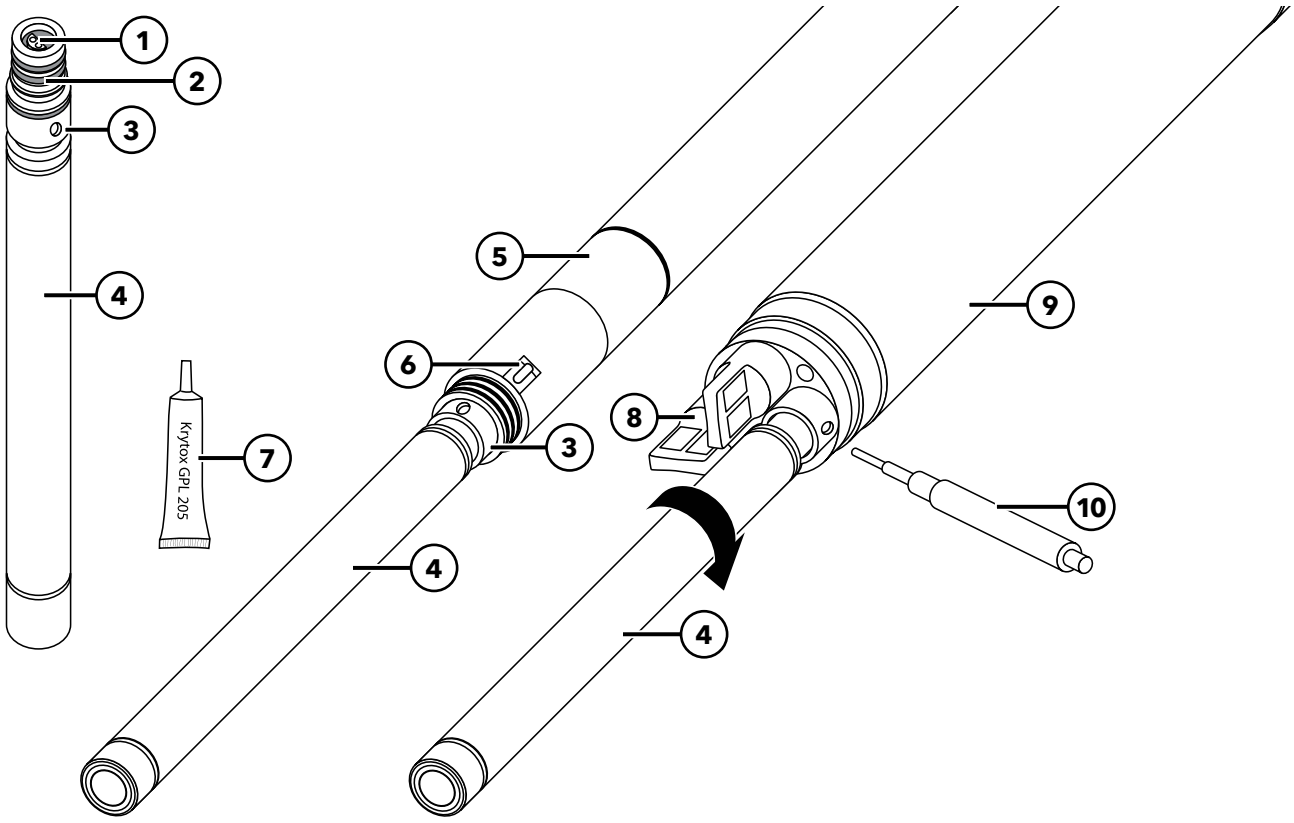


Figure 5 Sensor installation (1- and 4-port cables)

1 Sensor port	**6** Thermistor
2 O-ring	**7** O-ring lubricant
3 Sensor retaining nut	**8** Port plug
4 Sensor	**9** 4-port bulkhead
5 1-port bulkhead	**10** Sensor installation/removal tool

Sensor Installation

1. Remove the port cover shipped with the cable. This cover can be kept to protect the bulkhead ports from contamination during long-term storage.
2. Inspect each bulkhead port for contamination. If the port is dirty or wet, clean it with compressed air.
3. Apply a thin coat of o-ring lubricant to the sensor o-rings. Wipe off excess o-ring grease with a lint-free cloth.
4. Carefully align the sensor and bulkhead connectors by inserting the sensor into the port then gently rotating the sensor until the connectors align. Once aligned, push the sensor toward the bulkhead until the sensor seats in the port.
5. Carefully finger-tighten the retaining nut clockwise. If any resistance is felt, loosen the retaining nut completely to prevent cross-threading.
6. Use the sensor installation/removal tool to tighten the retaining nut clockwise until snug, about a ¼ to ½ additional turn of the retaining nut. Be careful not to over-tighten the retaining nut.

NOTICE: Incorrect installation or over-tightening can cause damage to the sensor or bulkhead that is not covered by the warranty.

Sensor Removal

To remove a sensor, insert the sensor installation/removal tool into the retaining nut, then rotate the retaining nut counterclockwise to loosen. After the retaining nut has been completely unscrewed from the bulkhead, pull the sensor straight out of the port and place it on a clean surface. Install a port plug if not reinstalling a sensor in the exposed port. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

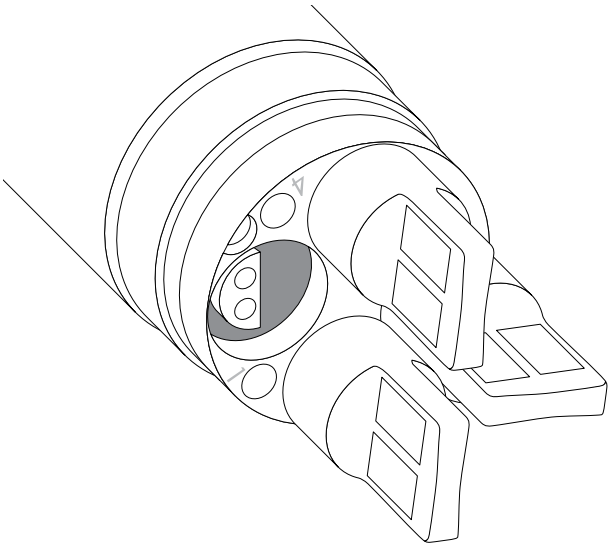


Figure 6 Sensor port plugs and port numbering (4-port cables)

Port plugs

Port plugs and a tube of o-ring lubricant are included in the maintenance kit that ships with all 1-port and 4-port cables.

Installation

1. Apply a thin coat of o-ring lubricant to the o-rings on the plug port.
2. Remove any excess lubricant from the o-rings and port plug with a lint-free cloth.
3. Insert the port plug into the empty port and press until firmly seated.
4. Finger-tighten the port plug clockwise to install. If necessary, use the sensor installation tool to make sure that the plug is fully seated into the port. The o-rings will not be visible if a port plug is correctly installed. Do not over-tighten the port plug.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

Sensor Guard and Weight Installation

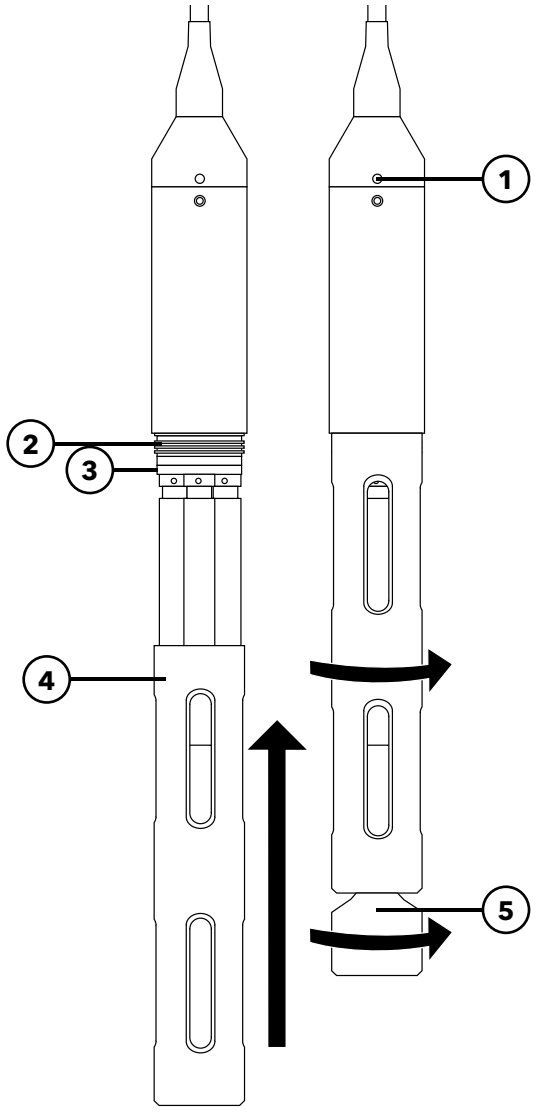


Figure 7 Sensor guard and weight installation on a 4-port cable assembly

1. Carefully slide the sensor guard over the bulkhead and attached sensors/port plugs. Push the sensor guard toward the bulkhead until the sensor guard threads align with the bulkhead threads.
2. Carefully hand-tighten the sensor guard clockwise. If any resistance is felt, loosen the sensor guard completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard or bulkhead that is not covered by the warranty.

1	Depth sensor (if equipped)
2	Bulkhead threads
3	Bulkhead
4	Sensor guard
5	Weight

Sensor Guard Weights

To help stabilize the sensors when profiling at deeper depths, a sensor guard weight is supplied with 1-port and 4-port assemblies 10 meters and longer. To attach the weight, carefully hand-tighten it clockwise on to the bottom of the sensor guard (Figure 7). If any resistance is felt, loosen the sensor guard weight completely to prevent cross-threading.

The bottom of the weight is threaded so that additional weights can be added if needed. YSI recommends installing no more than 5 lbs of weight on ProDIGITAL cables. See Accessories.

NOTE: *Do not have any weights installed on the sensor guard when calibrating using the calibration cup.*

2. Operation

2.1 Keypad and Navigation

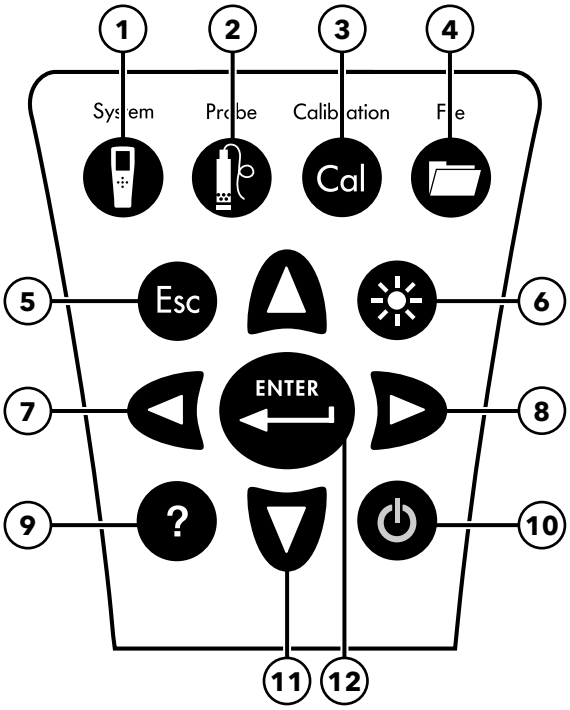


Figure 8 Keypad description

1	**System:** Opens the system menu. Use to adjust system settings.	**7**	**Left arrow key:** Navigate left in an alpha/numeric entry screen. Push to return to previous menu in all screens except alpha/numeric entry. On the Run screen, push to show graphical representations of the displayed measurements.
2	**Probe:** Opens the sensor menu. Use to setup sensors, change the units shown, select the sensor averaging mode, and turn on/off Auto Stable and GPS.	**8**	**Right arrow key:** Navigate right in an alpha/numeric entry screen. On the Run screen, push to show graphical representations of the displayed measurements. In the View Data screen, push to view additional parameters in the data set.
3	**Calibrate:** Opens the calibration menu. Use to calibrate sensors or restore default calibration.	**9**	**Help:** Shows context sensitive help.
4	**File:** Opens the file menu. Use to view logged data and calibration files, backup data to a USB stick, and delete data.	**10**	**ON/OFF:** Turn on or turn off the instrument.
5	**Exit/Escape key:** Exits to the Run screen. When in an alpha/numeric entry screen, returns to previous menu.	**11**	**Up/Down arrow keys:** Scroll through menus or enter numbers and letters.
6	**Backlight:** Turns the keypad backlight on or off for use in low light conditions.	**12**	**Enter key:** Push to confirm selections. On the Run screen, push to log a single data point or start continuous data logging.

2.2 Startup

Push the On/Off (⏻) key to turn on the handheld. If the handheld does not turn on, make sure that the battery is charged. Push and hold the ⏻ key for 1.5 seconds to turn the handheld off.

2.3 Navigation

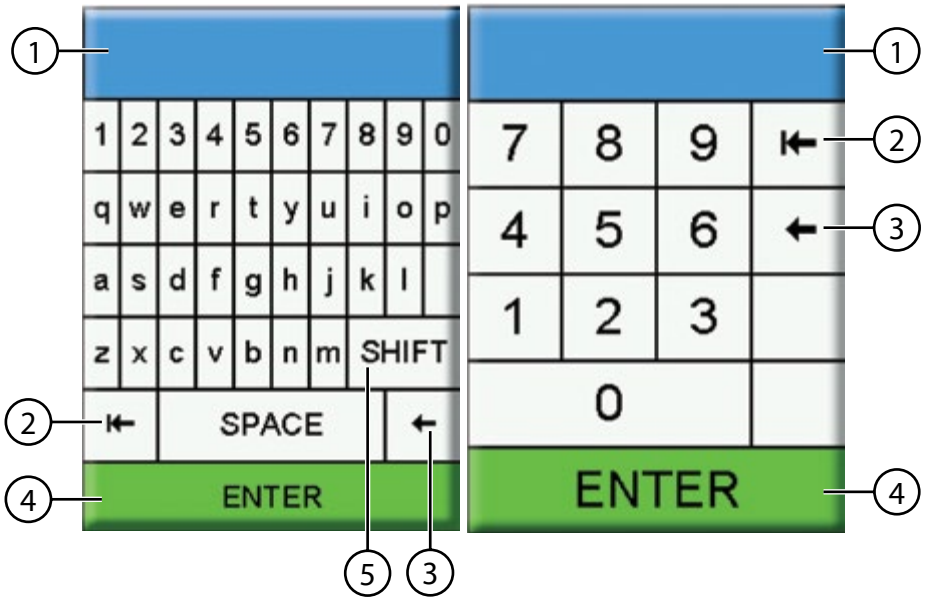
The handheld contains menus to change user-defined options, functions, and parameters. Use the arrow keys (▲ and ▼) to highlight different options within menus and sub-menus, then push the Enter (ENTER) key to select the option. Push the left arrow (◀) key to return to the previous menu.

Push the Exit/Escape (Esc) key to return to the Run screen. To enable or disable an option, highlight the option, then push the ENTER key. Enabled functions appear as a circle with a dot (◉) or a box with a check mark (☑). Disabled functions appear as a circle only (○) or an empty box (☐).

Alpha/Numeric Entry

When required, an alpha/numeric entry screen will be shown. Use the arrow keys to highlight a specific character and push the ENTER key to select it for entry. When finished entering information, highlight **ENTER**, then push the ENTER key to save the entry (Figure 9).

NOTE: *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the Esc key to cancel and return to the previous menu.*



1	User entry field
2	Delete entire entry
3	Backspace
4	Enter (highlighted selection)
5	Upper/lowercase

Figure 9 Alpha/numeric and numeric entry screens

2.4 Main Display Description

The main display (Run screen) shows the current measurements and units as defined in the Sensor Display menu. If more measurements are selected than can be displayed on the Run screen, a scroll bar will be shown. Use the ▲ and ▼ arrow keys to view the additional measurements (Figure 10).

The message area shows status messages, error messages, and information about selected functions.

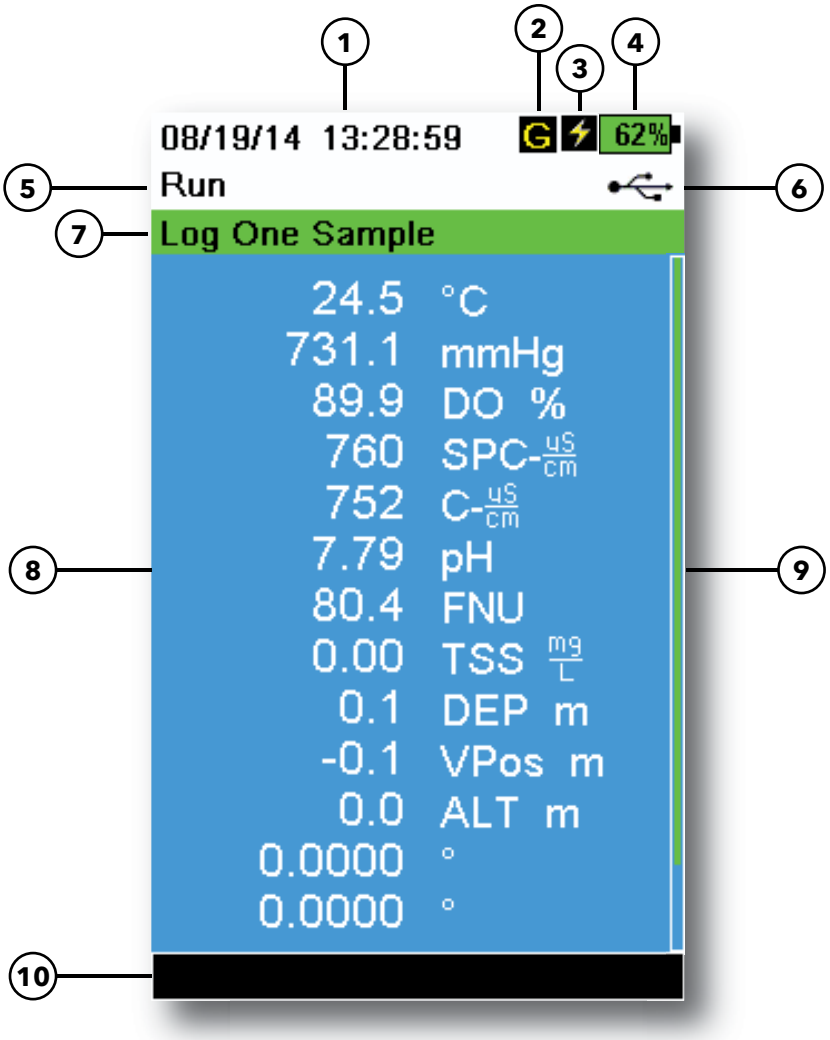


Figure 10 Main display example

1	Date/Time	**6**	USB/PC connection indicator
2	GPS signal indicator	**7**	Log or sampling (update measurements) prompt on Run screen (single or continuous)
3	Battery charging indicator	**8**	Displayed measurements
4	Battery charge %	**9**	Scroll bar
5	Current screen/menu	**10**	Message area

2.5 System Menu

Push the System ( ) key to view and adjust instrument settings. Highlight a sub-menu then push the ENTER key to view the sub-menu options (Figure 11).

Pre-defined or user-selected options are noted within brackets (**[ ]**).

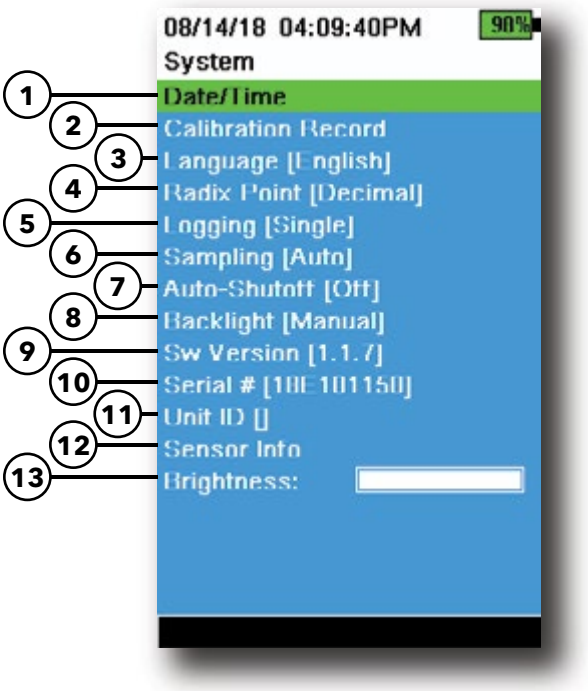


Figure 11 System menu

1	Set the Date and Time
2	Change the user-defined Calibration Options
3	Change the instrument Language settings
4	Change the Radix Point
5	Change the Logging options
6	Change the Sampling options
7	Set the handheld Auto-Shutoff time
8	Set the Backlight mode
9	View the Software Version
10	View the handheld Serial Number
11	View and adjust the Unit ID
12	View the Sensor specific information
13	Adjust the display Brightness

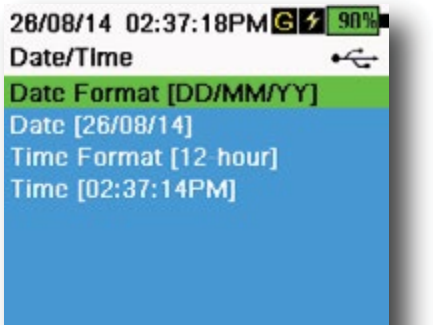


Figure 12 Date/Time

Date/Time

→ **Date/Time**

For accurate logging and calibration data, correctly set the date and time options (Figure 12). Select any of the following options to set the Date/Time.

Date/Time options:

- Set YY/MM/DD, MM/DD/YY, DD/MM/YY or YY/DD/MM date format
- Set the correct date
- Select 12 or 24 hour time format
- Set the correct time

Calibration Record

Detailed sensor calibration information is stored for later review. The instrument's internal memory can save up to 400 individual calibration records. After 400 records, the instrument will overwrite previously stored calibration records, starting with the oldest. To prevent the permanent loss of calibration records, periodically download the calibration files to a computer using the KorDSS software.

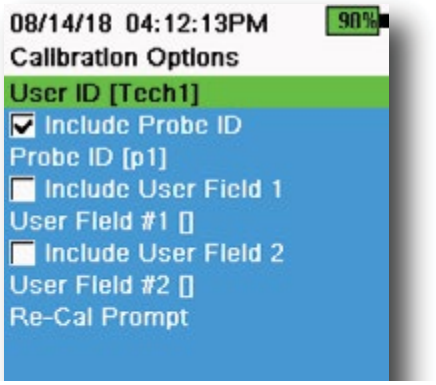


Figure 13 Calibration Options

Calibration Options

→ **Calibration Record** → **Options**

User ID, Probe ID, or User Field #1 or 2 can be user-defined for positive calibration file identification of:

- The person calibrating the instrument
- The sensor/cable serial number used during calibration (or other, user-defined Probe ID)
- Other user-specific identification (User Field #1 and #2) (Figure 13)

NOTE: *User Field can be used to describe the condition of the probe. For example, new sensor or new ODO cap.*



Figure 14 Re-Cal Prompts

Re-Cal Prompts

→ **Calibration Record** → **Options** → **Re-Cal Prompts**

Re-Cal Prompts provide a reminder to recalibrate a probe in the user-defined number of days (Figure 14). Select the desired sensor Re-Cal prompt, then enter the desired number of days before the Re-Cal prompt occurs. This reminder will be provided when the instrument is powered on and will reoccur every day until the sensor is re-calibrated.

Set the sensor value to zero (0) days (default) to turn off Re-Cal prompts.

Calibration Security

→ **Calibration Record** → **Security**

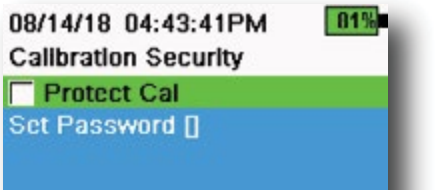


Figure 15 Calibration Security

The Calibration menu can be password protected to prevent accidental or unauthorized sensor calibration (Figure 15).

1. From the Calibration Record menu, select **Security**, then enter the default password "ysi123".
2. Select **Set Password** [ ] and change the default password.
3. Select the **Protect Cal** check box to password protect the Calibration menu.

NOTE: *Write down and keep the password in a safe place. Contact YSI Technical Support if you lose the password (Technical support).*

Language

→ **Language**



Figure 16 Language

The instrument is shipped with English enabled. If a different language is desired and selected, the handheld will take approximately 10 to 20 seconds to enable the new language (during the first installation only).

Optional languages:

- Spanish
- French
- German
- Italian
- Portuguese
- Norwegian
- Japanese
- Simplified Chinese
- Traditional Chinese
- Korean
- Thai

Radix Point

→ **Radix Point**

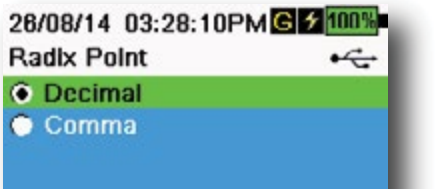


Figure 17 Radix Point

The radix point can be changed to display a comma or a decimal in numeric displays (*e.g.* 1.00 becomes 1,00 when Comma is selected) (Figure 17).

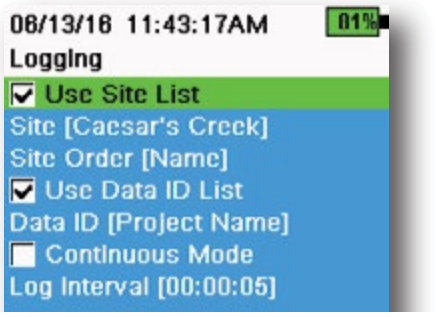


Figure 18 Logging

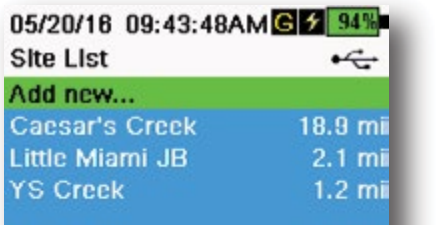


Figure 19 Site List



Figure 20 Site

Logging

→ **Logging**

The handheld can add a user-defined Site and/or Data ID to a data record if these functions are enabled under the Logging menu. A check mark in the box next to these features indicates they are enabled (Figure 17).

After selecting **Site** [ ] or **Data ID** [ ], the Site List or Data ID List will be shown (Figure 19). New entries can be created by choosing **Add new...**

If the handheld has a GPS signal, the current GPS coordinates will be auto-populated when creating a new site. If the handheld does not have a built-in GPS, the coordinates and altitude can be entered manually.

Sites can be listed in order of Name (*i.e.* alphanumeric order) or Distance from the current position (Figure 19).

Choose an entry from the Site List or Data ID List to **Select**, **Edit**, or **Delete** (Figure 20). When selected, data recorded will be tagged with the specific site and/or data ID.

NOTE: *The Manage Sites menu in KorDSS Software can be used to send a picture of the Site to the instrument.*

Continuous Mode (Interval logging): Select the Continuous Mode check box and enter the user-defined Log Interval (in hours:minutes:seconds) to log samples continuously at the specified time interval. The Run screen will display **Start Logging...** when in Continuous Mode. Press ENTER to begin logging.

One sample logging: Clear the Continuous Mode check box. The Run screen will display **Log One Sample**. A sample will be logged each time the ENTER key is pushed when in the Run screen.

NOTE: *An option to change Site and/or Data ID (if enabled) appears once* ENTER *is pressed to begin logging.*

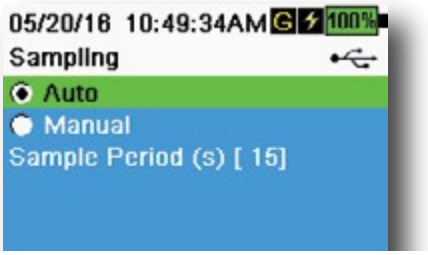


Figure 21 Sampling

Sampling

→ **Sampling**

Auto sampling mode continuously updates measurements on the display (Figure 21).

When in Manual mode, the instrument will take measurements for the duration of the user-defined Sample Period (in seconds) then "lock" or hold the readings on the display. The default sample period is 50 seconds, and can be adjusted from 15 to 60 seconds. Manual mode helps conserve battery power.

Once the measurements are locked, push the ENTER key to log the held data, or the Esc key and then the ENTER key to take a new measurement.

NOTE: *When both Continuous Logging Mode and Manual Sampling mode are enabled, the handheld will power the sensors on and take measurements for 15 seconds before logging a data set.*

Auto-Shutoff

→ **Auto-Shutoff**

To conserve battery power, auto-shutoff powers off the instrument after a user-defined time period (in minutes). The auto-shutoff time can be adjusted from 1 to 255 minutes. Set to 0 (zero) to disable Auto-Shutoff.

Backlight

→ **Backlight**

In Automatic mode, the instrument display will dim 60 seconds after the last key was pushed. Once any key is pushed, the instrument display will return to the user-defined brightness setting and the keypad backlight will turn on. The screen will dim and the keypad backlight will turn off after another 60 seconds of inactivity.

In manual mode, the instrument display remains at the user-defined brightness and the keypad backlight is turned on and off by the Backlight key. Setting the backlight to manual mode is recommended for bright conditions.

Software (Sw) Version

→ **Sw Version**

Sw Version shows the instrument's software version number. The latest instrument software and update instructions are available at YSI.com. Instrument software can be updated through the KorDSS Software under the **Instrument and Sensors** tab.

Serial

→ **Serial #**

Serial # shows the serial number of the handheld instrument. Note the serial number when contacting YSI support.

Unit ID

→ **Unit ID**

Users can set a custom Unit ID. The Unit ID identifies the instrument in KorDSS Software.

Sensor Info

→ **Sensor Info**

Sensor info shows measurement data, and hardware/software information for each component of the system: instrument, sensor, and bulkhead. Use the ▲ and ▼ arrow keys to scroll through the components.

Brightness

→ **Brightness**

The screen brightness can be adjusted to accommodate lighting conditions and to conserve battery power (Figure 22). Use the ◀ and ▶ arrow keys to adjust the screen brightness.

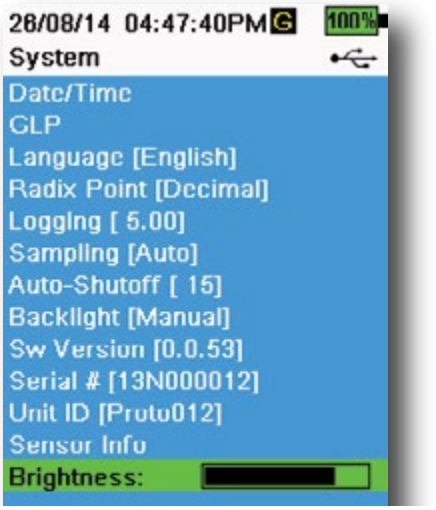


Figure 22 Display Brightness

2.6 Sensor Menu

Use the Probe ( ) key to access the Sensor menu and change sensor settings (if applicable), enable the measurement units displayed on the Run screen, set Auto Stable parameters, change the sensor averaging mode, and if equipped, turn on/off GPS.

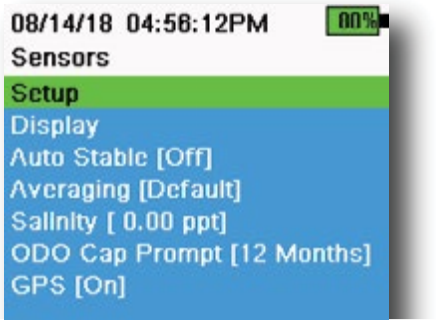


Figure 23 Probe (Sensor) menu

Push the key to access the sensor menu (Figure 23). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Pre-defined or user-selected sensor settings are noted within brackets (**[]**).

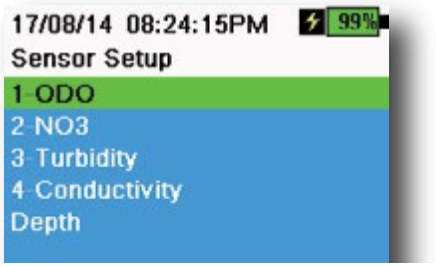


Figure 24 Sensor Setup

Sensor Setup

→ **Setup**

The Sensor Setup menu will show all sensors connected to the instrument (Figure 24). If a sensor is connected but is not listed on the Sensor Setup menu (**<None>** displayed), check the sensor and cable connections.

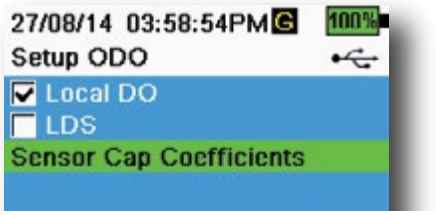


Figure 25 Setup ODO

Setup ODO

→ **Setup** → **ODO**

Local DO: Enable or disable localized DO% measurements. When enabled, the calibration value is set to 100% regardless of altitude or barometric pressure. When enabled, an L will be shown next to DO% on the run screen. DO mg/L measurements are unaffected when Local DO is enabled (Figure 25).

LDS: Last Digit Supression (LDS) rounds the DO value to the nearest tenth, *e.g.* 8.27 mg/L becomes 8.3 mg/L.

Sensor Cap Coefficients: The sensor cap coefficients must be updated after sensor cap replacement. Update the sensor cap coefficients using the coefficient sheet provided with the new sensor cap. Once updated, the coefficients are saved to the ODO sensor and do not need to be re-entered.

NOTE: *The coefficients stay with the sensor even when used with different handheld meters.*



Figure 26 TSS coefficients

Setup Turbidity

→ **Setup** → **Turbidity**

TSS Coefficients: Total Suspended Solids (TSS) can be measured if correlation coefficients are calculated in KorDSS.

To obtain these coefficients, collect turbidity data at the sampling site with corresponding grab samples. Analyze the samples in a lab to determine a true TSS measurement (mg/L). At least 2 and up to 6 value pairs of turbidity and TSS measurements can be used.

Correlation data must be collected for each unique sampling site, as this correlation is site-specific.

In KorDSS Software, enter the field-obtained turbidity measurements and the corresponding lab-obtained TSS measurements in the Instrument and Sensors menu. Coefficients can then calculated with KorDSS and sent to the sensor.

NOTE: *Although correlation coefficients can be entered directly into the handheld (Figure 26), only KorDSS Software can calculate the coefficients.*

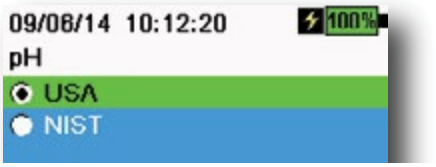


Figure 27 Setup pH

Setup pH

→ **Setup** → **pH**

Select USA auto-buffer recognition (4.00, 7.00, and 10.00) or NIST auto-buffer recognition (4.01, 6.86, and 9.18) (Figure 27). Calibration values are automatically compensated for temperature for both buffer sets.

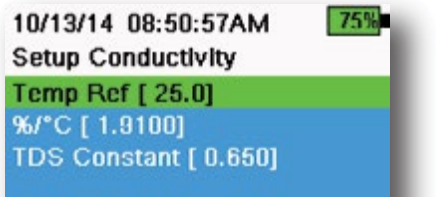


Figure 28 Setup Conductivity

Setup Conductivity

→ **Setup** → **Conductivity**

Temp Ref: Reference temperature is used to calculate temperature compensated specific conductance. All specific conductance values are compensated to the Temp Ref temperature. The default value is 25°C (Figure 28). Enter a new value between 15.00°C and 25.00°C.

%/°C (Percent per degree Celsius): The temperature coefficient is used to calculate temperature compensated specific conductance. The default is 1.91% based on KCl standards. Enter a new value between 0 and 4%.

TDS Constant: This is a multiplier used to calculate an estimated Total Dissolved Solids (TDS) value from conductivity. The multiplier is used to convert specific conductance in mS/cm to TDS in g/L. The default value is 0.65. Enter a new value between 0 and 0.99.

The TDS multiplier is highly dependent on the nature of the ionic species present in the water sample. To be assured of moderate accuracy for the conversion, you must determine a multiplier for the water at your sampling site. Use the following procedure to determine the multiplier for a specific sample:

1. Determine the specific conductance of a water sample from the site.
2. Filter a portion of water from the site.
3. Carefully measure a volume of the filtered water. Completely evaporate to yield a dry solid.
4. Accurately weigh the remaining solid.
5. Divide the weight of the solid (in grams) by the volume of water used (in liters) to yield the TDS value in g/L for the site.
6. Divide the TDS value in g/L by the specific conductance of the water in mS/cm to yield the conversion multiplier.

NOTE: *If the nature of the ionic species at the site changes between sampling studies, the TDS values will be in error. TDS cannot be calculated accurately from specific conductance unless the make-up of the chemical species in the water remains constant.*

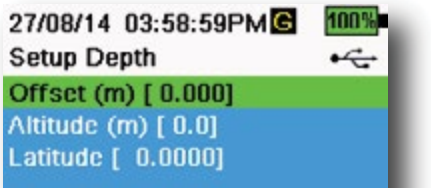


Figure 28 Setup Depth

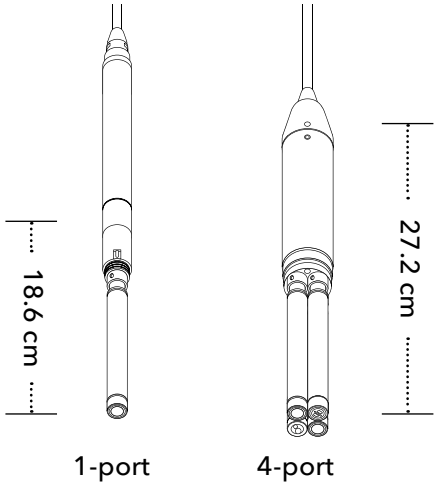


Figure 30 Distance of depth sensor to WQ sensors

Setup Depth

→ **Setup** → **Depth**

Cable assemblies with a depth sensor in the bulkhead can measure virtual vented depth. The virtual vented depth measurement allows for real time compensation for atmospheric pressure using the handheld's barometer.

Depth offset: Depth offset can be used if referencing water elevation against a known value. If a depth offset is entered (in meters), the output value will shift by the value of the offset (Figure 29).

A common offset entered by the user is the depth sensor location relative to the rest of the WQ sensors. This value is 18.6 cm on the 1-port cable and 27.2 cm on the 4-port cable. (Figure 30).

Altitude/Latitude: To compensate for atmospheric pressure based on elevation and gravitational pull, enter the local altitude in meters relative to sea level and latitude in degrees where the instrument is sampling.

Latitude effect: Varying latitudes can cause up to a 200 mm change in depth from equator to pole.

Altitude effect: A 100 m change in altitutde causes a 1.08 mm of change to the depth readings.



Figure 31 Sensor Display

Sensor Display

→ **Display** (Figure 31)

The Sensor Display menu determines the parameters and units that are shown on the Run screen (Figure 10). The Run screen will only show measurements for sensors that are attached to the cable bulkhead.

If more measurements are selected than can be displayed on one screen, a scroll bar will be shown. Use the ▲ and ▼ keys to scroll through the measurements.

NOTE: *For depth profiling, enable Vertical Position under Depth Display to view the real-time position of the depth sensor in the water column. This is helpful in profiling applications to ensure the depth sensor is lowered to the desired depth without waiting for the depth data to stabilize.*

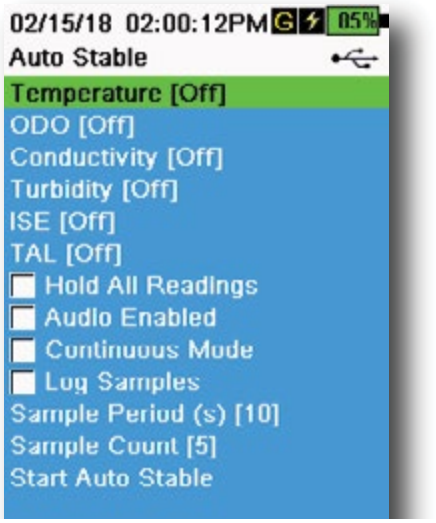


Figure 32 Auto Stable

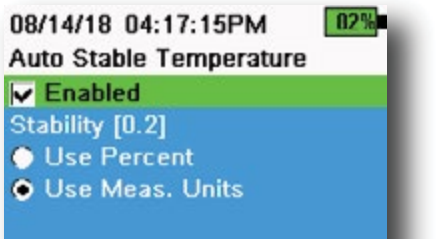


Figure 33 Auto Stable stability threshold

Auto Stable

→ **Auto Stable**

Auto Stable indicates when a measurement is stable. Sensors with Auto Stable enabled will have A S flash beside the measurement on the Run screen.
A S will flash green when the measurement is stable.

Select a sensor to enable or disable Auto Stable (Figure 32). Then set the stability threshold parameters.

The Auto Stable stability threshold can be set by percent of measurement or in the units of measurement selected in the Sensor Display menu. Enter the stability value, then select **Use Percent** or **Use Meas. Units** (Figure 33).

This threshold is used to compare the last reading with the previous. The smaller the number entered in % or units, the longer it will take for the instrument to reach the auto stable criteria.

Example: For temperature in °C, if Measurement Units threshold is set to 0.2 and the temperature reading changes by more than 0.2 degrees, A S will continue to be red until the reading does not change by more than 0.2°C over the defined sample period and sample count.

Hold All Readings: After all sensors have reached their stability criteria, the measurements will be held or 'locked' on the display. If disabled, the sensor measurements will continue to change in real time.

Audio Enabled: An audio alert will sound when stability is reached.

Continuous Mode: The handheld will continuously check sensor values against the stability criteria even after the sample period and sample count have been met.

Log Samples: Logs the sample/s defined by the Sample Period to memory.

Sample Period: Time interval between samples that are used to determine stability. Set the interval in seconds (1 to 900).

Sample Count: Number of consecutive samples required for stability (1 to 10).

Select Start Auto Stable to enable.

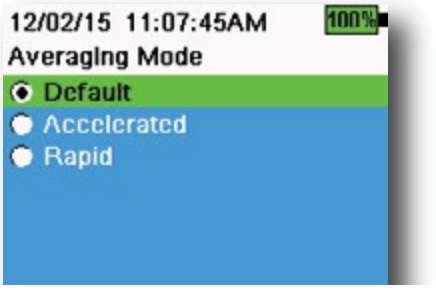


Figure 34 Averaging

Averaging

→ **Averaging** (Figure 34)

The averaging mode determines how the handheld will filter data. A smaller time frame for the rolling average window allows changes in the sensor's measurements to be more quickly observed, while a larger rolling window provides more stable measurement readings and a smooth result. Each averaging mode will decrease the time span of the rolling window if a large change in the sensor measurement is detected, allowing the handheld to adapt when an event occurs.

The **Default** mode provides optimum averaging for all sensors. This mode has up to 40 seconds of averaging on the sensors to curb spikes and outliers, resulting in more stable data.

In **Accelerated** mode, changes in sensor measurements are more quickly observed than default (approximately 10 seconds of averaging). This mode is recommended when the sensors are moving through the water, such as during profiling studies and most spot sampling applications.

NOTE: *For profiling applications, enable Vertical Position under Depth Display to view unfiltered depth measurements. This helps to ensure the depth sensor is lowered to the desired depth without waiting for the averaged measurement.*

In **Rapid** mode, sensor response is very fast (approximately 2 seconds of averaging), but the instrument will never settle on a single steady number. This mode is recommended when the sensors are moving quickly through the water, such as rapid profiling and towed applications.

Salinity

→ **Salinity**

Salinity is determined by calculations derived from the conductivity and temperature sensors.

When a conductivity sensor is installed, the instrument will automatically use the salinity measurement for DO and "As Measured" will be displayed. If no conductivity sensor is installed (*e.g.* ODO/T cable assembly used), the salinity value will be user-selectable.

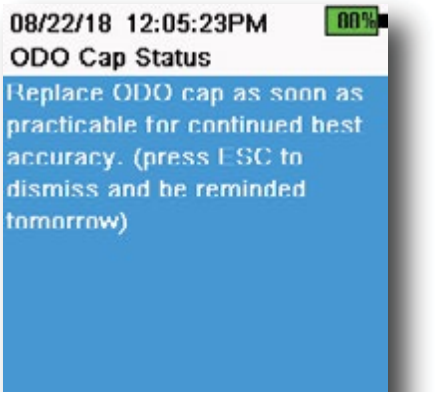


Figure 35 ODO Cap Status

ODO Cap Prompt

→ **ODO Cap Prompt**

The handheld can remind users when it is time to replace the ODO Cap based on a user-defined interval (Figure 35). To set the reminder, select ODO Cap Prompt and **input a number in months**. YSI recommends enabling this setting to match the warranty period of the ODO Cap:

- ProDSS ODO Sensor Cap [SKU: 626890] = **12** months
- ODO Extended Warranty Sensor Cap [SKU: 627180] = **24** months

The handheld will automatically recognize the last time the ODO Sensor Cap coefficients were updated and alert the user when the Cap is due for replacement. To disable the prompt, simply enter **0** for the number of months.

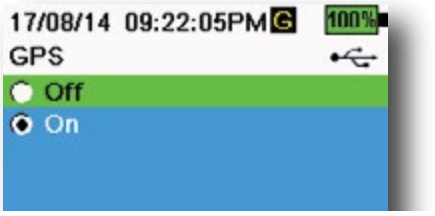


Figure 36 GPS

GPS (Optional)

→ **GPS**

Some handhelds feature a built-in GPS. GPS turns the handheld Global Positioning System On or Off. The G symbol is shown when a GPS signal is received (Figure 36).

When enabled, the GPS coordinates will be saved with the Calibration Record and logged data. Note that the battery will drain more rapidly when GPS is enabled than when it is not enabled.

NOTE: *GPS data will be most accurate when there is a clear line of sight to satellites. It may be difficult for the handheld to receive a good GPS signal when under canopy or indoors.*

2.7 Calibration Menu

Push the Calibrate (Cal) key to access the Calibration menu (Figure 37). Highlight a sub-menu then push the ENTER key to view sub-menu options. Pre-defined or user-selected parameters are noted within brackets (**[ ]**). Refer to the Calibration section for sensor specific calibration procedures.

NOTE: *User ID, Probe ID, and User Field #1 and #2 can be enabled in the* ***Calibration Settings*** *under the System menu.*

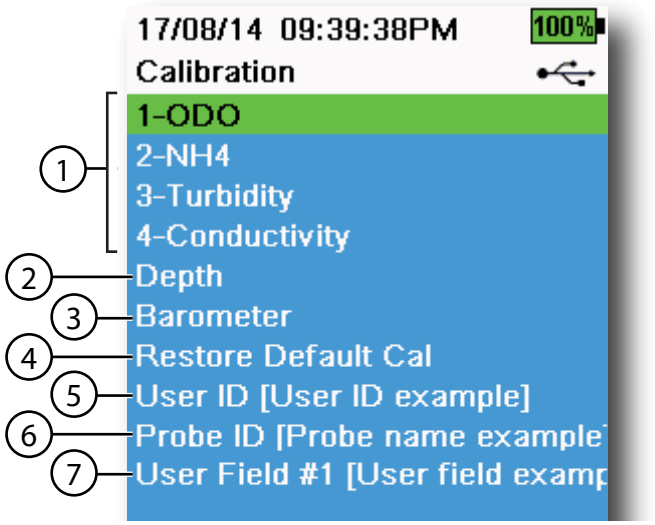


Figure 37 Calibration menu

1 Sensors connected	**5** User ID
2 Optional Depth sensor calibration	**6** Probe ID
3 Barometer calibration	**7** User Field #1
4 Restore Default Calibration - restores specified sensor to factory default	

2.8 Files Menu

Push the File ( ) key to access the Files menu (Figure 38). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Use the Files menu to view, delete or backup logged data or the calibration file. Data can be filtered by a specific date and time range and by user-created Site and Data ID lists.

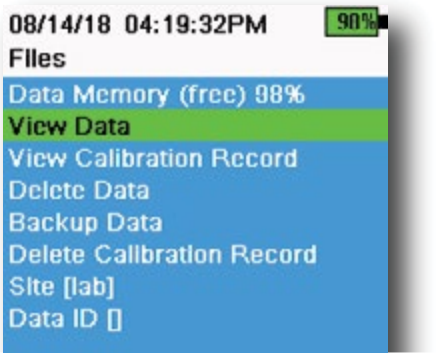


Figure 38 Files menu

Data Memory: (free) % shows the remaining memory available. Download or delete data to free available internal memory.

The Site List and/or Data ID List can be seen by selecting **Site [ ]** or **Data ID [ ]**. To enable the use of Site and/or Data ID when logging data, select **Logging** under the System menu.

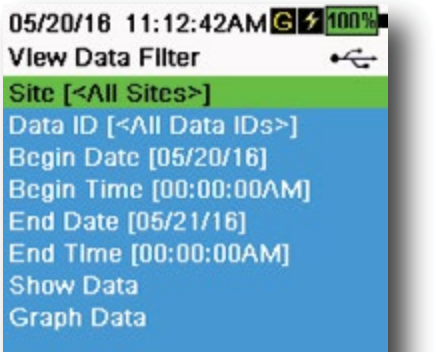


Figure 39 View Data Filter

View Data Filter

→ **View Data**

Enter the desired filter criteria, then select **Show Data** or **Graph Data** to view the tabular or graphical data. If necessary, use the arrow keys to scroll through the data (Figure 39 and Figure 40).

Site: View data from one site or all sites.

Data ID: View data from one ID or all IDs.

Begin/End: View data within specific date and time ranges.

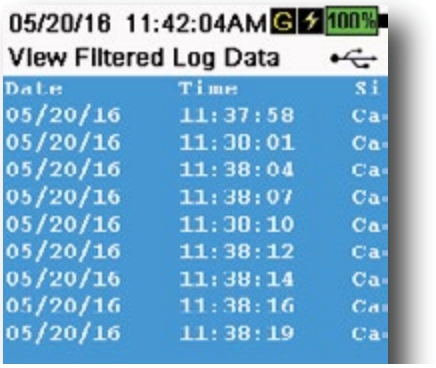


Figure 40 View Filtered Log Data

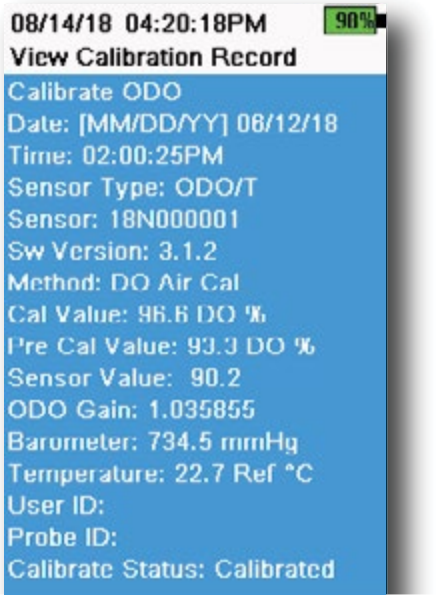


Figure 41 View GLP

View Calibration Record

→ **View Calibration Record**

Select **View Calibration Record** to show the stored sensor calibrations (Figure 41).

Use the arrow keys to scroll through the calibration file data.

Calibration Information

Information in each calibration record:

- Sensor calibrated
- Date/time stamp
- Sensor ID
- Sensor serial #
- Sensor software version
- User ID (optional)
- Probe ID (optional)
- User Fields #1 and #2 (optional)
- Calibration status
- Calibration value
- Temperature

Depending on the parameter, a calibration record may include additional information such as the Conductivity cell constant, ODO gain, ORP offset, and pH slope.

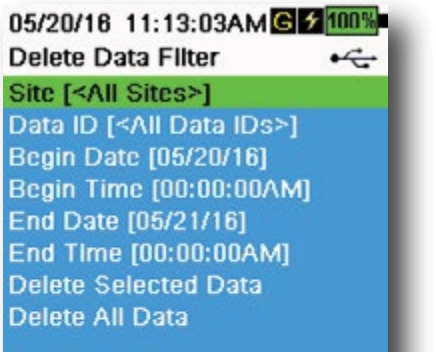


Figure 42 Delete Data Filter

Delete Data

→ **Delete Data**

Enter the desired filter criteria, then select **Delete Selected Data** to *permanently* delete the data (Figure 42).

Select **Delete All Data** to permanently delete all logged data from the handheld.

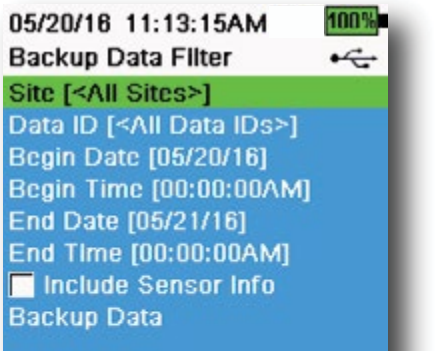


Figure 43 Backup Data

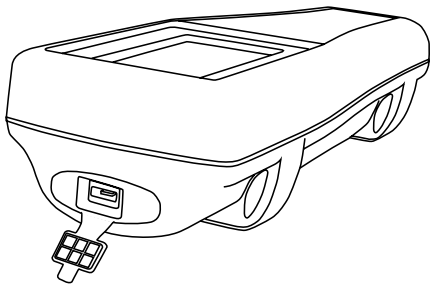


Figure 44 Micro USB female connector

Backup Data

→ **Backup Data**

This function allows you to backup logged data to a flash drive based on Site, Data ID, and log date (Figure 43). A USB female to micro USB male adapter is included with new instruments for this data backup.

NOTE: *The USB storage device must be formatted as FAT32, not NTFS or exFAT. The handheld will only support FAT32.*

If the box next to "**Include Sensor Info**" is checked, each data set will be sent to a flash drive as a separate file with sensor serial number and sensor software information included. If the box is not checked (default), all data sets will be sent in a single backup file with no sensor serial number or sensor software information.

NOTE: *It is suggested to send data to the USB flash drive as a single file (i.e. box is not checked) unless this sensor information is needed. This makes importing the data much faster and easier.*

Once the filter settings are configured, select **Backup Data** to send the data to a flash drive. The data is exported in a CSV file.

If the data backup is not successful, ensure the correct filter criteria are selected and the USB connection indicator can be seen at the top of the screen (Figure 10).

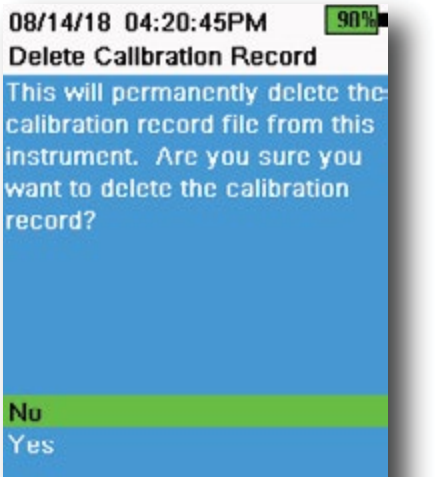


Figure 45 Delete Calibration Record

Delete Calibration Record

→ **Delete Calibration Record**

To permanently delete the Calibration Record file from the instrument, select **Yes**, then push the ENTER key (Figure 45).

2.9 Taking Measurements

For the highest accuracy, calibrate the sensor(s) before taking measurements.

1. Create Site and Data ID lists for logged data (if applicable).
2. Set the logging method (single or interval).
3. Set the Auto Stable parameters (if applicable).
4. Verify that the sensors and/or port plugs are correctly installed in all bulkhead ports.
5. Install the probe guard.
6. Insert the probe into the sample. Make sure the probe is fully submerged.
7. Move the probe in the sample to release any air bubbles and to provide a fresh sample to the sensors.
8. Wait for the sensor/s to stabilize in the sample.
9. On the main run screen, press 

to begin logging (single or interval) (See Logging).

   NOTE: *An option to change Site and/or Data ID (if enabled) appears once* 

is pressed to begin logging.

10. To stop continuous logging, simply press 

key again.

3. Calibration

ProDIGITAL sensors (except temperature) require periodic calibration. Calibration procedures follow the same basic steps with variations for specific parameters. Before calibration, adjust *Calibration Record* settings under the **System** menu if applicable to user requirements. Set up sensor options, settings, and coefficients as applicable.

3.1 Calibration Setup

Make sure the calibration cup, sensor guard, and all sensors are clean. YSI strongly recommends installing the sensor guard before placing the sensors into the calibration cup.

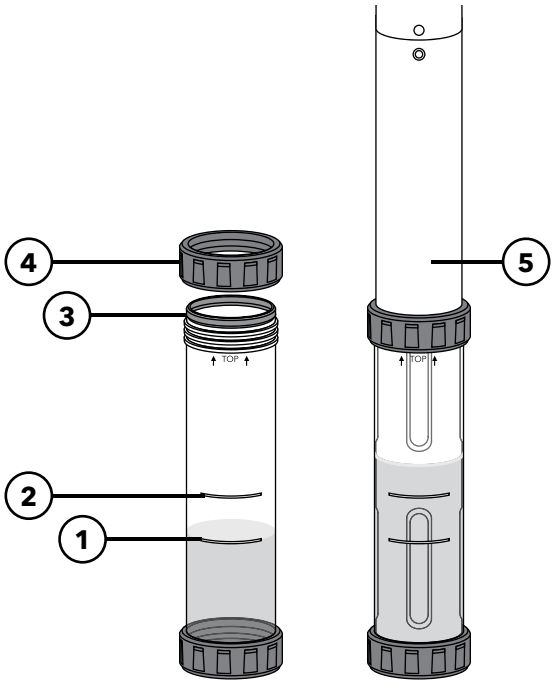
For highest data accuracy, thoroughly rinse the calibration cup and sensors with a small amount of the calibration standard for the sensor to be calibrated. Discard the rinse standard, and proceed with a fresh standard.

Be careful to avoid cross-contamination with other standards between calibrations by thoroughly rinsing with DI water and drying the calibration cup and sensors.

Ensure the calibration cup gasket is correctly seated. Loosely install the retaining nut on the cup. Slide the calibration cup over the sensors and sensor guard and tighten the retaining nut (Figure 46).

For cables and probes without dedicated calibration cups, please use the included graduated cylinder or a clean conatainer large enough to submerge the sensors. When calibrating the 1-port cable assembly, please ensure the built-in thermistor is fully submerged in the calibration solution.

Calibration Cup Installation for 4-Port Cable Assemblies



1	Fill line one (for all calibration solutions except for conductivity)
2	Fill line two (for conductivity calibration solution)
3	Gasket
4	Retaining nut
5	Calibration cup installed

It takes 170 mL of solution to fill the calibration cup to line 1, while it takes 225 mL to fill to line 2.

Figure 46 Calibration cup standard volume (4-port cable)

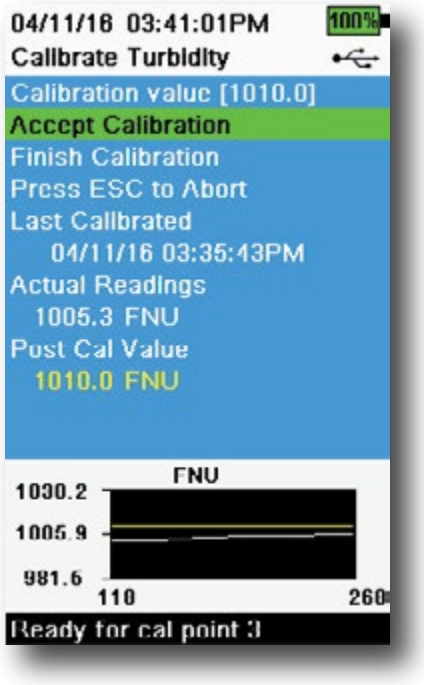


Figure 47 Layout of calibration screen

Calibration Screen Layout

The calibration screen has the same basic layout for each parameter (Figure 47).

Calibration value: This is the value the sensor will be calibrated to. The Yellow Line on the graph corresponds to this value.

Accept Calibration: Select this to calibrate the sensor to the calibration value.

Finish Calibration: This option is only available with multi-point calibrations (*i.e.* pH, ISE, turbidity, PC, PE, and chlorophyll). Finishes the calibration by applying previously accepted points.

Press ESC to Abort: Press the ESC key to leave the calibration. The sensor will not be calibrated to any points. The last successful calibration will be used.

Last Calibrated: View the date and time of the last successful sensor calibration.

Actual Readings: This shows the current measurement value on the Run screen. The White Line on the graph corresponds to this value. Observe the White Line to ensure the measurement is stable before choosing Accept Calibration.

Post Cal Value: This is the same as the calibration value. This will be the measurement value in the current solution after the calibration is finished.

3.2 Depth

NOTE: *This calibration option is available only if your bulkhead is equipped with a depth sensor.*

Depth is calculated from the pressure exerted by the water column minus atmospheric pressure. Factors influencing depth measurement include barometric pressure, water density, and temperature. Calibration in the atmosphere "zeros" the sensor with respect to the local barometric pressure.

YSI recommends calibrating depth at the location of measurement. A change in barometric pressure will result in a zero shift unless the transducer is recalibrated to the new pressure.

If applicable, enter the depth offset to set the depth measurement to something other than zero. Enter the altitude and latitude of your sampling location to increase the accuracy of your depth measurement.

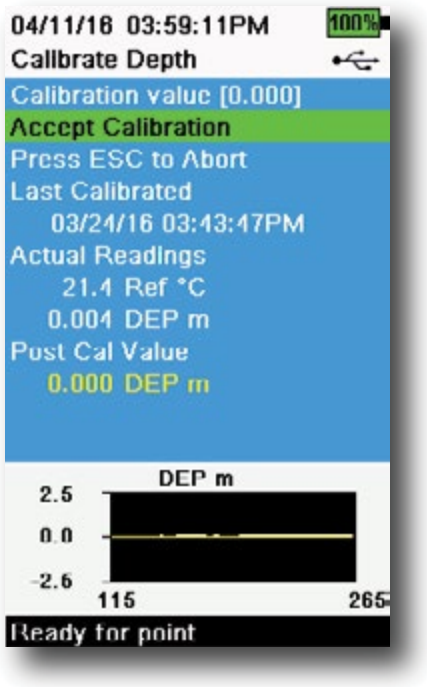


Figure 48 Calibrate Depth

Depth Calibration

1. Make sure that the depth sensor is clean and dry in air, not immersed in any solution. For best results, keep the bulkhead still and in one position while calibrating.
2. Push the Cal key, then select **Depth**. The **Calibration Value** is set to 0.000 and should not be changed for air calibrations, even if using an offset.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 48).

If the depth offset is used, the depth measurement will be adjusted after calibration.

3.3 Conductivity

The conductivity/temperature sensor can measure and calculate conductivity, specific conductance (temperature compensated conductivity), salinity, non-linear function (nLF) conductivity, TDS, resistivity, and density. Calibration is only available for specific conductance, conductivity, and salinity. Calibrating one of these options automatically calibrates the other conductivity/temperature parameters listed above. For both ease of use and accuracy, YSI recommends calibrating specific conductance.

Select the appropriate calibration standard for the conductivity of the sampling environment. Standards at least 1 mS/cm (1000 µs/cm) are recommended for the greatest stability. For fresh water applications, calibrate to 1,000. For salt water applications, calibrate to 50,000 µS.

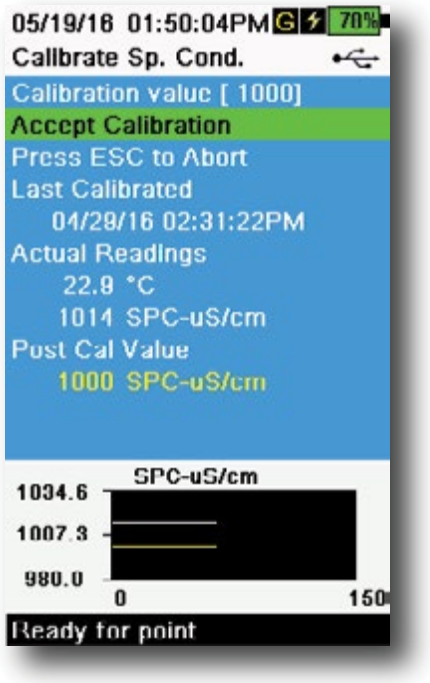


Figure 49 Calibrate specific conductance

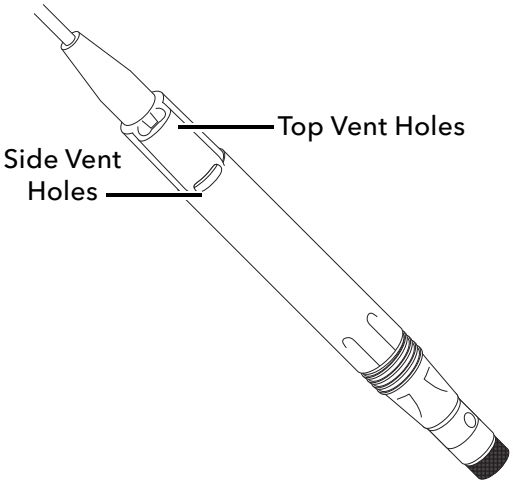


Figure 50 ODO/CT Cable Assembly

Conductivity Calibration

1. Make sure the conductivity sensor is clean prior to calibration. If necessary, clean the conductivity cell with the supplied soft brush.
2. Place the correct amount of conductivity standard into a clean and dry or pre-rinsed calibration cup.
3. Carefully immerse the sensors into the solution. Make sure the solution is above the vent holes on the side of the conductivity sensor.

   If using the ODO/CT assembly, ensure the vent holes at the top of the sensor are completely immersed and the solution level is at least 1 cm higher than the top vent holes (Figure 50). A graduated cylinder is included with ODO/CT cable assemblies for the purpose of calibrating conductivity.

   For 4-port cable assemblies, fill the calibration cup to the second line with fresh calibration standard. It takes 225 mL of solution to fill to line 2.
4. Gently rotate and/or move the sensor up and down to remove any bubbles from the conductivity cell. Allow at least 40 seconds for temperature equilibration before proceeding.
5. Push the Cal key, select **Conductivity**, then select **Specific Conductance**.
6. Select **Calibration value** then enter the calibration value of the standard used. Note the measurement units the instrument is reporting and calibrating and be sure to enter in the correct calibration value for the units being used. For example, 10,000 µS = 10 mS. Make sure that the units are correct and match the units displayed on the handheld.
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 49). "Calibration successful!" will be displayed in the message area.

(continued on next page)

8. Rinse the sensor in clean water then dry.

NOTE: *If the data is not stabilized after 40 seconds, gently rotate the sensor or remove/reinstall the calibration cup to make sure that no air bubbles are in the conductivity cell.*

If you get calibration error messages, check for proper sensor immersion, verify the calibration solutions is fresh, the correct value has been entered into the handheld, and/or try cleaning the sensor.

3.4 Barometer

The barometer is factory calibrated and should rarely need to be recalibrated. The barometer is used for DO calibration, %Local measurements, and for virtual vented depth measurements. Verify that the barometer is accurately reading "true" barometric pressure and recalibrate as necessary.

Laboratory barometer readings are usually "true" (uncorrected) values of air pressure and can be used "as is" for barometer calibration. Weather service readings are usually not "true", *i.e.* they are corrected to sea level and cannot be used until they are "uncorrected". Use this approximate formula:

True BP in mmHg=[Corrected BP in mmHg] - [2.5* (Local altitude in ft. above sea level/100)]

Example:

Corrected BP = 759 mmHg

Local altitude above sea level = 978 ft

True BP = 759 mmHg - [2.5*(978ft/100)] = 734.55 mmHg

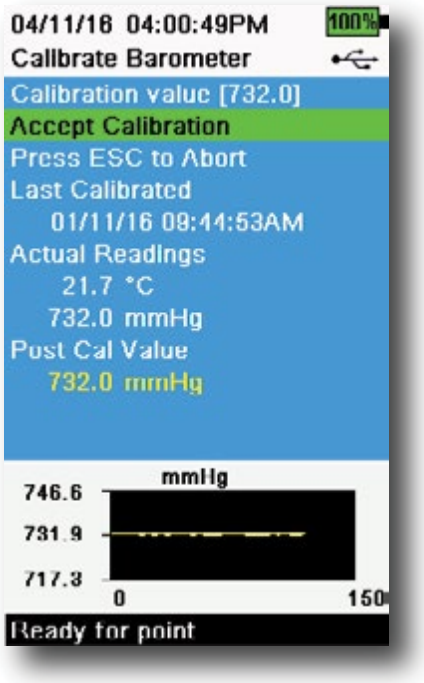


Figure 51 Calibrate Barometer

Barometer Calibration

1. Push the Cal key, then select **Barometer**.
2. Select **Calibration value** then enter the correct "true" barometric pressure.

NOTE: *The measurement units during calibration are dictated by what is enabled in the sensor setup menu. Be sure to enter in the correct units.*

- BP in mmHg=25.4 x BP inHg
- BP in mmHg=0.750062 x BP mb
- BP in mmHg=51.7149 x BP psi
- BP in mmHg=7.50062 x BP kPa
- BP in mmHg=760 x BP atm

3. Select **Accept Calibration** (Figure 51). "Calibration successful!" will be displayed in the message area.

3.5 Dissolved Oxygen

ODO calibration requires the current "true" barometric pressure. Make sure that the barometer is reading accurately prior to ODO calibration.

Calibrating in DO% or DO% local automatically calibrates the mg/L and ppm measurement. There is no reason to calibrate both parameters. For both ease of use and accuracy, we recommend that you calibrate DO% or DO% Local and not mg/L.

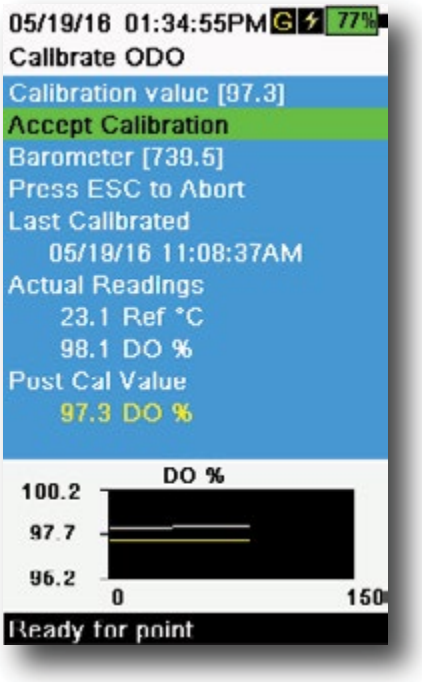


Figure 52 Calibrate ODO %

ODO% and ODO% Local - Water Saturated Air Calibration

1. Place a small amount of clean water (5 mL) in the calibration cup or a wet sponge into the calibration sleeve (for ODO/T and ODO/CT probes and 1-port cable assemblies).
2. Make sure there are no water droplets on the ODO sensor cap or temperature sensor.
3. Attach the probe guard and carefully slide into the calibration cup. Make sure a seal is not created around the probe. Atmospheric venting is required for accurate calibration.
4. Turn the instrument on and wait approximately 5 to 15 minutes for the air in the storage container to be completely saturated with water.
5. Push the Cal key, then select **ODO.** Select **DO%**.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 52). "Calibration successful!" will be displayed in the message area.

NOTE: *If you see a calibration error message, verify the barometer reading and inspect the sensor cap. Clean and/or replace the sensor cap as needed.*

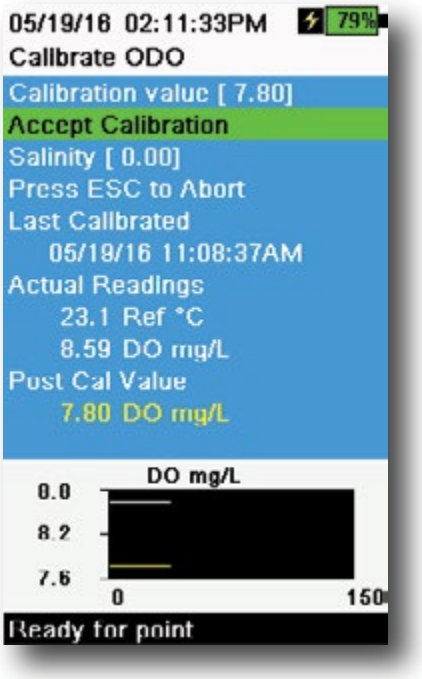


Figure 53 Calibrate ODO mg/L

ODO mg/L Calibration

1. Place the ODO and conductivity/temperature sensor into a water sample that has been titrated by the Winkler method to determine the dissolved oxygen concentration in mg/L.
2. Push the Cal key, then select **ODO**. Select **DO mg/L**.
3. Select **Calibration value.**
4. Enter the dissolved oxygen concentration of the sample in mg/L.
5. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 53). "Calibration successful!" will be displayed in the message area.
6. Rinse the bulkhead and sensors in clean water then dry.

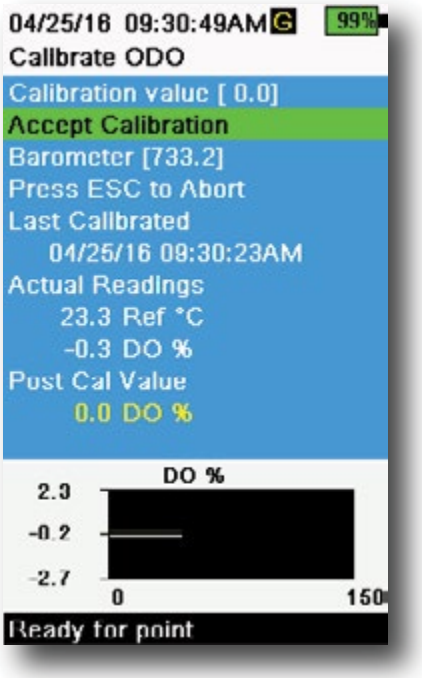


Figure 54 Calibrate ODO zero point

ODO Zero Point Calibration

1. Place the ODO and Conductivity/Temperature sensors in a solution of zero DO.

   NOTE: *A zero DO solution can be made by dissolving approximately 8-10 grams of sodium sulfite into 500 mL of tap water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.*

2. Push the Cal key, then select **ODO**. Select **Zero**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 54). "Calibration successful!" will be displayed in the message area.
4. Thoroughly rinse the bulkhead and sensors in clean water then dry.
5. Perform a ODO % water-saturated air calibration after performing a zero point calibration.

3.6 Turbidity

Standards

For best results, YSI recommends the following standards for turbidity calibration:

Calibration Point	Standard Value
1	0 FNU [SKU: 608000]
2	12.4 FNU [SKU: 607200] or 124 FNU [SKU: 607300]
3	1010 FNU [SKU: 607400]

Other standards may be acceptable as long as they have been prepared according to details in Standard Methods for the Treatment of Water and Wastewater (Section 2130 B). These standards include:

- YSI Certified AMCO-AEPA polymer-based standards (see above)
- Hach StablCal™ standards in various NTU denominations
- Dilutions of 4000 NTU formazin concentrate purchased from Hach
- Other formazin standards prepared according to the Standard Methods

The use of standards other than those mentioned above will result in calibration errors and inaccurate field readings. It is important to use the same type of standard for all calibration points; do not mix formazin and polymer-based standards for different points in a multi-point calibration.

When using an alternative standard (non-YSI), calibration can be completed using the following limits:

	Min	Max	Unit
1st Calibration Point	0.0	1.0	FNU or NTU
2nd Calibration Point	5.0	200	FNU or NTU
3rd Calibration Point	400	4000	FNU or NTU

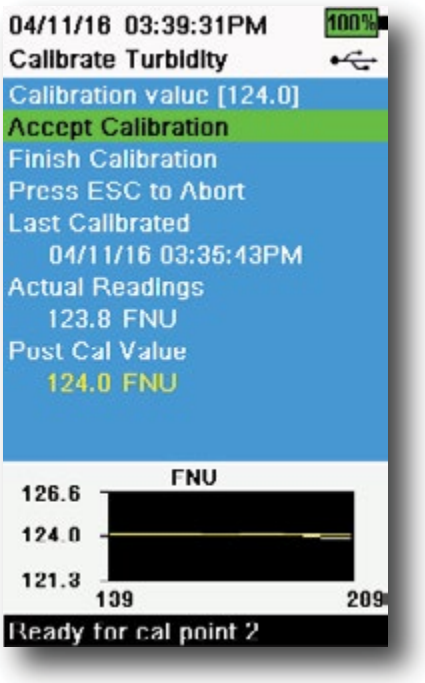


Figure 55 Calibrate Turbidity

Turbidity Calibration 2-Point

Turbidity calibrations, more than most other paramters, are susceptible to interference from contamination. It is critical for calibrations to be performed with very clean sensors, guards, and cups.

NOTE: *Calibration standards should not be re-used.*

1. Fill the calibration cup to the appropriate level with 0 FNU standard (deionized water may be used as a substitute). The sensor guard must be installed to ensure an accurate calibration. Make sure the guard is intalled and immerse the probe in the zero standard.
2. Push the Cal key, then select **Turbidity**.
3. Select **Calibration Value** and enter 0.00.
4. Make sure there are no air bubbles on the turbidity sensor lens. If present, lightly tap the guard against the cup to dislodge any bubbles. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), and then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
5. Discard the used standard, and rinse the probe, guard, and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
6. Fill the calibration cup to the appropriate level with fresh standard for the second calibration point. Immerse the probe in the standard.
7. Select **Calibration Value** and enter the value of the second calibration standard.
8. Make sure there are no air bubbles on the turbidity sensor lens. Observe the actual measurement readings for stability, and then select **Accept Calibration** (Figure 55). "Ready for cal point 3" will be displayed in the message area.
9. Select **Finish Calibration** to complete a 2-point calibration or continue for the 3-point calibration.

Repeat steps 5 through 8 for a 3-point calibration. "Calibration successful!" will be displayed in the message area. After calibration, rinse with water and dry the probe.

3.7 Total Algae

TAL Sensors

YSI offers two Total Algae (TAL) sensor options. Both are dual-channel fluorescence sensors.

The channels on the TAL-PC sensor refer to two independent data sets: one results from a blue excitation beam that excites the chlorophyll a (Chl) molecule and the second results from an orange excitation beam that excites the phycocyanin (PC) accessory pigment. TAL-PC sensors are typically selected for monitoring freshwater cyanobacteria.

The TAL-PE sensor is similar in having a chlorophyll channel, but utilizes a slightly blueshifted beam that excites the pigment phycoerythrin (PE). TAL-PE sensors are typically selected for monitoring marine cyanobacteria.

TAL Units

The TAL sensors report data in RFU and µg/L of pigment (Chl, PC or PE) units. YSI recommends reporting in Relative Fluorescence Units (RFU).

RFU is used to set sensor output relative to a stable secondary standard, Rhodamine WT dye. This allows users to calibrate sensors identically so that results from sensor to sensor can be compared. Calibration with Rhodamine WT also enables users to monitor for sensor drift and external factors such as biofouling or declining sensor optical performance over time as the LEDs age.

The excellent linearity of RFU, once the channels are calibrated with Rhodamine WT, translates to the best accuracy of measurements. For example, a chlorophyll reading of 100 units will represent twice the pigment detected by the sensor than with a chlorophyll reading of 50 units. This high linearity (R2>0.9999) doesn't always hold for µg/L of pigment since that unit was derived from laboratory monocultures, and an environmental algal population can behave quite differently. This is also why the TAL sensors and in situ monitoring should not be regarded as a perfect replacement for other methods such as pigment extractions and cell counting.

The µg/L output generates an estimate of pigment concentration that is based upon correlations built with sensor outputs and extractions of pigments from laboratory-grown blue-green algae. Synonymous with parts per billion (ppb), µg/L is still commonly used by regulatory agencies, but has the drawback that it is very dependent upon the composition of the algal population, the time of day, the physiological health of the algae, and a number of other environmental factors. Thus, users are advised to do their own check of our correlation with a population of algae relevant to their own sites, as described below.

A 2-point RFU calibration is advised to be performed first. Next, with samples collected from the site of interest, measure both RFU and µg/L with the sensor(s). Observing careful handling and preservation of the samples, as soon as possible extract the pigments from the samples, using standardized methods to determine the µg/L in each sample. The extraction data may be used to assess how RFU and µg/L delivered by the sensor compare with the µg/L of pigment that would be predicted by RFU from the sensor. The user's requirements can guide the decision as to whether RFU or µg/L is the best unit to read from the sensor for any specific application.

TAL Raw values can only be seen under Sensor info in the System menu and are unaffected by user calibrations. These values range from 0-100, representing the percent of full scale that the sensor detects in a sample, and are used for diagnostic purposes.

Rhodamine WT Dye Solution Preparation

Rhodamine WT dye solution must be used when completing a 2-point calibration. Purchase Rhodamine WT as a 2.5% solution to follow the procedure below. Kingscote Chemicals (Miamisburg, OH, 1-800-394-0678) has historically had a 2.5% solution (item #106023) that works well with this procedure. Note that there are many types of Rhodamine—make sure Rhodamine **WT** is selected. If a 2.5% solution cannot be obtained commercially, prepare it from a solid or from another concentration of a liquid solution to a 2.5% final concentration, or adjust the dilutions below accordingly. It should be stored in the refrigerator when not in use.

For PC and chlorophyll channel calibrations, a 0.625 mg/L solution of Rhodamine WT should be prepared. For PE channel calibration, a 0.025 mg/L solution of Rhodamine WT should be prepared. The steps below describe one procedure to prepare these solutions.

1. *For any TAL sensor calibration, prepare a 125 mg/L solution of Rhodamine WT.* Transfer 5.0 mL of the 2.5% Rhodamine WT solution into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water and mix well to produce a solution that is approximately 125 mg/L of Rhodamine WT. Transfer to a storage bottle and retain it for future use.

   *This solution can be stored in the refrigerator (4°C). Its degradation will depend upon light exposure and repeated warming cycles, but solutions used 1-2 times a year can be stored for up to two years. Users should implement their own procedures to safeguard against degradation.

2. *For PC and chlorophyll channel calibrations, prepare a 0.625 mg/L solution of Rhodamine WT.* Transfer 5.0 mL of the 125 mg/L solution prepared in step one into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution that is 0.625 mg/L of Rhodamine WT. Use this solution within 24 hours of preparation and discard it after use.
3. *For PE channel calibration, prepare a 0.025 mg/L solution of Rhodamine WT.* Transfer 0.2 mL of the 125 mg/L solution prepared in step one into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution that is 0.025 mg/L of Rhodamine WT. Use this solution within 24 hours of preparation and discard it after use.

In addition to preparing the Rhodamine solution(s), it is also necessary to determine temperature-compensated calibration values for solutions. In general, fluorescence is inversely related with temperature. Measure the temperature of the Rhodamine solution(s) and use the temperature of the solution at the time of calibration to select the compensated solution concentrations, in either RFU (recommended) or µg/L pigment equivalents, from the table below.

As an example, assume that you will calibrate the chlorophyll channel in RFU, and that the temperature measured in the 0.625 mg/L Rhodamine WT solution is 22°C. The first standard value entered will be 0, and the second standard value will be 16.4 (see table on page 41). Likewise, if you intend to use the default µg/L unit when calibrating chlorophyll, the second standard value would be 66 in this example. Using the same 0.625 mg/L Rhodamine WT solution to calibrate the PC channel will yield a second standard value of 16.0 RFU or 16 µg/L. These values will be entered when performing a 2-point calibration.

Rhodamine WT Dye Solution Preparation *(continued)*

	Chlorophyll		Phycocyanin		Phycoerythrin	
Temp (°C)	RFU	µg/L	RFU	µg/L	RFU	µg/L
30	14.0	56.5	11.4	11.4	37.3	104.0
28	14.6	58.7	13.1	13.1	39.1	109.0
26	15.2	61.3	14.1	14.1	41.0	115.0
24	15.8	63.5	15.0	15.0	43.0	120.0
22	16.4	66	16.0	16.0	45.0	126.0
20	17.0	68.4	17.1	17.1	47.0	132.0
18	17.6	70.8	17.5	17.5	49.2	138.0
16	18.3	73.5	19.1	19.1	51.4	144.0
14	18.9	76	20.1	20.1	53.6	150.0
12	19.5	78.6	21.2	21.2	55.9	157.0
10	20.2	81.2	22.2	22.2	58.2	163.0
8	20.8	83.8	22.6	22.6	60.6	170.0

TAL Calibration

A 1- or 2-point calibration can be completed for all channels on the TAL-PC and TAL-PE sensors.

A 1-point calibration, typically completed in clear deionized or distilled water, is simply a re-zeroing of the sensor. This calibration does not reset the second point entered during the previous 2-point calibration. The consequence is that error will be alleviated at and near zero, but more error can accumulate in the measurement the farther away from zero the measured value is. The amount of error is dependent upon how much the second point drifts, which is not always equivalent to how much the zero point drifts.

For many users, especially those with sites where pigment is rarely detected and values are at or near zero most of the time, the far-from-zero accumulation of error is a non-issue. For others, it is best to perform a 2-point calibration using a Rhodamine WT solution.

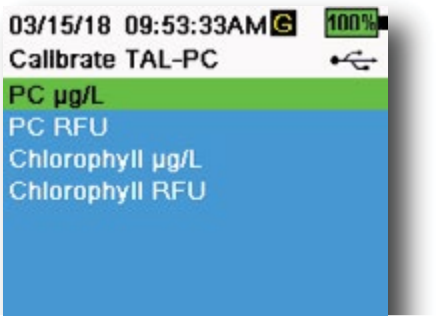


Figure 56 TAL-PC Calibration Options

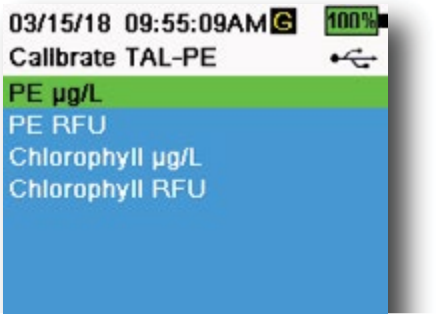


Figure 57 TAL-PE Calibration Options

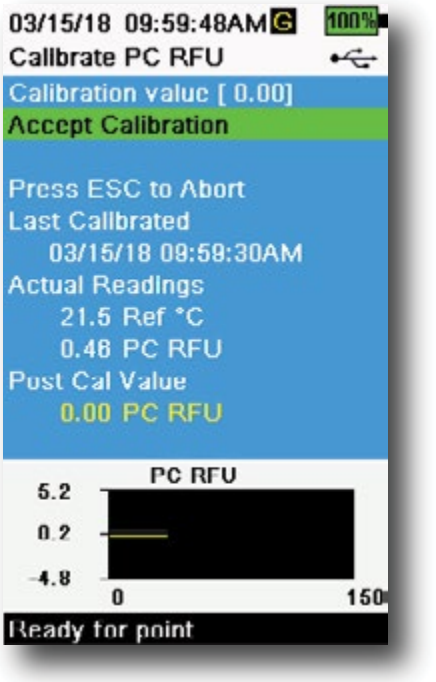


Figure 58 Calibrate PC RFU

PE, PC and Chlorophyll Calibration 2-Point

Each channel of the sensor must be calibrated independently. Calibration of the chlorophyll channel does not set the calibration for the PC channel or the PE channel. In addition, calibrating in RFU for a channel does not automatically calibrate the µg/L measurement for the same channel. The following calibration procedure must be performed for each channel and each unit the user would like to display.

1. Fill the calibration cup to the appropriate level with deionized water (0 standard). Immerse the probe in the standard. Make sure the sensor guard is installed.
2. Push the Cal key, then select either **TAL-PC** or **TAL-PE**, depending on the sensor to be calibrated.
3. Select the channel and units to be calibrated. Options for the TAL-PC sensor are shown in Figure 56, while options for the TAL-PE sensor are shown in Figure 57.
4. Select **Calibration Value** and enter 0.00.
5. Make sure there are no air bubbles on the sensor lens. If present, lightly tap the guard against the cup to dislodge any bubbles. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), and then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
6. Discard the used water, and rinse the probe, guard, and calibration cup with a small amount of the standard for calibration point #2. Discard the rinse standard.

   NOTE: *For standard #2, use the 0.625 mg/L Rhodamine WT solution when calibrating chlorophyll (RFU or µg/L) on either TAL sensor, or when completing a PC (RFU or µg/L) calibration on a TAL-PC sensor. Use the 0.025 mg/L Rhodamine WT solution when completing a PE (RFU or µg/L) calibration on a TAL-PE sensor.*

7. Fill the calibration cup to the appropriate level with fresh standard #2. Immerse the sensors in the second calibration standard.
8. Observe the temperature reading on the calibration display (Figure 58). Use the table in the Rhodamine WT dye solution preparation section to identify the appropriate value for the calibration standard.
9. Select **Calibration Value** and enter the value of the second calibration standard.
10. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. The procedure will automatically finish after calibrating using the second standard.

3.8 pH/ORP

Observe the pH mV readings during calibration to understand the condition and response of the pH sensor. In buffer 7, pH mVs should be between -50 and +50. In pH4 buffer, the mV reading should be 165 to 180 mV higher than the reading in pH 7 buffer. In pH 10 buffer, the mV reading should be 165 to 180 mV lower than the reading in pH 7 buffer. The theoretically ideal slope is -59 mV/pH unit.

1-Point
While a 1-point pH calibration is possible, this calibration procedure adjusts only the pH offset and leaves the previously determined slope unaltered. This should only be performed if you are adjusting a previous 2-point or 3-point calibration.

2-point
Perform a 2-point pH calibration if the pH of the media to be monitored is known to be either basic or acidic. In this procedure, the pH sensor is calibrated with a pH 7 buffer and a pH 10 or pH 4 buffer depending upon the pH range you anticipate for your water to be sampled.

3-point
Perform a 3-point pH calibration to assure maximum accuracy when the pH of the environmental water cannot be anticipated or fluctuates above and below pH 7. In this procedure, the pH sensor is calibrated with pH 7, pH 10, and pH 4 buffer solutions.

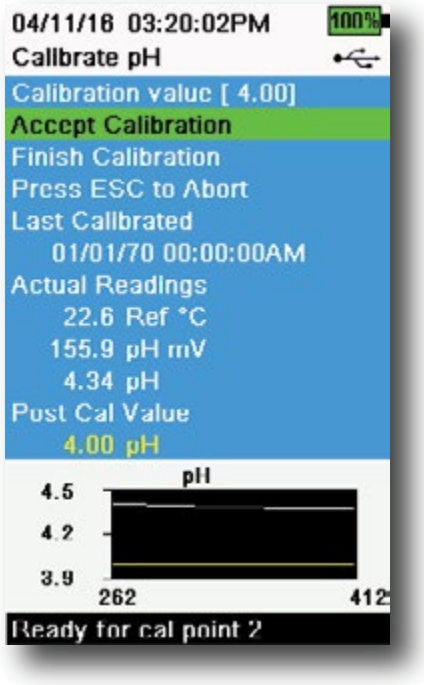


Figure 59 Calibrate pH 2- or 3-point

pH Calibration 3-Point

1. Always start the calibration with pH 7 buffer. Fill the calibration cup to the appropriate level with pH 7 buffer solution.
2. With the probe guard installed, carefully immerse the probe into the buffer solution. Make sure both the pH sensor and temperature sensor are submerged.
3. Push the (Cal) key; then select **pH** or **pH/ORP**.
4. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature. Alternatively, the Calibration value can be manually entered..
5. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.
6. Select **Accept Calibration** and press the (ENTER) key. "Ready for cal point 2" will be displayed in the message area.
7. Rinse the probe and calibration cup. Fill to the appropriate level with either pH 10 or pH 4 buffer solution; it doesn't matter which one comes next.
8. Immerse the probe into the buffer solution. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature.
9. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.
10. Select **Accept Calibration** and press the (ENTER) key. "Ready for cal point 3" will be displayed in the message area.

NOTE: *For 2-Point calibrations, select Accept Calibration before selecting Finish Calibration.*

11. Rinse the probe and calibration cup. Fill to the appropriate level with the final buffer solution.

12. Immerse the probe into the buffer solution. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature.

13. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.

14. Select **Accept Calibration** and press the ENTER key. The procedure will automatically finish after calibrating the third point.

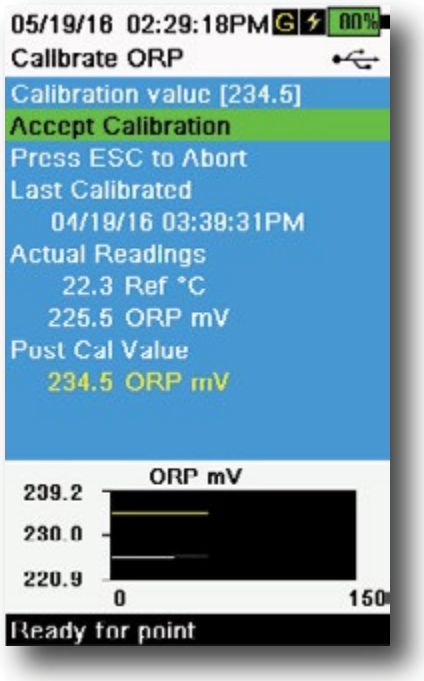


Figure 60 Calibrate ORP

ORP Calibration

1. Obtain a premixed standard solution that is approved for use with Ag/AgCl ORP sensors or prepare a standard with a known oxidation reduction potential (ORP) value. Zobell solution is recommended.

2. With the probe guard installed, carefully immerse the probe into the standard solution. Make sure both the ORP sensor and temperature sensor are submerged.

3. Push the Cal key, then select **pH/ORP**, then **ORP**.

4. If using YSI Zobell solution, the **Calibration value** will automatically be adjusted based on the temperature. Otherwise, refer to the table included with the standard solution and enter the mV value that corresponds to the temperature of the solution.

5. Wait for the ORP mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.

6. Select **Accept Calibration** and press the ENTER key. "Calibration successful!" will be displayed in the message area.

3.9 ISEs

Ammonium, Nitrate, & Chloride

YSI recommends a 2-point calibration for ISEs. For best results, use standards that differ by 2 orders of magnitude:

- 1 mg/L and 100 mg/L for Ammonium and Nitrate
- 10 mg/L and 1,000 mg/L for Chloride

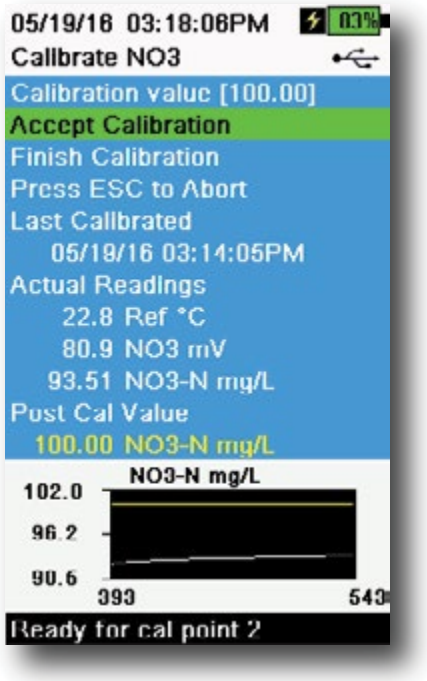


Figure 61 Calibrate ISE

ISE Calibration

1. Fill the calibration cup to the appropriate level standard for calibration point #1. Immerse the probe in the standard.
2. Push the Cal key, then select the applicable ISE sensor.
3. Select **Calibration value** and enter the value that corresponds to the first calibration standard.
4. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
5. Discard the used standard and rinse the probe and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
6. Fill the calibration cup to the appropriate level with fresh standard for the second calibration point. Immerse the probe in the standard.
7. Select **Calibration value** and enter the value of the second calibration standard.
8. Observe the actual measurement readings for stability, and then select **Accept Calibration** (Figure 61). "Ready for cal point 3" will be displayed in the message area.
9. Select **Finish Calibration** to complete a 2-point calibration.

Optimal mV for ISE calibration

Ammonium mV values

- NH_4 1 mg/L = 0 mV +/- 20 mV (new sensor only)
- NH_4 100 mg/L = 90 to 130 mV greater than the mV reading in the 1 mg/L standard
- The mV span between 1 mg/L and 100 mg/L values should be approximately 90 to 130 mV. The slope should be 45 to 65 mV per decade of ammonium concentration in mg/L

Nitrate mV values

- NO_3 1 mg/L = 200 mV +/- 20 mV (new sensor only)
- NO_3 100 mg/L = 90 to 130 mV less than the mV reading in the 1 mg/L mV standard
- The mV span between 1 mg/L and 100 mg/L values should be approximately 90 to 130 mV. The slope should be -45 to -65 mV per decade of nitrate concentration in mg/L

Chloride mV values

- Cl 10 mg/L = 225 mV +/- 20 mV (new sensor only)
- Cl 1,000 mg/L = 80 to 130 mV < 10 mg/L mV value
- The mV span between 10 mg/L and 1000 mg/L values should be approximately 80 to 130 mV. The slope should be -40 to -65 mV per decade of chloride concentration in mg/L

Chilled Third Calibration Point

The chilled 3-point calibration is recommended if there is a large temperature variation during sampling or when the temperature of the media cannot be anticipated. The highest concentration solution and one of the lower concentration solutions should be at ambient temperature. The other lower concentration solution should be chilled to less than 10°C to prior calibration point.

1. Discard the used standard and rinse the probe and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
2. Fill the calibration cup to the appropriate level with fresh standard for the third calibration point. Immerse the probe in the standard.
3. Select **Calibration value** and enter the value of the third calibration standard.
4. Observe the actual measurement readings for stability, and then select **Accept Calibration**. "Calibration successful!" will be displayed in the message area.

Preparing Standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can follow these recipes to prepare their own standards.

⚠ **CAUTION:** Some of the chemicals required for these solutions could be hazardous under some conditions; therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these chemicals.

Ammonium Standards

You will need:

- Solid ammonium chloride or a certified 100 mg/L NH_4^+-N from a supplier
- Lithium acetate dihydrate
- Concentrated hydrochloric acid
- High purity water
- A good quality analytical balance
- A 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL and 10 mL of solution
- And a 1000 mL glass or plastic storage vessels

⚠ **CAUTION:** Hydrochloric acid is highly corrosive and toxic and should therefore be handled with extreme care in a well-ventilated fume hood. The equivalent amount of a less-hazardous, more dilute sample of the acid may be used if preferred.

100 mg/L Standard

1. Accurately weigh 0.3817 g of ammonium chloride and transfer quantitatively into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water to the flask. Swirl to dissolve all of the reagents and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity. Alternatively, 100 mL of certified 100 mg/L NH_4^+-N standard can be used in place of the solid ammonium chloride.

Ammonium Standards *(continued)*

1 mg/L Standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity.

Other concentrations can be made by altering the amount of ammonium chloride. All other ingredient concentrations should remain unchanged.

Nitrate Standards

You will need:

- Solid potassium nitrate or a certified 1000 mg/l NO_3-N from a supplier
- Magnesium sulfate, high purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL, 10 mL and 1 mL of solution
- And 1000 mL glass or plastic storage vessels

100 mg/L standard

1. Accurately weigh 0.7222 g of anhydrous potassium nitrate and transfer quantitatively into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of water to the flask. Swirl to dissolve all of the reagents, and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Rinse the flask extensively with water prior to its use in the preparation of the 1 mg/l standard. Alternatively, 100 mL of certified 1000 mg/L NO_3-N standard can be used in place of the solid potassium nitrate.

1 mg/L standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents, and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.

Other concentrations can be made by altering the amount of potassium nitrate. All other ingredient concentrations should remain unchanged.

Chloride Standards

You will need:

- Solid sodium chloride or a certified 1000 mg/L chloride solution from a supplier
- Magnesium sulfate
- High-purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- An accurate 10 mL measuring devices
- And 1000 mL glass or plastic storage vessels

1000 mg/L Standard

1. Accurately weigh 1.655 grams of anhydrous sodium chloride and transfer into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water to the flask, swirl to dissolve all of the reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 1000 mg/L standard to a storage bottle.
5. Rinse the flask extensively with water prior to its use in the preparation of the 10 mg/L standard. Alternatively, simply add 0.5 grams of magnesium sulfate to a liter of a 1000 mg/L chloride standard from a certified supplier.

10 mg/L Standard

1. Accurately measure 10 mL of the above 1000 mg/L standard solution into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water, swirl to dissolve the solid reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 10 mg/L standard to a storage bottle.

4. Maintenance and Storage

Follow all maintenance and storage procedures in this section. Incorrect or unapproved maintenance and/or storage can cause handheld, sensor or cable damage not covered by the warranty.

Storage terms are defined as follows:

Short-term Storage = Less than 4 weeks

Short-term storage is appropriate when the handheld, cables, and sensors will be used at regular intervals (daily, weekly, etc.).

Long-term Storage = More than 4 weeks

During long periods of inactivity, such as the "off-season" for environmental monitoring, the instrument, sensors, and cables should be placed in long-term storage.

YSI recommends cleaning and maintenance before long-term storage.

4.1 ProDIGITAL Handheld

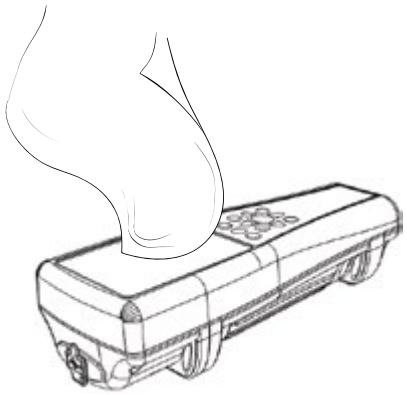


Figure 62 Handheld cleaning

Wipe the keypad, screen, and case with a cloth dampened with a mild solution of clean water and dish soap (Figure 62). Optimal storage temperature of the handheld instrument is 0-45°C. The battery pack permanently loses capacity at a faster rate when above 45°C.

Short-term Storage:

Assure that the handheld instrument is powered off, and store it in a temperature-controlled, secure location. Ideally all ports should be covered to prevent dust, water, or other contamination.

Long-term Storage:

In addition ot the short-term storage guidelines above, remove the battery pack to prevent any damage from possible battery leaks. Reinstall the battery cover. Store the battery pack in a dry place ideally around 25°C.

4.2 1-Port and 4-Port Bulkheads

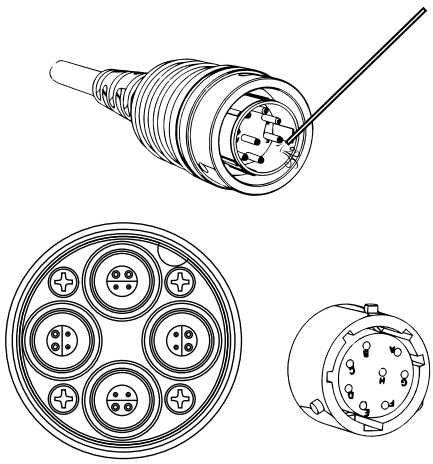


Figure 63 Cable, bulkhead, connector maintenance

Wipe the cable and bulkhead with a cloth dampened with a mild solution of clean water and dish soap. Make sure sensors or port plugs are installed so the bulkhead ports do not get wet when cleaning. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

For short-term storage, YSI recommends leaving the sensors installed on the bulkhead. The ODO, pH, and pH/ORP sensors must be kept in a moist air environment; therefore, place a small amount of water (5-10 mL) in the calibration cup and tighten the retaining nut to seal the storage chamber.

For long-term storage, YSI recommends uninstalling the sensors from the bulkhead and following each sensor's respective long-term storage instructions. Inspect the bulkhead ports and cable connectors for contamination. If dirty or wet, clean it with compressed air (Figure 63). Install the cap that protected the bulkhead during initial shipment. Alternatively, install the bulkhead port plugs.

4.3 Sensor Guard

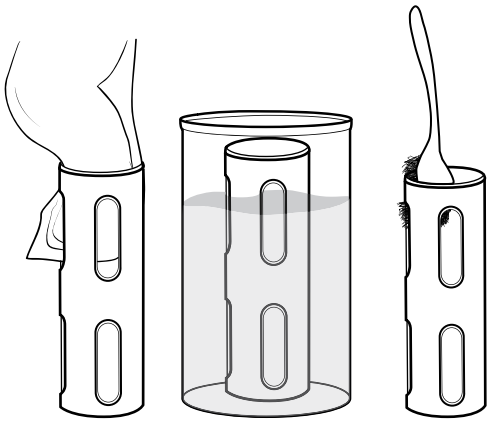


Figure 64 Sensor guard maintenance

Remove light bio-fouling with a cloth soaked in a mild solution of clean water and dish soap. Soak in vinegar to remove hard growth and deposits. Use a plastic scrub brush to remove any remaining bio-fouling. Rinse the sensor guard with clean water (Figure 64).

NOTICE: Do not sand or polish the guard. Removal of the guard coating can affect some sensor readings.

4.4 Depth Sensor



Figure 65 Depth sensor flush

The depth sensor should be flushed after each use. Fill the syringe (included with the maintenance kit) with clean water and gently push water through the ports located on the bulkhead. Flush until clean water flows from the opposite depth port (Figure 65).

The sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry.

NOTICE: Do not insert objects into the depth ports. Damage to the depth transducer from incorrect cleaning is not covered by the warranty.

4.5 Temperature Sensor

To ensure optimal performance, it is important to keep the temperature sensor free of any deposits. Rinse the thermistor after each use. If deposits have formed, use mild soapy water and a soft bristle cleaning brush. The ProDSS smart sensor can be stored wet or dry.

However, if you're using the **ODO/T** or **ODO/CT** cable assembly, the sensor must be stored in a moist enviornment. A grey storage sleeve is shipped with the cable for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

4.6 Conductivity Sensor

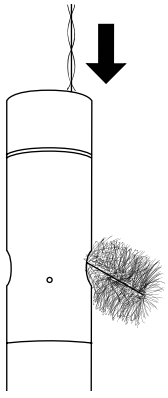


Figure 66 Channel brush

The conductivity channels should be cleaned after each use. Dip the sensor's cleaning brush (included with the maintenance kit) in clean water, insert the brush at the top of the channels, and sweep the channels 15 to 20 times (Figure 66).

If deposits have formed on the electrodes, use a mild solution of dish soap and water to brush the channels. For heavy deposits, soak the sensor in white vinegar, then scrub with the cleaning brush. Rinse the channels with clean water following the sweepings or soak.

The ProDSS sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry.

However, if you're using the **ODO/CT** cable assembly, the sensor must be stored in a moist enviornment.

4.7 Optical Dissolved Oxygen Sensor

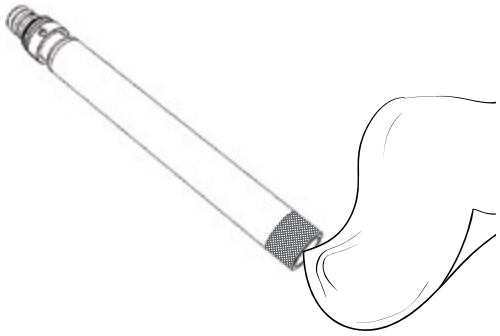


Figure 67 Wiping the ODO sensor window

The ODO sensor should be kept clean since some types of fouling may consume oxygen which could affect the dissolved oxygen measurements.

To clean the sensor cap, gently wipe away any fouling with a lens cleaning tissue that has been moistened with water to prevent scratches (Figure 67). Do not clean the ODO sensor with organic solvents as they may damage the cap.

To minimize sensor drift, always store the ODO sensor in a wet or water-saturated air environment.

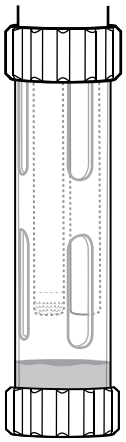


Figure 68 ODO short-term storage

Short-term Storage:

Store the ODO sensor in a moist air environment. A storage sleeve with a wet sponge or the calibration cup with a small amount of water is recommended (Figure 68).

This is true for both ProDSS sensors and the ODO cables assemblies.

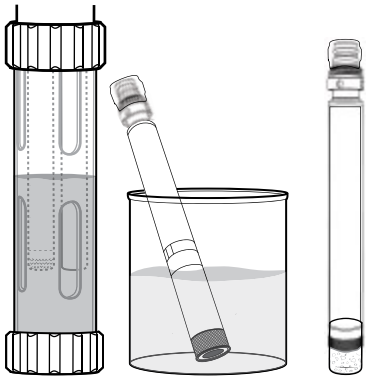


Figure 69 ODO long-term storage

Long-term Storage:

- **Method 1:** Submerge the sensing end of the sensor in a container of distilled or deionized water. Periodically check the level of the water to make sure that it does not evaporate.
- **Method 2:** Wet the sponge located in the cap originally included with the ODO sensor, then install on sensing end of the ODO sensor. Replace the sponge if it becomes dirty.

For ProDSS ODO sensors, the sensor can be left on the 4-port bulkhead or removed for long-term storage (Figure 69).

For ODO cable assemblies, the sensor must be stored in a moist enviornment. A grey storage sleeve is shipped with the cable for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

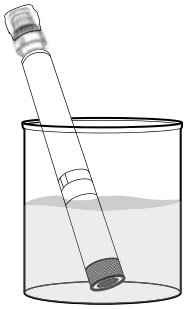


Figure 70 ODO rehydration

ODO Sensor Rehydration

If the ODO sensor has accidentally been left dry for longer than 8 hours, it must be rehydrated. To rehydrate, soak the ODO sensor in room temperature tap water for approximately 24 hours. After the soak, calibrate the sensor (Figure 70).

ODO Sensor Cap

Optical DO sensor caps are warrantied for either 12 or 24 months depending on the model:

- ProDSS ODO Sensor Cap [SKU: 626890] = **12** months
- ODO Extended Warranty Sensor Cap [SKU: 627180] = **24** months

Depending on usage and storage practices, the cap may last longer than its warranty period.

As the ODO sensor caps ages, deterioration of the dye layer can reduce measurement stability and response time. Periodically inspect the sensor cap for damage and large scratches in the dye layer. Replace the cap when readings become unstable and cleaning the cap and DO recalibration do not remedy the symptoms.

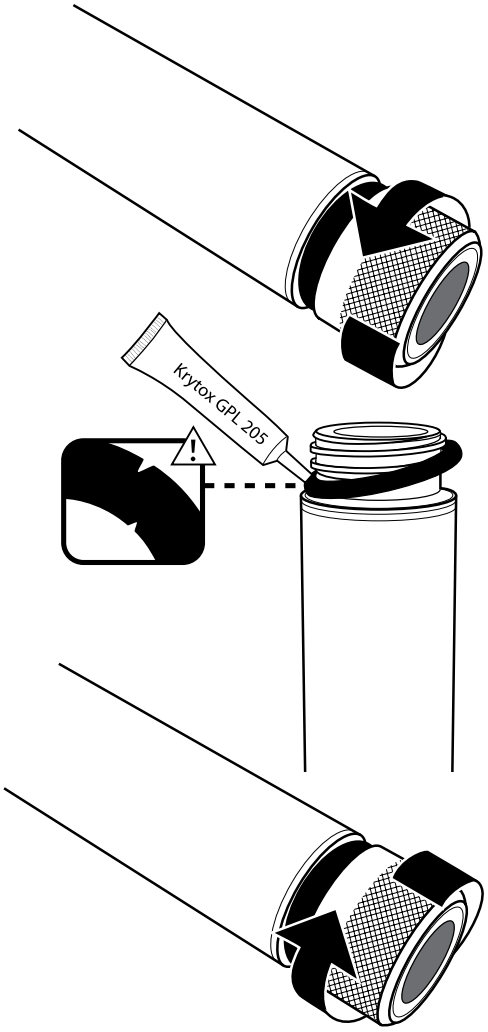


Figure 71 ODO cap replacement

ODO Sensor Cap Replacement

The instruction sheet shipped with the replacement ODO sensor cap includes the calibration coefficients specific to that sensor cap. Make sure to save the ODO sensor cap instruction sheet in case you need to reload the calibration coefficients.

1. Remove the old sensor cap assembly from the probe by grasping the probe body with one hand and rotating the sensor cap counterclockwise until it is completely free. Do not use any tools for this procedure.
2. Carefully remove the o-ring by pinching it with your fingers and rolling it up. Do not use any tools to remove the o-ring. Clean the area of any debris with a lens cleaning tissue.
3. Install the new o-ring that is included with the replacement sensor cap.
4. Apply a thin coat of o-ring lubricant (included with the new cap) to the installed o-ring. Remove any excess o-ring lubricant with a lens cleaning tissue. Be careful to avoid contact with the sensor lens.
5. Inspect the sensor lens for any moisture or debris. If necessary, wipe the lens carefully with a non-abrasive, lint-free cloth to prevent scratches. Do not use organic solvents to clean the ODO sensor lens.
6. Remove the new sensor cap from its hydrated container and dry the inside cavity of the sensor cap with lens cleaning tissue. Make sure the cavity is completely dry before proceeding with the installation.
7. Using clockwise motion, thread the new sensor cap onto the probe assembly until it is finger-tight. The o-ring should be compressed between the sensor cap and probe. Do not over-tighten the sensor cap and do not use any tools for the installation process.
8. After installing the new sensor cap, store the sensor in either water or in the water-saturated air storage chamber.

NOTE: *Be sure to update the ODO Sensor Cap Coefficients after replacement.*

Updating the ODO Sensor Cap Coefficients

After installing a new sensor cap, connect the probe to the handheld and turn the instrument on. Locate the Calibration Code Label on the ODO Sensor Cap Instruction Sheet. This contains the calibration codes for this particular sensor cap. Follow the procedures below to enter the new calibration coefficients into the instrument.

1. Push the  key to access the Sensor menu, then select **Setup**, then **ODO**.
2. Select **Sensor Cap Coefficients**.
3. Highlight each coefficient in turn (K1 through KC) and use the numeric entry screen to enter the corresponding new coefficient from the Calibration Code Label. Push the 

key after each entry and then proceed to the next K selection.
4. After all the new coefficients have been entered, select **Update Sensor Cap Coefficients**.
5. A message will appear warning that you will be overwriting the current sensor cap coefficients and you should confirm that you wish to carry out this action. Select **Yes** to confirm the new coefficients.

After updating the Coefficients, the Serial # in the Sensor Cap menu will be updated automatically based on your entries.

If errors are made in entering the Sensor Cap Coefficients, the instrument will block the update and an error message will appear on the display. If you see this error message, re-enter the coefficients and check them carefully.

NOTE: *After entering the sensor cap coefficients, the ODO sensor must be calibrated.*

4.8 Turbidity & Total Algae Sensors

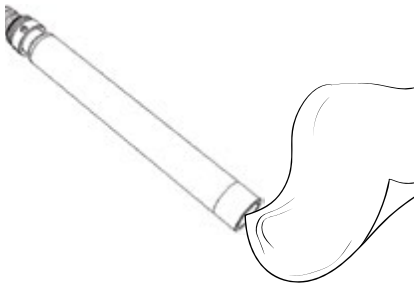


Figure 72 Wiping the sensor window

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 72). If necessary, use mild soapy water.

The sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry. Install the shipping cap or sensor guard to prevent scratches or damage to the optical sensing window.

4.9 pH/ORP Sensor

The pH and pH/ORP sensors are shipped with their tips in a storage bottle containing potassium chloride (KCl) solution. Keep this bottle for long-term storage.

Periodic maintenance is necessary to clear contamination from the sensing elements. Contaminants on the bulb and/or junction can slow sensor response time. Clean the sensors when deposits, bio-fouling or other contamination appears on the glass or when the sensor response time is noticeably slow. There are several methods to clean and restore the sensor depending on the severity of fouling or contamination.

Cleaning Methods

Standard Rinse

Rinse the sensor with tap water each time it is brought in from the field. This is generally recommended for most sensors and use cases to clear mild contamination.

If contaminants remain or the sensor exhibits a slow response time, continue with advanced cleaning.

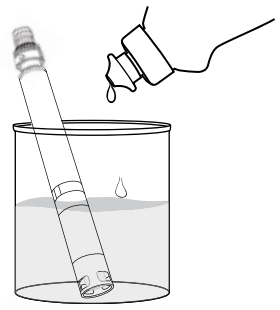


Figure 73 Cleaning the pH and pH/ORP sensor with dish soap

Advanced Cleaning

For moderate contamination or slow response after advanced rinsing, remove the sensor from the bulkhead and perform the following steps:

1. Remove any foreign matter from the sensor tip. If necessary, use a moistened cotton swab to carefully remove foreign material from the glass bulb and junction. Be careful to avoid direct contact with the glass bulb. The bulbs are fragile and will break if pressed with sufficient force.
2. Soak for 10 minutes in a mild solution of clean water and dish soap (Figure 73). Rinse the sensor with tap water and inspect.

If contaminants are removed, attach the sensor to the bulkhead and test the response time.

If contaminants remain or response time does not improve, continue to the hydrochloric acid (HCl) soak.

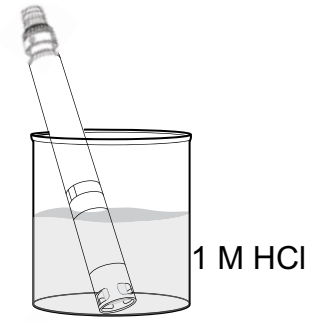


Figure 74 Cleaning the pH and pH/ORP sensor with hydrochloric acid

Acid Soak

For heavy contamination or slow response after advanced cleaning, remove the sensor from the bulkhead and perform the following steps:

1. Soak the sensor for 30 to 60 minutes in one molar (1 M) HCl (Figure 74). HCl reagent can be purchased from most chemical or laboratory distributors. To prevent injury, carefully follow the HCl manufacturer's instructions. If HCl is not available, soak in white vinegar.
2. After soaking, thoroughly rinse the sensor with tap water. Then soak the sensor in clean tap water for 60 minutes, stirring occasionally. Finally, rinse the sensor once again with tap water.

Attach the sensor to the bulkhead and test the response time. If response time does not improve or biological contamination of the reference junction is suspected, continue to the chlorine bleach soak.

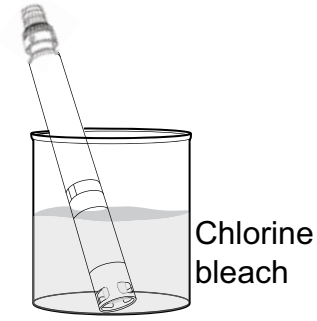


Figure 75 Cleaning the pH and pH/ORP sensor with chlorine bleach

Bleach Cleanse

If biological contamination of the reference junction is suspected or if good response is not restored by the previous methods, remove the sensor from the bulkhead and perform the following steps:

1. Soak the sensor for 60 minutes in a 1:1 dilution of chlorine bleach and tap water.
2. After soaking, thoroughly rinse the sensor with tap water. Then soak the sensor in clean tap water for 60 minutes. Finally, rinse the sensor once again with tap water.

Attach the sensor to the bulkhead and test the response time. If response time does not improve the sensor may be nearing the end of its useful life.

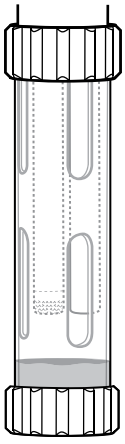


Figure 76 pH and pH/ORP short-term storage

Short-term Storage:

When in regular field use, the pH-pH/ORP sensors should remain on the bulkhead with the calibration/storage cup installed. Place a small amount of tap or surface water in the cup prior to storage or transport. The probes should be kept in this water-saturated air chamber between uses; not submerged (Figure 76). Make sure the storage cup makes a tight connection to prevent evaporation.

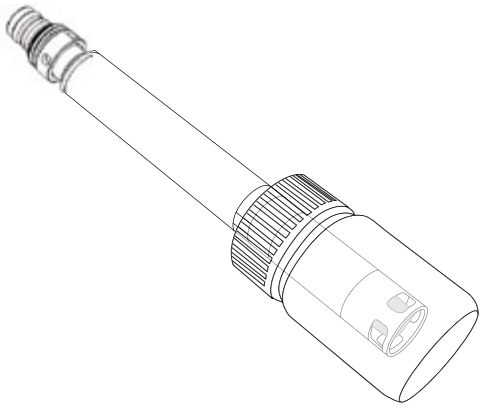


Figure 77 pH and pH/ORP long-term storage

Long-term Storage:

Remove the sensor from the bulkhead and plug the bulkhead port. Insert the sensor tip into the storage bottle and solution that were originally supplied with the sensor (Figure 77). The storage bottle features an open cap and o-ring to form a tight seal around the sensor tip; the solution contains KCl with potassium phthalate and a preservative. If this original solution is not available, one can prepare a 2 M KCl solution or use pH 4 buffer as an alternative, though these solutions should be monitored for microbial growth and replaced if growth is apparent. Other sensors and system components should not be stored in or exposed to these pH buffers for long periods of time.

NOTICE: Do NOT let the sensor dry out. Do NOT store the sensor in distilled or deionized water. Either of these will radically shorten the lifespan of the sensor module and void its warranty.

Sensor Module

The pH and pH/ORP sensors feature user-replaceable sensor modules. These modules contain a reference solution that depletes over time. The warranty period for both of these modules is 12 months:

- Replacement pH Module [SKU: 626963] = **12** months
- Replacement pH/ORP Module [SKU: 626964] = **12** months

Depending on usage and storage practices, the module may last longer than its warranty period. Replace the module if the sensor exhibits a slow response time after trying all the cleaning methods listed above.

4.10 ISE Sensor

ISE sensors are shipped with their tips in a storage bottle. Keep this bottle for long-term storage.

Do not let the ISE sensor reference electrode junctions dry out. Clean the sensors when deposits, bio-fouling or other contamination appears on the membrane.

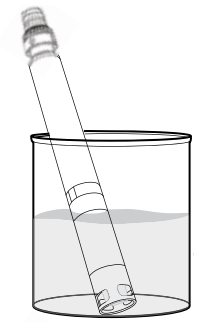


Figure 78 Soaking the ammonium or nitrate ISE sensor

Ammonium and Nitrate Sensor Maintenance

1. Carefully clean the ammonium or nitrate sensor by rinsing with DI water followed by soaking in the high standard calibration solution.
2. Carefully dab the sensor dry with a clean, lint-free cloth.

NOTICE: The ion-selective membranes are very fragile. Do not use coarse material (*e.g.* paper towels) to clean the membranes or permanent damage to the sensor can occur. The only exception is fine emery cloth on the chloride sensor.

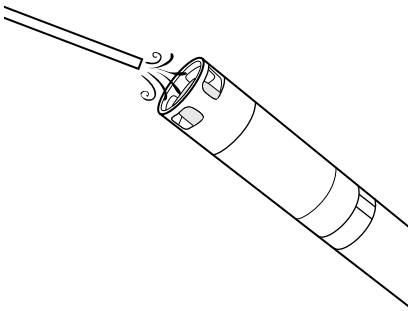


Figure 79 Rinsing the chloride sensor

Chloride Sensor Maintenance

1. Carefully clean the chloride sensor by carefully polishing with fine emery paper in a circular motion to remove deposits or discoloration.
2. Carefully rinse with DI water to remove any debris.

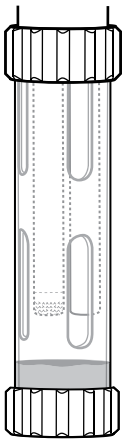


Figure 80 ISE short-term storage

Short-term Storage:

When in regular field use, ISEs should remain on the bulkhead with the calibration/storage cup installed. Place a small amount of tap or surface water in the cup prior to storage or transport. The probes should be kept in this water-saturated air chamber between uses; not submerged. Make sure the storage cup makes a tight connection to prevent evaporation (Figure 80).

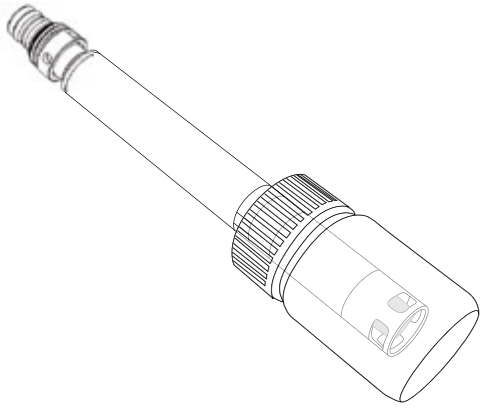


Figure 81 ISE long-term storage

Long-term Storage:

Remove the sensor from the bulkhead and plug the bulkhead port. Insert the sensor tip into the storage bottle with a small amount of high-calibration solution or tap water. The sensor tip should not be submerged. The storage bottle features an open cap and o-ring to form a tight seal around the sensor tip (Figure 81).

NOTICE: Do NOT let the sensor dry out. Do NOT store the ISE sensor in conductivity standard, pH buffer, or salt water. Either of these will radically shorten the lifespan or kill the sensor module and void its warranty.

Rehydrating the Reference Junction

If an ISE module has been allowed to dry, soak the sensor for several hours (preferably overnight) in the sensor's high-calibration solution. If the sensor is irreparably damaged, the sensor module must be replaced.

Sensor Module

Ammonium, chloride and nitrate sensors feature user-replaceable sensor modules. These modules contain a reference solution that depletes over time. The warranty period for ISE modules is 6 months:

- Replacement Nitrate Module [SKU: 626965] = **6** months
- Replacement Ammonium Module [SKU: 626966] = **6** months
- Replacement Chloride Module [SKU: 626967] = **6** months

Depending on usage and storage practices, the module may last longer than its warranty period. When it is time, perform a sensor module replacement in a clean, dry laboratory environment.

4.11 ProDSS Sensor Module Replacement

Sensor modules for pH, pH/ORP, nitrate, ammonium, and chloride all require periodic replacement. Perform a sensor module replacement in a clean, dry laboratory environment. Remove the sensor from the bulkhead and perform the following steps:

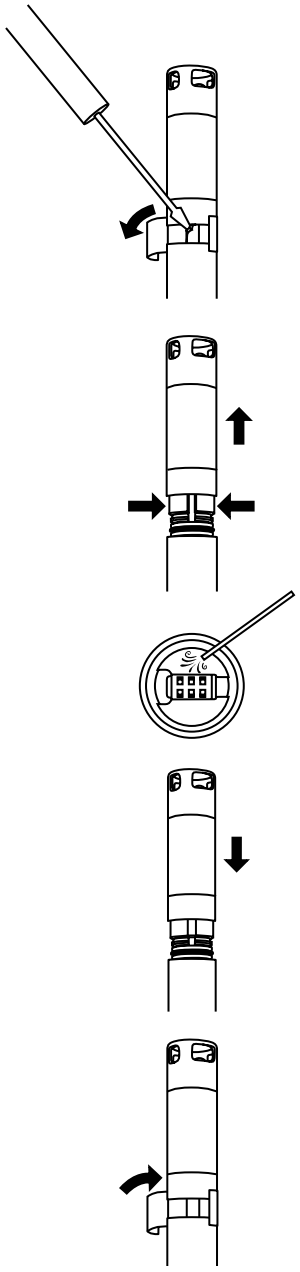


Figure 82 Sensor module replacement

Module Replacement

1. Peel off and discard the sticker that covers the junction of the sensor body and the module (Figure 82).
2. With a small, flat-blade screwdriver, carefully remove the square rubber plug from the gap in the hard plastic ring at the base of the sensor module.
3. Using two fingers, squeeze the sensor module's hard plastic ring so that it compresses the gap left by the rubber plug.
4. While squeezing, steadily pull the sensor module straight from the sensor body, rocking slightly if necessary. Do not keep the used o-rings as they are unusable after removal from the sensor body. Discard the old sensor module.
5. Inspect the sensor connector port for debris or moisture. If detected, remove it with lint-free cloth or a light blast of compressed air.
6. The new sensor module comes with two o-rings installed and pre-lubricated. Visually inspect the o-rings for nicks, tears, contaminants or particles. Replace any damaged o-rings.

   NOTICE: If a sensor module is removed for any reason, the o-rings must be replaced.

7. Align the prongs on the base of the sensor module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation. Push the sensor module firmly into position until it clicks. Wipe any excess o-ring lubricant from the assembled components.
8. Wrap the junction of the sensor module and sensor body with the new sticker included in the sensor module kit. The sticker helps keep the sensor module junction clean and retain the rubber plug throughout deployment.
9. Write the replacement date on the sticker.

NOTE: *Be sure to calibrate the sensor after module replacement.*

5. KorDSS Software

5.1 Introduction

KorDSS Software and drivers require permissions for successful installation. Administrative privileges may be necessary for a business or networked PC. Contact your organization's IT department for admin privileges.

System Requirements

Supported 32 bit (x86) and 64 bit (x64) Microsoft Operating Systems:

- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8 Home Basic
- Microsoft Windows 8 Home Premium
- Microsoft Windows 8 Professional
- Microsoft Windows 8 Enterprise
- Microsoft Windows 8.1 Basic
- Microsoft Windows 8.1 Professional
- Microsoft Windows 8.1 Enterprise
- Microsoft Windows 10 Home
- Microsoft Windows 10 Professional
- Microsoft Windows 10 Enterprise
- Microsoft Windows 10 Education

Ram Memory Requirement:

- Minimum of 2 GB of RAM installed

Hard Disk Free Space:

- Minimum of 500 MB of free hard drive space

Internet Access Required to Support:

- Software and device updates, software licensing

5.2 Installing the Driver and Software



Figure 83 KorDSS Installer



Figure 84 ProDSS Driver Installer



Figure 85 Back button



Figure 86 KorDSS license agreement



Figure 87 Launch KorDSS

Follow these steps to complete the installation process and establish connection to the handheld:

NOTE: *Be sure to install the driver* ***before*** *connecting the handheld to your PC for the first time.*

1. Insert the supplied USB flash drive into a USB port on your computer.
2. Depending on the PC operating system and system settings, the KorDSS Installer may appear. If it does not appear, open the flash drive in Windows Explorer and double-click **Start.exe** to start the installer. Figure 83 shows how the installer will appear once it starts.
3. On the KorDSS Installer, click **Install Driver**. Then choose to Install the driver on the screens that follow (Figure 84).
4. After the driver has installed, choose to go **Back** to the KorDSS Installer (Figure 85) .
5. On the KorDSS Installer, click **Install KorDSS Application**. A license agreement will appear (Figure 86).
6. You may be asked if you want to allow a program from an unknown publisher to make changes on the computer. If so, select **Yes**.
7. After successful installation of KorDSS, click **Launch** to start the program (Figure 87).
8. Connect the handheld meter to the PC with the supplied USB cable.
9. Power on the handheld and click **Connect** when it appears under the **Instrument Connection Panel**; there may be a short delay before it appears in the software.

6. Accessories

6.1 Ordering

Telephone: 800 897 4151 (USA)
+1 937 767 7241 (Globally) Monday through Friday
8:00 AM to 5:00 ET
Fax: +1 937 767 9353 (orders)
Email: info@ysi.com
Mail: YSI Incorporated 1725 Brannum Lane
Yellow Springs, OH 45387 USA
Web: Visit YSI.com to order replacement parts, accessories, and calibration stolutions.

When placing an order please have the following available:

1. YSI account number (if available)
2. Name and phone number
3. Purchase Order or Credit Card number
4. Model Number or brief description
5. Billing and shipping addresses
6. Quantity

ProDIGITAL Handhelds

YSI Item #	Description
626650	ProSolo handheld, no GPS, not compatible with ProSwap 1-port or ProDSS 4-port cable assemblies
626700-1	ProSwap handheld, no GPS, not compatible with ProDSS 4-port cable assemblies
626700-2	ProSwap handheld with GPS, not compatible with ProDSS 4-port cable assemblies
626870-1	ProDSS handheld, no GPS
626870-2	ProDSS handheld with GPS

ProDIGITAL Probe Assemblies

NOTE: *The ODO and OBOD sensor caps come pre-installed on the following probe assemblies, with calibration coefficients of the sensor cap pre-loaded into the probe at the factory.*

YSI Item #	Description
	Optical Dissolved Oxygen and Temperature Probes
627200-1	ODO/T Probe Assembly, 1m
627200-4	ODO/T Probe Assembly, 4m
627200-10	ODO/T Probe Assembly, 10m
627200-20	ODO/T Probe Assembly, 20m
627200-30	ODO/T Probe Assembly, 30m
627200-50	ODO/T Probe Assembly, 50m
627200-100	ODO/T Probe Assembly, 100m
	Optical Dissolved Oxygen, Conductivity, and Temperature Probes
627150-1	ODO/CT Probe Assembly, 1m
627150-4	ODO/CT Probe Assembly, 4m
627150-10	ODO/CT Probe Assembly, 10m
627150-20	ODO/CT Probe Assembly, 20m
627150-30	ODO/CT Probe Assembly, 30m
627150-50	ODO/CT Probe Assembly, 50m
627150-100	ODO/CT Probe Assembly, 100m
	Self-Stirring Optical Biochemical Oxygen Demand Probes
626400	ProOBOD probe assembly (lab BOD probe); U.S./Japanese version with power supply
626401	ProOBOD probe assembly (lab BOD probe); International version with power supply

ProSwap 1-Port Cable Assemblies (No Sensors Included)

YSI Item #	Description
626750-1	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 1m
626750-4	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 4m
626750-10	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 10m
626750-20	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 20m
626750-30	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 30m
626750-50	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 40m
626750-100	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 100m
626760-1	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 1m
626760-4	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 4m
626760-10	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 10m
626770-20	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 20m
626770-30	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 30m
626770-50	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 50m
626770-100	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 100m

ProDSS 4-Port Cable Assemblies (No Sensors Included)

YSI Item #	Description
626909-1	ProDSS 4-port cable assembly, no depth, 1m
626909-4	ProDSS 4-port cable assembly, no depth, 4m
626909-10	ProDSS 4-port cable assembly, no depth, 10m
626909-20	ProDSS 4-port cable assembly, no depth, 20
626909-30	ProDSS 4-port cable assembly, no depth, 30m
626909-40	ProDSS 4-port cable assembly, no depth, 40m
626909-50	ProDSS 4-port cable assembly, no depth, 50m
626909-60	ProDSS 4-port cable assembly, no depth, 60m
626909-70	ProDSS 4-port cable assembly, no depth, 70m
626909-80	ProDSS 4-port cable assembly, no depth, 80m
626909-90	ProDSS 4-port cable assembly, no depth, 90m
626909-100	ProDSS 4-port cable assembly, no depth, 100m
626910-1	ProDSS 4-port cable assembly, with depth, 1m
626910-4	ProDSS 4-port cable assembly, with depth, 4m
626910-10	ProDSS 4-port cable assembly, with depth, 10m
626911-20	ProDSS 4-port cable assembly, with depth, 20m
626911-30	ProDSS4-port cable assembly, with depth, 30m
626911-40	ProDSS 4-port cable assembly, with depth, 40m
626911-50	ProDSS 4-port cable assembly, with depth, 50m
626911-60	ProDSS 4-port cable assembly, with depth, 60m
626911-70	ProDSS 4-port cable assembly, with depth, 70m
626911-80	ProDSS 4-port cable assembly, with depth, 80m
626911-90	ProDSS 4-port cable assembly, with depth, 90m
626911-100	ProDSS 4-port cable assembly, with depth, 100m

ProDSS Sensors (for 1-Port and 4-Port Cable Assemblies)

YSI Item #	Description
626900	Optical dissolved oxygen sensor
626902	Conductivity and temperature sensor
626901	Turbidity sensor
626903	pH sensor with module
626904	pH/ORP sensor with module
626906	Ammonium sensor with module
626905	Nitrate sensor with module
626907	Chloride sensor with module
626210	Total algae sensor, PC
626211	Total algae sensor, PE

Replacement Sensor Modules and ODO Sensor Caps

YSI Item #	Description
626890	Replacement ProDSS Optical Dissolved Oxygen sensor cap (for 626900 smart sensor)
626482	Replacement ProOBOD Optical Dissolved Oxygen sensor cap (for 626400 or 626401 lab probes)
627180	Replacement ODO Extended Warranty Sensor Cap (only compatible with ODO/T and ODO/CT probe assemblies)
626963	Replacement ProDSS pH sensor module
626964	Replacement ProDSS pH/ORP sensor module
626966	Replacement ProDSS Ammonium sensor module
626965	Replacement ProDSS Nitrate sensor module
626967	Replacement ProDSS Chloride sensor module

Calibration Standards

YSI Item #	Description
065270	Conductivity standard, 1000 µmhos/cm (quart, glass); ideal for fresh water
065272	Conductivity standard, 10000 µmhos/cm (quart, glass); ideal for brackish water
065274	Conductivity standard, 100000 µmhos/cm (quart, glass); ideal for supersaturated sea water
060907	Conductivity standard, 1000 µmhos/cm (box of 8 individual pints, plastic); ideal for fresh water
060906	Conductivity standard, 1413 µmhos/cm, ±1%, 0.01 M KCl (box of 8 individual pints, plastic)
060911	Conductivity standard, 10000 µmhos/cm (box of 8 individual pints, plastic); ideal for brackish water
060660	Conductivity standard, 50000 µmhos/cm (box of 8 individual pints, plastic); ideal for sea water
061320	ORP (mV) standard, Zobell solution, powder - needs hydrated (125 mL bottle, plastic)
061321	ORP (mV) standard, Zobell solution, powder - needs hydrated (250 mL bottle, plastic)
061322	ORP (mV) standard, Zobell solution, powder - needs hydrated (500 mL bottle, plastic)
003821	pH 4 buffer (box of 6 individual pints, plastic); ideal for storage solution for pH sensor
003822	pH 7 buffer (box of 6 individual pints, plastic)
003823	pH 10 buffer (box of 6 individual pints, plastic)
603824	Assorted case of pH 4, 7, and 10 buffers (2 individual pints of each buffer, plastic)
005580	Confidence solution to verify conductivity, pH and ORP system (box of 6 individual 475 mL bottles, plastic). ***Note:*** *Not for calibration*
003841	Ammonium standard, 1 mg/L (500 mL, plastic)
003842	Ammonium standard, 10 mg/L (500 mL, plastic)
003843	Ammonium standard, 100 mg/L (500 mL, plastic)
003885	Nitrate standard, 1 mg/L (500 mL, plastic)
003886	Nitrate standard, 10 mg/L (500 mL, plastic)
003887	Nitrate standard, 100 mg/L (500 mL, plastic)
608000	Turbidity standard, 0 FNU (1 gallon, plastic)
607200	Turbidity standard, 12.4 FNU (1 gallon, plastic)
607300	Turbidity standard, 124 FNU (1 gallon, plastic)
607400	Turbidity standard, 1010 FNU (1 gallon, plastic)

ProDIGITAL Accessories

YSI Item #	Description
626946	Large, hard-sided carrying case (Fits ProDSS 4-port cables 10, 20, and 30 meters in length, cable management kit, handheld, and accessories)
603075	Large, soft-sided carrying case
626945	Small, hard-sided carrying case (Fits ProDSS 4-port cables 1 and 4 meters in length, handheld, flow cell, and accessories)
599080	Flow cell for ProDSS 4-port cables
603076	Flow cell for ODO/CT cables (requires single port adapter; 603078)
603078	Adapter required for ODO/CT flow cell (603076)
603056	Flow cell mounting spike
063507	Tripod (screws into back of meter)
063517	Ultra clamp (screws into back of meter)
603070	Shoulder strap
603069	Belt clip (screws into back of meter)
626942	USB car charger
626943	Small external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged handheld battery to about 50%)
626944	Large external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged battery to full charge, plus have power to charge a second battery to 20%)
626940	AC charger (USA). Includes power supply and USB cable (included with handheld)
626941	AC charger (international). Includes power supply, USB cable and outlet adapters (included with handheld)
626846	Replacement Lithium-ion battery pack
626969	USB flash drive (included with handheld)
626991	Cable for charging and PC connection (included as part of 626940 and 626941)
626992	Cable for connection to USB drive (included with handheld)
626990	ProDSS maintenance kit (included with all ProDSS 4-port cables): • 3 port plugs • 1 tube of o-ring lubricant • 1 brush • 1 syringe • 1 sensor installation/removal tool • O-rings (6)
626919	Sensor guard for 4-port ProDSS cable assembly (included with all 4-port cables)
599786	Calibration/storage cup for 4-port ProDSS cable assembly (included with all 4-port ProDSS cables)
627195	Calibration cup for ODO/CT cable assembly (included with all ODO/CT cables)
603062	Cable management kit (included with **ProDSS 4-port cables** 10, 20, and 30-meters long; **ODO/CT cables** 4, 10, 20, and 30-meters long; and **ODO/T cables** 4, 10, 20, and 30-meters long)
626918	1 lb weight (included with ProDSS 4-port cables 10-meters and longer)
605978	4.9 oz weight

7. Safety and Support

7.1 Rechargeable Lithium-Ion Battery Pack Safety Warnings and Precautions

⚠ **CAUTION:** Failure to follow the safety warnings and precautions can result in fire, personal injury and/or equipment damage not covered under warranty.

⚠ **CAUTION:** If the internal battery fluid comes into contact with skin, wash the affected area(s) with soap and water immediately. If it comes into contact with your eye(s), flush them with generous amounts of water for 15 minutes and seek immediate medical attention.

⚠ **CAUTION:** Always keep batteries away from children.

⚠ **WARNING:** In the unlikely event a lithium-ion battery catches fire, **DO NOT** attempt to put the fire out with water, use a Class A, B or C fire extinguisher.

Do:

- Store the battery pack in a cool, dry, ventilated area.
- Store the battery pack in a non-conductive and fireproof container.
- Store the battery pack at approximately 50% of the capacity.
- Disconnect the battery pack when not in use and for long-term storage.
- Follow applicable laws and regulations for transporting and shipping of batteries.
- *Immediately discontinue* use of the battery pack if, while using, charging or storing the battery pack:
  - Emits an unusual smell
  - Feel hot
  - Changes color
  - Changes shape
  - Appears abnormal in any other way.

Battery Pack General Precautions:

- **DO NOT** put the battery in fire or heat the battery.
- **DO NOT** connect the positive and the negative terminal of the battery to each other with any metal object (*e.g.* wire).
- **DO NOT** carry or store the battery pack with neckaces, hairpins or other metal objects.
- **DO NOT** carry or store the battery pack with hazardous or combustible materials.
- **DO NOT** pierce the battery pack with nails, strike with a hammer, step on or otherwise subject the battery pack to strong impacts or shocks.
- **DO NOT** solder directly onto the battery pack.
- **DO NOT** expose the battery pack to water or salt water or allow it to get wet.
- **DO NOT** disassemble or modify the battery pack. The battery contains safety and protection devices that, if damaged, can cause the battery to generate heat, rupture or ignite.
- **DO NOT** place the battery pack on or near fires, stoves or other high-temperature locations.
- **DO NOT** place the battery pack in direct sunlight or extreme temperatures for extended periods of time or store the battery pack inside cars in hot weather. Doing so may cause the battery pack to generate heat, rupture or ignite. Using the battery pack in this manner may also result in a loss of performance and a shortened life expectancy.
- **DO NOT** place the battery pack in microwave ovens, high-pressure containers or on induction cookware.
- **DO NOT** ship damaged or potentially defective batteries to YSI or any of our authorized service centers unless instructed otherwise. All federal and international shipping laws should be consulted prior to shipping lithium-ion batteries.

Charging/Discharging/Handling the Battery Pack

⚠ **WARNING:** Failure to follow the battery pack charging/discharging instructions can cause the battery to become hot, rupture or ignite and cause serious injury and/or equipment damage.

⚠ **WARNING:** Only charge the battery using charging devices designed specifically for the ProDIGITAL handheld by YSI. Use of unapproved chargers can result in battery failure and potentially serious injury to the user.

If at any time the battery pack becomes damaged, hot or begins to balloon or swell, discontinue charging (or discharging) immediately. Quickly and safely disconnect the charger. Then place the battery pack and/or charger in a safe, open area way from flammable materials. After one hour of observation, remove the battery pack from service. **DO NOT** continue to handle, attempt to use or ship the battery.

Damaged or swollen batteries can be unstable and very hot. **DO NOT** touch batteries until they have cooled. In the event of a fire use a Class A, B, or C fire extinguisher. **DO NOT** use water.

- **DO NOT** attach the battery pack to a power supply plug or directly to a car's cigarette lighter.
- **DO NOT** place the battery pack in or near fire or into direct extended exposure to sunlight. When the battery pack becomes hot, the built-in safety equipment is activated, preventing the battery pack from charging further. Heating the battery pack can destroy the safety equipment and cause additional heating, breaking or ignition.
- **DO NOT** leave the battery pack unattended while charging.

  NOTICE: The ambient temperature range over which the battery pack can be discharged is -20°C to 60°C (-4°F to 140°F). Use of the battery pack outside of this temperature range may damage the performance of the battery pack or may reduce its life expectancy.

- **DO NOT** discharge the battery pack using any device except for a ProDIGITAL handheld. When the battery pack is used in other devices it may damage the performance of the battery or reduce its life expectancy. Use of a non-approved device to discharge the battery pack can cause an abnormal current to flow, resulting in the battery pack to become hot, rupture or ignite and cause serious injury.
- **DO NOT** leave the battery pack unattended while discharging.

Battery Disposal

When the battery pack is worn out, insulate the terminals with adhesive tape or similar materials before disposal. Dispose of the battery pack in the manner required by your city, county, state or country. For details on recycling lithium-ion batteries, please contact a government recycling agency, your waste-disposal service or visit reputable online recycling sources such as www.batteryrecycling.com.

This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

For more information about where you can drop off your waste equipment for recycling, please contact your local city office, or your local waste disposal service. **DO NOT ship batteries to YSI or a YSI authorized service center unless instructed to do otherwise.**

Contact YSI Technical Support at (937) 767-7241 if you have additional questions.

7.2 Service Information

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit ysi.com and click 'Support' or contact YSI Technical Support directly at 800-897-4151 (+1 937-767-7241).

When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from YSI.com.

7.3 Technical Support

Telephone: 800 897 4151 (USA)

+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET

Fax: +1 937 767 9353 (orders)

Email: info@ysi.com

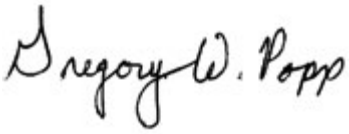
Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA

Internet: YSI.com

7.4 Declaration of Conformity

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for the listed European Council Directive(s) and carries the CE mark accordingly.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	ProDSS, ProSwap, ProSolo
Conforms to the following:	
Directives:	EMC 2004/108/EC RoHS 2011/65/EU WEEE 2012/19/EU
Harmonized Standards:	EN61326-1:2013 (IEC 61326-1:2012) IEC 61000-3-2:2005 +A1:2008+A2:2009 IEC 61000-3-3:2008
Supplementary Information:	All performance met the operation criteria as follows: 1. ESD, IEC 61000-4-2:2008 2. Radiated Immunity, IEC 61000-4-3:2006 +A1:2007+A2:2010 3. Electrical Fast Transient (EFT), IEC 61000-4-4:2004 +A1:2010 4. Immunity to Surge, IEC 61000-4-5:2005 5. Radio Frequency, Continuous Conducted Immunity, IEC61000-4-6:2008 6. IEC 61000-4-8:2009 7. IEC 61000-4-11:2004
Authorized EU Representative	Xylem Analytics UK Ltd Unit 2 Focal Point, Lacerta Court, Works Road Letchworth, Hertfordshire, SG6 1FJ UK



Signed: Gregory Popp
Title: Quality Manager

Date: March 10, 2020

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for electrical equipment under US FCC Part 15 and ICES-003 for unintentional radiators.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	Professional Digital Sampling System Instrument
Model Numbers	
Instrument/Accessory:	ProDSS non-GPS (626870-1) / ProDSS GPS (626870-2), ProSwap non-GPS (XXX), ProSwap GPS (XXX), ProSolo (626650)
Probe/Cable Assemblies:	626909-1, 626909-4, 626909-10, 626909-20, 626909-30, 626909-40, 626909-50, 626909-60, 626909-70, 626909-80, 626909-90, 626909-100, 626910-1, 626910-4, 626910-10, 626911-20, 626911-30, 626911-40, 626911-50, 626911-60, 626911-70, 626911-80, 626911-90, 626911-100 626750-1, 626750-4, 626750-10, 626750-20, 626750-30, 626750-50, 626750-100 626760-1, 626760-4, 626760-4 626770-20, 626770-30, 626770-50, 626770-100, 627200-1, 62700-4, 627200-10, 627200-20, 627200-30, 627200-50, 627200-100 627150-1, 627150-4, 627150-10, 627150-20, 627150-30, 627150-50, 627150-100 626250-1, 626250-4, 626250-10, 626250-20, 626250-30, 626250-40, 626250-50, 626250-60, 626250-70, 626250-80, 626250-90, 626250-100 626400, 626401
Sensors:	626900, 626902, 626901, 626903, 626904, 626906, 626905, 626907, 626210, 626211
Conforms to the following:	
Standards:	• FCC 47 CFR Part 15-2008, Subpart B, Class B, Radio Frequency Devices • ICES-003:2004, Digital Apparatus
Supplementary Information:	Tested using ANSI C63.4-2003 (excluding sections 4.1, 5.2, 5.7, 9, and 14)



Signed: Gregory Popp Date: March 10, 2020
Title: Quality Manager

7.5 Warranty

The YSI Professional Series Digital (ProDIGITAL) handheld meters are warranted for three (3) years from date of purchase by the end user against defects in materials and workmanship. Digital sensors and cables (ProSwap 1-port, ProDSS 4-port, ODO/CT, ODO/T, and ProOBOD) are warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. The ODO Extended Warranty Sensor Cap (627180) for the ODO/T and ODO/CT cable assemblies is warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. ProDSS pH and pH/ORP sensor modules, optical ODO sensor caps (all but the 627180 cap previously mentioned), and Li-Ion battery pack are warranted for one (1) year from date of purchase by the end user against defects in material and workmanship; ProDSS ISE sensor modules (ammonium, nitrate, and chloride) are warranted for 6 months. ProDIGITAL systems (instrument, cables & sensors) are warranted for 1 year (excluding sensor modules) from date of purchase by the end user against defects in material and workmanship when purchased by rental agencies for rental purposes. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio at +1 937 767-7241, 800-897-4151 or visit www.YSI.com (Support tab) for a Product Return Form. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

LIMITATION OF WARRANTY

This Warranty does not apply to any YSI product damage or failure caused by:

1. Failure to install, operate or use the product in accordance with YSI's written instructions;
2. Abuse or misuse of the product;
3. Failure to maintain the product in accordance with YSI's written instructions or standard industry procedure;
4. Any improper repairs to the product;
5. Use by you of defective or improper components or parts in servicing or repairing the product;
6. Modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

8. Appendices

8.1 Appendix A
DO% Calibration Values

Calibration Value	Pressure			
D.O. %	**in Hg**	**mmHg**	**kPa**	**mbar**
101%	30.22	767.6	102.34	1023.38
100%	29.92	760.0	101.33	1013.25
99%	29.62	752.4	100.31	1003.12
98%	29.32	744.8	99.30	992.99
97%	29.02	737.2	98.29	982.85
96%	28.72	729.6	97.27	972.72
95%	28.43	722.0	96.26	962.59
94%	28.13	714.4	95.25	952.46
93%	27.83	706.8	94.23	942.32
92%	27.53	699.2	93.22	932.19
91%	27.23	691.6	92.21	922.06
90%	26.93	684.0	91.19	911.93
89%	26.63	676.4	90.18	901.79
88%	26.33	668.8	89.17	891.66
87%	26.03	661.2	88.15	881.53
86%	25.73	653.6	87.14	871.40
85%	25.43	646.0	86.13	861.26
84%	25.13	638.4	85.11	851.13
83%	24.83	630.8	84.10	841.00
82%	24.54	623.2	83.09	830.87
81%	24.24	615.6	82.07	820.73
80%	23.94	608.0	81.06	810.60
79%	23.64	600.4	80.05	800.47
78%	23.34	592.8	79.03	790.34
77%	23.04	585.2	78.02	780.20
76%	22.74	577.6	77.01	770.07
75%	22.44	570.0	75.99	759.94
74%	22.14	562.4	74.98	749.81
73%	21.84	554.8	73.97	739.67
72%	21.54	547.2	72.95	729.54

8.2 Appendix B
Oxygen Solubility Table

Solubility of oxygen in mg/L in water exposed to water-xaturated air at 760 mm Hg pressure.

Salinity = Measure of quantity of dissolved salts in water.

Chlorinity = Measure of chloride content, by mass, of water.

S(0/00) = 1.80655 x Chlorinity (0/00)

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.93	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	6.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;

2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

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ANALYTICAL SOPs

Lab	SOP Title	SOP Title
EET	6	Analysis of Volatile Organic Compounds in SUMMA™ Polished Canisters by Modified EPA Methods TO-14A/TO-15*, 05/24/24, Revision 52
EET	50	Sample Receiving/Login Procedures, 4/30/26, Revision 34
EET	54	Analysis of Natural Gases by Modified ASTM D1945, 07/23/25, Revision 34
EET	63	Sample Tracking, Transmittal and Custody Procedures, 07/23/25, Revision 27
EET	83	EPA Method TO-14A/TO-15 Volatile Organic Compounds (Low-Level), March 5, 2026, Revision 32*
EET	91	EPA Method TO-14A/TO-15 Volatile Organic Compounds (5&20 ppbv)*
AAC	SCAQMD 307.91	Determination of Sulfur Compounds in a Gaseous Matrix by Gas Chromatography and Chemiluminescence, 10/09/25, Revision 7*
AAC	LAB.107	Sample Receiving, Shipping and Disposal, 3/18/2024, Revision 12
AAC	LAB.103	Sample Login Using Labtrack, 3/18/2024, Revision 3
SGS	MS010.14	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260 SIM), 10/2025
SGS	MET108.11	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D), 04/2026
SGS	GN237-06	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A), 09/2025
SGS	SAM101.23	Sample Receipt and Storage, 9/1/2024
SGS	SAM108.14	Sample and Laboratory Waste Disposal, 11/2025

Notes:
AAC = Atmospheric Analysis and Consulting
EET = Eurofins Environment Testing Northern California
SGS = SGS North America
*SOP available upon request

Eurofins Environment Testing Northern California, LLC

STANDARD OPERATING PROCEDURE

SOP #50

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1) PURPOSE

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The purpose of this Standard Operating Procedure is to outline the procedures for receiving samples, entering them into the Laboratory Information Management System (LIMS), and logging them into the proper sample storage area. This SOP establishes specific guidelines for sample acceptance, which are generally accepted practices under EPA, DoD-ELAP, DOECAP and NELAP protocols. All samples must adhere to the Sample Acceptance Policy.

2) SCOPE

This document is applicable primarily to Login Recieving Staff and Project Managers/Project Manager Assistants.

3) PERSONNEL TRAINING AND QUALIFICATIONS

3.1 All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP.

3.2 All qualifed Login Receiving personnel must maintain training documentation and competencies as outlined in *Job Plan 93104* - Login Receiving Development Plan and assigned competencies.

4) SAMPLE RECEIPT

4.1) RECEIVING PACKAGES

When receiving a delivery, such as from Fed-Ex or UPS, keep the packages together until the last one is brought in. Count the items, confirm with the driver the number of packages received and sign for them. If the count isn't confirmed, have the driver rescan all the packages and verify that all packages are intended for this laboratory as signing for the packages assumes custody of them.

If the count from the driver is lower than the number of packages received, Receiving can accept and sign for the packages. (Example: FedEx Express shows it's delivering 45 packages, but receiving has counted 46 packages in total and verified the count. The Express driver is unable to locate the missing package to scan it in. Receiving can sign for and accept the delivery).

If the count from the driver is higher than the number of packages received. Receiving **CAN NOT** sign for the delivery and the driver must rescan all packages. (Example: The driver has a count of 40 samples being delivered. The count by receiving is 38 and this count has been verified by another Login Analyst. Receiving can not sign for the delivery and the driver must rescan packages.)

4.2) SORT PACKAGES

4.2.1 Line up coolers near the receiving counter. Place coolers from the same client (based on company and point of contact) touching, as these samples are probably from the same project.

4.2.2 In an appropriate area, line up the boxes. Boxes from the same client (based on company and point of contact) should be touching, as they are probably from the same project.

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4.3) OPENING PACKAGES AND RECEIPT DOCUMENTATION

4.3.1 Open all packages/boxes check for Sorbents/Passives/Tedlar Bags packed with canisters. Locate and fill out the COC (Chain of Custody). If there is no COC, notify the PM (Project Manager).

*Laboratory COCs have a place for the items noted below. If receiving a client COC, the following information still needs to be documented and there are stamps on the front counter to aid in this process.

4.3.2 In the Received section, place signature followed by "EATL" (to denote receipt by lab) and the date/time (in military time) when the samples arrived at EATL.

4.3.3 Verify and fill in Custody Seal Info.

ºYes: Custody seals present, intact, signed and dated.

ºNo: Custody seals present but not intact, not covering an opening or not signed and dated.

ºNone: Custody seals not present.

4.3.4 If applicable, measure and record the temperature of sample(s) via the Temperature Blank. Repack the ice and close the coolers to maintain temperature. **All sorbent/passive COCs must be stamped to record sample temperature information.** (See section 6.1 for storage requirements and documentation) If temperature recording is not applicable, write "NA" for the temperature.

4.3.4.1 Verify and fill in condition of sample(s).

ºGood: No obvious damage and proper temperature.

ºIf an issue is found, enter NCM on the COC: Issues include evidence of possible shipping damage, custody seals are not intact, samples were received at an improper temperature or the COC is incomplete (refer to section 5.0).

•Fill in Shipper Name (Ex: Fed-Ex). If shipping documents are loose, then detach them from package to be transferred with the COC into the work order folder. If the shipping documents cannot be detached from the package, write the tracking number on the Air Bill section of the COC or take a scan of the airbill and include the copy with the work order. (Note: If the airbill can be placed in folder there is no need to fill in the Air Bill#)

•If there is any indication on the COC that the samples are on a TAT of 7 Days or faster, place a red folder with the samples and if the indicated TAT is 4 Days or faster alert other Login Analysts as to the rush status and Place a Teal folder with the COC.

4.3.5 Do a cursory hold time check, alerting the lab and PM of any samples with sensitive hold times.

4.3.6 Samples Designated By Clients To Be Used For Evidentiary Purposes

4.3.6.1 Clients may designate that samples will be used for evidentiary purposes either on the COC or in some other documented manner.

4.3.6.2 Unless specific instructions are received from the client and are agreed to by the laboratory, samples that are designated for evidentiary purposes will be logged in and maintained identically to samples not identified for this purpose.

4.4) Triage

For more information detailing triage procedures, refer to *WI 50-2 Sample Receiving/Login Triage*

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Check Hold Times/Turn Around Times on the Profile

4.4.1 Open TALs and open the Cust. Service Mgmt>Project module. Look at the sample tag on the canister or the COC to determine the TALs project.

4.4.2 Click the Find button in the top left and search for the project number. **NO SAMPLES MAY BE LOGGED IN WITHOUT A PROJECT PROFILE**.

4.4.3 Verify if the sample(s) methods TAT and Hold Time (Once the project is loaded, select the Analysis Groups Tab and the Methods subtab, expand the methods to check the container for 14day/7day hold times). During Triage all sample sets will need a yellow/red folder, a teal folder will be added if necessary. All COCs, airbills and PM Contacts/Confirmations prior to login must be placed in the folder.

Base Folder:

Yellow Folder - TAT of 8+ Days
Red Folder - TAT of 7 days or faster

Additional Folder Marking Priority:

Teal Folder - COC Request/Method TAT of 4 days or faster and/or samples will expire withing 14 days of receipt.

4.4.4 Based on the expiration date, TAT and if the samples need to be refrigerated, determine the priority for logging in the samples. Communicate with the lab and PM to let them know of any rush analyses (2 Days or sooner) or expiring samples. Communicate priorities to other Login Analysts.

To maintain temperatures all samples requiring refrigeration (PUFs, TO17s, etc). These samples must be immediately stored in their designated refrigerator. During the Login process, samples remain in the cooler packed with blue ice.

4.4.5 Client Canisters or non-barcoded media

4.4.5.1 For Tedlar Bags, Client Canisters or sample media without barcode scanning information, use the information on the COC to locate the correct project profile. See WI 50 for more detailed instructions. If unable to positively determine the project profile due to missing client information or project information, it will require project manager confirmation; if the PM is not available to confirm, the job will be placed on hold. When the correct project profile has been identified, the Project Manager will send an email confirmation and notify sample receiving to proceed with the log-in.

Note: To ensure a correct profile is selected, the company name on CoC must match the profile, unless otherwise noted in profile or confirmed by PM. The project name or number should match with profile or previous workorders. If any doubt, confirm with project managers. The sample acknowledgement should not be sent until profile is confirmed.

4.5) SAMPLE RECEIPT VIA CLIENT COURIER

If receiving packages directly from a client or client's courier:

4.5.1 Ensure proper documentation on the COC in regard to custody transfer.

4.5.2 Fill out the COC as in 4.3.4.1 above, writing “HD” as the Shipper Name, this shall indicate the media was Hand Delivered (An Airbill is not necessary for Hand Delivered items).

4.5.3 Do a cursory check to make sure that the COC is filled in properly, the TAT is apparent and the type of analysis requested is consistent with the media that has been submitted. Ask questions, if needed. Give the client a copy of the COC.

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4.5.4 If there is any indication on the COC that the samples are on a rush TAT, put a red and teal(If applicable) folder with the documentation and alert other Login Analysts as to the rush status.

4.5.5 Do a cursory hold time check, alerting the lab and PM of any samples with sensitive hold times or turnaround times of 2 Days or sooner.

4.6) SAMPLE RECEIPT VIA EATL COURIER

If receiving packages directly from an EATL Courier:

4.6.1 Should the laboratory Courier have the COC in hand, they shall sign and date with time the 'Relinquished by' area to ensure proper documentation on the COC in regard to custody transfer.

4.6.2 Fill out the COC as in 4.3.4.1 above, writing "Courier" as the Shipper Name. An Airbill is not necessary for the laboratory Courier delivered items.

4.6.3 Do a cursory check to make sure that the COC is filled in properly, the TAT is apparent and the type of analysis requested is consistent with the media that has been submitted. Contact the PM with any questions, if needed.

4.6.4 If there is any indication on the COC that the samples are on a rush TAT, put a red and teal(If applicable) folder with the documentation and alert other Login Analysts as to the rush status.

4.6.5 Do a cursory hold time check, alerting the lab and PM of any samples with sensitive hold time or turnaround times of 2 Days or sooner.

4.6.6 If the laboratory Courier delivered packages while Login Analysts were away from receiving, the laboratory Courier shall sign and date with time the "Relinquished by" area, while Lab personnel will sign and date with time the "Received by" area.

4.7) SECOND TRIAGE

Second triage will be performed daily once FedEx & UPS priority/ground shipments have been delivered. Emphasis for second triage walkthrough is to target any missed rush TATs, short hold times or Tedlar Bags in the initial triage.

5) LOGGING IN JOBS (J)

For more information detailing login procedures, refer to WI 50-1 Sample Receiving/Login Procedures, WI 50-4 Sample Receiving/Login - Passive/Sorbent and Sample Receiving/Login - 325B.

5.1) LOGIN PREP

5.1.1 Open TALS, open the login module (Sample Mgmt>Login).

5.1.2 Set out samples in order, as shown on the COC, verifying the sample tags/canister barcodes against the COC. Document discrepancies with a NCM (**see Section 7.0**).

5.1.2.1 Collection times not present on the COC or consistent with sample tags are not considered to be a discrepancy.

5.1.2.2 Each sample is given a unique fraction number in order based on the COC (Page 1 top to bottom through page X) (i.e.: 650-6126-1, 650-6126-2, ...). The fraction number is written next to the sample on the COC in the left hand column, if there is no room to legibly write this by the analyst it is possible to use the right hand margin. At this time, check the

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client sample identifications on the COC. Client sample IDs with the same method must be unique. If client sample IDs are not unique, create the appropriate NCM.

5.1.3 Clients may have more than one project in progress and may pull cans related to a different profile, to ensure the correct profile is used: Compare the project profile against the COC for project name/number, the requested analysis, etc.

5.1.3.1 If a matching profile cannot be found, contact the PM for confirmation.

5.1.3.1.1 If the Project Profile does not have the appropriate information, (such as the profile is limited to TO-15 analysis, but the COC requests TO-3), contact the appropriate PM for clarification. (Note: Follow-up with the PM within 24-hours if a response is not provided)

5.1.4 Click New Button in TALS

5.1.4.1 If the media is barcoded, press the Scan Asset button and scan the item, this will pull up a project if it is our media. If you have unbarcoded media, select +Add and search for the correct profile by Company/Description/project number.

5.1.4.2 This will populate the project info into the results section, but does not automatically highlight the first record in the results section. Manually highlight the row and Verify that the information matches the COC and press OK.

5.1.4.3 Please read all of the popups and acknowledge them, make note of any special login procedures listed.

5.2) RECEIPT TAB

5.2.1 Receipt>Info

5.2.1.1 Update the received by: and the Date/Time Received: fields to match who received the COC and at what date and time.

5.2.1.2 Update the received via field to match how the sample was received. (Lab Courier, Client Dropoff or based on the airbill with the samples.)

5.2.1.3 If samples are received through FedEx/DHL/UPS/etc we will add a cooler and input the tracking number from the airbill into the available field.

5.2.1.3.1 If a sample arrived in a cooler with a temp blank the temperature will be recorded on the COC at the time of receipt. Enter both the initial temp (temp(C) field) and final temp (Corr Temp (C) field) from the COC and update the Ice Type field to match what coolant was used.

5.2.2 Receipt> Assets and Receipt > Containers for barcoded and nonbarcoded media.

5.2.2.1 Receiving Barcoded assets/Sample Media

5.2.2.1.1 If you have barcoded media click the Assets subtab. click the Add button and then scan in the Barcoded Sample Media (Canisters/TO17 tubes/etc). The media will not show up until you press close. Verify that all of the Barcoded Sample Media is scanned in by total count and that there were no errors during scanning.

5.2.2.1.2 Highlight all rows that contain Barcoded Sample Media right click and select Generate Samples. This will automatically create containers for your sample media.

5.2.2.1.3 Once you have created all necessary containers, scan in any Flow Controllers or other barcoded non sample media. Verify that the remaining

media count matches what was scanned in and that there was no errors during scanning.

5.2.2.1.4 Check each unique shipping order for any additional charges for consumable media or nonbarcoded media, record these for later.

5.2.2.1.5 Move to the container subtab. On sample 1 select the correct storage location based on the media type (Canisters>Pressurization, TO17s > R4, etc)

5.2.2.1.6 Use the copy feature to copy this storage location to all samples. Unused sample media does not need a storage location.

5.2.2.2 Receiving Non-barcoded sample media

5.2.2.2.1 When receiving non-barcoded sample media, we will navigate directly to the Receipt>Containers subtab.

5.2.2.2.2 Press the +Add button. Based on the COC, change the number of samples to the amount required. Set the sample collection date to the End Sample Date (This can be edited later)

5.2.2.2.3 Change the container type to match what was received (Tedlar, PUF/XAD High-volume/etc)

5.2.2.2.4 Update the storage location to the correct location where the sample will be stored.

5.2.2.2.5 Use the copy feature to copy this information to all similar samples.

5.2.3 Receipt> Comments

5.2.3.1 If there were lab notes that popped up when the profile was added, copy and paste them here. To pull them back up, click the All Notes button on the top to view them again.

5.2.3.2 After we have confirmed sample media unused, a comment will be added here detailing how much media, the type of media, and how it was determined unused. The secondary review will also be added in this section. For more information please reference Work Instruction 050-1-WI88605 SAMPLE RECEIVING/LOGIN PROCEDURES - UNUSED MEDIA.

5.3) LOGIN TAB

5.3.1 Login>Samples

5.3.1.1 Enter the sample names from the COC into the Client Sample ID Field. For unused media append "-UNUSED" after the barcode. For more information on procedures for Unused Media see WI050-3.

5.3.1.2 Set the sample Matrix as AIR. Highlight the Sample Matrix row and right click then select Sample Options> Sample Matrix > Air to set all samples as AIR

5.3.1.3 Enter the Sample Date/Time and other information. Refer to WI 50 for more information.

5.3.2 Login>Groups

5.3.2.1 Press the New button to add an analysis group. Select the appropriate analysis based on the COC requests/project notes.

5.3.2.2 Add the Press_N2 method and Pre_Screen_Air method when necessary.

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5.3.2.3 If the COC lists compounds/analytes verify that these are present in the selected list by selecting a sample with the method assigned to it, then pressing the Analytes button.

5.3.2.4 If there are any questions on whether the lists available are correct, please reach out to the PM for confirmation.

5.4) JOB TAB

5.4.1 Job> Job

5.4.1.1 Change the "Job Description" field to match the project name listed on the COC.
5.4.1.2 Change the "Workorder" field to match the Project Number listed on the COC.
5.4.1.3 Change the "Purchase Order" field to match the PO number listed on the COC. If a PO# is not listed on the COC, do not remove what is auto populated.
5.4.1.4 If the client requests a nonstandard Turn Around Time, adjust the "Job TAT" field based on the request.

5.4.2 Job > Pricing

5.4.2.1 If a TAT is changed by client request and the TAT is now a rush, we will update the pricing to reflect the rush.

5.4.2.2 If only select methods requested a RUSH TAT.

5.4.2.2.1 Sort the methods by clicking the filter icon on the "Method Code" Row and select the method that was adjusted.

5.4.2.2.2 When filtered, left click the "TAT Multiplier" row header to highlight the entire row.

5.4.2.2.3 Right click TAT Multiplier, enter the correct surcharge amount into the field and press OK.

5.4.2.2 If all methods are changed to RUSH TAT.

5.4.2.2.1 Left click the "TAT Multiplier" row header to highlight the entire row.

5.4.2.2.2 Right click TAT Multiplier, enter the correct surcharge amount into the field and press OK.

5.4.3 Job > Other Charges

5.4.3.1 Verify that the quantity for media charges match what physical media was received.

5.4.3.2 Add the Quantity of consumables and non-barcoded media from the shipping orders that have not been pulled.

5.4.3.3 Update the deliverable charges and SERWM fees if these apply by adjusting the Quantity.

5.4.3.4 Remove the remaining $0 media charges.

5.5) LOGIN CHECKLIST

Sample Receipt Checklist is to be completed by the Primary Login personnel. See appendix A for a list of items pertaining to this checklist.

5.5.1 Receipt > Checklist and Login Release

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5.5.2 Answer the prompts listed in the Receipt>Checklist. Yes indicates a pass, a No indicates a fail and NA indicates not applicable.

5.5.2.1 If No is selected, select the appropriate failure reason and set up a NCM to narrate.

5.5.3 Once all items have been reviewed and NCMs added check the Login Release box on the top left of the screen.

5.5.4 Click Save.

5.5.5 Please read any prompts that pop up and make changes as necessary.

5.6) PRINTING SAMPLE LABELS

5.6.1 Once the job has finished saving it will move you out of the work order.

5.6.2 Go to the Receipt>Containers tab.

5.6.3 Press the "Labels" button in the bottom left.

5.6.3.1 You can adjust which labels to print in this menu. For receiving make sure the COC box is checked, and the "Use 2D" Box is checked on the bottom.

5.6.4 Press OK.

5.6.5 A preview window will pop up, you can verify that you are printing the correct labels here. If everything is correct, press the printer icon in the top left of the window to print the labels.

5.7) PRINT SAMPLE SUMMARY FOR SAMPLES REQUIRING PRESSURIZATION

5.7.1 While the login module is open, press the printer button on the top.

5.7.2 Select "Login Summary Report" and press Print.

5.7.3 In the folder that is included with the samples at pressurization - include the COC and Login Summary Report with the method highlighted.

5.7.3.1 If the canisters have multiple TO15 Analysis, we will want to print out multiple login summaries and highlight the relevant methods. Make copies of the COC(s) and include them in their respective folders.

5.7.3.2 Canisters will need to separated based on their TO15 analysis when placed on the pressurization racks. Information about pressurization manifold certification is available in *SOP 60*.

5.8) SCANNING COC TO LIMS

5.8.1 Take the 2D Label from the label printout sheets and attach it to the COC. This is the small square label, not the long barcode.

5.8.1.1 If the COC is multiple pages, write the job number on the additional pages in the Workorder Number field/Top of the COC.

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5.8.2 Scan the COC into the TALS COC folder on the printer, this will automatically attach the COC to the job.

5.9) SAMPLE LABELING

5.9.1 Canisters

5.9.1.1 Each sample is labeled with a unique, indelible identification. This label is printed out from TALS.

5.9.1.2 *Never* affix a label directly on a canister. Attach the sample label to the blue tag which is attached to each canister, being careful not to obstruct existing information. If a sample tag is not present, the Login Analyst will attach a new one to the canister.

5.9.1.2 The Sample Login Analyst will double-check lab sample IDs and canister barcode numbers when affixing the labels.

5.9.1.3 If the sample canister must be pressurized with Helium, ensure a green folder is used for the work order, indicating special pressurization requirements.

5.9.1.4 If the client specifically requests that a sample be held for a period of time, a small orange tag must be stapled to the blue sample tag for these samples. The Do Not Release dates are set up at the project level.

5.9.1.5 For samples which are marked either on the sample tag or COC as having high concentrations of a known compound, the Sample Login Analyst will place a Pink tag marked "High Levels" on the canister. Samples that arrive with an obvious odor are handled following Section 9.0 of this SOP.

5.9.1.6 If canisters or any laboratory equipment are labeled as faulty, they are tagged with pink Equipment Check tag that are filled with appropriate information then follow the c.Support procedure as outlined in Work Instructions WI50

5.9.2 Tedlar Bags

5.9.2.1Labels should be affixed directly onto the bag, making sure not to obstruct the bag valve or existing sample information.

5.9.3 Labeling Other Media

5.9.3.1 Labels should never be affixed to the samples themselves unless they are in a container which will not come in contact with the extraction or analysis equipment.

5.9.3.2 **Cartridges should not be touched by hand**; therefore the label is attached to the bubble wrap or plastic bag.

5.9.3.3 Radiello 130, Radiello 145, and TO17 tubes will have the bottle tag attached to the outer Vial/Cigar tube while being careful not to cover any sample information. The barcodes will be included in the bag for easy scanning into TALS.

5.10) STORAGE PRIOR TO ANALYSIS

5.10.1 Canisters that require pressurization

5.10.1.1 Samples at pressurization are sorted on the racks at pressurization by due date.

Green Sheet/Folder - Special pressurization requirements **Must list: Pressurize with He, Nonstandard final pressure, etc**
Teal Folder - Priority required. Samples either have a short hold time or are on a RUSH TAT.

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5.10.1.2 Samples at pressurization are stored on racks by job due date. Place the samples in order from left to right on the rack that has the matching due date.

5.10.3 Passives/Sorbents that are stored in Extractions.

5.10.3.1 PUF/XAD, Rad 130, and all WMS types will be stored in R12.

5.10.4 Passives/Sorbents that are stored in R4.

5.10.4.1 TO17 Tubes and Rad 145 will be stored in R4.

Section 9 - Sample Storage gives more information on storage locations and procedures.

6) LOGIN REVIEW

Login Review is performed on all jobs and must be completed by someone (Project Manager, Project Manager Assistant or designated personnel) other than the individual who originally logged in the samples. The Login Review process ensures that all incoming samples, assets, and documentation are accurate, complete, and properly recorded by confirming that the Chain of Custody is correct and legible, verifying that samples are logged to the appropriate project, ensuring that assets are assigned in accordance with the COC, and checking all data entries and associated NCMs for accuracy. Once the Login Review is complete, a check is placed in the TALs module to document the review, after which the login reviewer releases the samples to the laboratory for analysis and sends the Sample Acknowledgment.

Any discrepancies found during Login Review are routed back to the sample receiving team members for correction and/or notification.

For more details regarding Login Review procedures and guidelines, refer to WI-50-7 -Sample Receiving/Login - Login Review and *F3.60 - Login Review Checklist* for more information.

7) NON-CONFORMANCES (NCMs)

During the course of receiving, logging in and pressurizing the samples, sample discrepancies may be observed and a NCM will be created. Issues requiring immediate notification to the client are given to the PM to contact the client. This client interaction is also narrated on the NCM.

7.1 Possible General Non-Conformances include:

- Absence of a COC
- COC Incomplete
- COC not filled out in ink
- COC relinquished improperly
- Shipping Damage
- Number of samples on COC does not match the number of samples received
- Name of sample on COC does not match Sample Tag (See Work Instructions WI50 for exceptions)
- Sample collection date on COC does not match Sample Tag
- Not properly preserved
- Container type inappropriate for analysis
- Unlabeled samples
- Mislabeled samples
- Expired samples
- Custody Seals broken or improperly placed
- PM10 sample filters received wet

7.2 Possible Canister NCMs include:

- Leaked to ambient at time of pressurization.
- Canister received emitting a strong odor; sample can/cannot be analyzed

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- No brass cap or quick connect on canister and canister valve received open
- Flow controller used and canister sample received at ambient or under pressure
- Canister sample received with a vacuum difference >5.0”Hg between the receipt vacuum and the final vacuum reported on the COC, indicating potential valve leakage.
- Canister sample received at >15”Hg (not identified as a Trip/Field Blank).
- See *SOP060* for more information regarding pressurization NCMS and procedures.

7.3 Sorbent media

- Samples received outside of required temperature range; coolant was/was not present.
- Sample container was received broken; sample was/was not intact.
- Coolant was not properly dispersed throughout the cooler.

7.4 Tedlar Bags

- Tedlar bag appears to be leaking.
- Tedlar bag received flat.
- Tedlar bag received emitting a strong odor sample; can/cannot be analyzed (see Section 8.0).
- Tedlar Bag received with a significant volume of water.

7.5 EPA 325B

- Average Field Temperature not recorded on the COC.
- Loose end caps or missing end caps.
- No custody seal present on pelican case.

8) TECHNICAL PROCEDURES

8.1 Measuring Sample Temperatures

Equipment used to measure temperature (i.e. temperature probe) requires a quarterly verification and verification records are maintained by the QA department. See *SOP 034* Support Equipment for verification process.

The receipt temperature, correction factor, final temperature, equipment number and time stored in the designated refrigerator are recorded on the COC for samples that are required to be received chilled per the method requirement. These samples must be placed in the designated refrigerator immediately if not being actively logged in. At the time of sample login, samples remain in the cooler packed with blue ice to preserve temperature.

8.1.1 The laboratory ships a temperature blank (VOA vial filled with water) with every shipment of media that has this requirement. The vial is opened and the temperature is measured upon receipt using a NIST traceable thermometer probe. The required temperature should be 4 ± 2 ^{o}C.

*Client notification is required for samples received >6^{o}C using the appropriate NCM.

*Client notification is NOT required for sample received between 0-2^{o}C No narrative needed.

8.1.2 If a temperature blank is missing, frozen, broken, or otherwise compromised, receipt temperature of the cooler cannot be verified for compliance with the 4± 2 ^{o}C criterion. The client is notified on the sample Acknowledgment that the temperature blank could not be used to record the sample receipt temperature, noting whether the samples were received chilled with blue ice intact and frozen.

8.2 Setting up Job Series in TALs

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8.2.1 A job series should be set up at the request of a Project Manager or via the Receiving notes in a login.

8.2.2 To set up a job series, we first need to complete the login process. Refer to WI 50-1 and section 5 of this document for more information.

8.2.3 Once the login is complete, uncheck all login reviews/login release checks. You can press the Uncheck All Tasks button at the top of the program to uncheck everything but Login release, this must be manually unchecked.

8.2.4 Navigate to the Job>Pricing tab.

8.2.5 We need to add the appropriate number of job series that are needed. Press the +Add button on the left side, a popup will say "Do you want to add a new job?", press yes.

8.2.5.1 This will general J####-2 and if you do it again it will continue to add on more job series.

8.2.6 Once all job series are created, Click J####-2 and select the Job>Other Charges Tab.

8.2.6.1 When you create a new job series, it will duplicate the Other Charges. Please remove the duplicates or spread the items out as requested.

8.2.7 To update which job series will report what go to Job>Pricing.

8.2.7.1 To change which job series samples will report on, highlight all samples with the same Lab-Id (For Example: If you need to move samples 1 and 2 from Job 5432 you will want to highlight every row with the lab ID 5432-1 and 5432-2)

8.2.7.2 Hold CTRL and left click the "Job Id" column.

8.2.7.3 While the "Job Id" column is highlighted, right click and select the job series that you want to move the highlighted rows to.

8.2.7.4 Verify that all samples with the same Lab ID are now showing up under the new Job Id.

8.2.7.5 After all updates are completed, check the login release button and save.

8.3 Receiving Client Media

6.3.1 It is possible to receive media that is the property of the client. Look for a profile using the information on the COC and sample tags verify with the PM if there is any doubt. See *SOP 95* for the procedure relating to client canisters.

8.4 Receiving Laboratory Media Into our LIMS system.

8.4.1 Laboratory media or equipment will be entered into TALS either by scanning its barcode or creating a container and assigning the correct media. Tracked media(barcoded media) is charged as it is returned. Non-Barcoded, non-canister related media and related equipment will be auto-invoiced at the time the shipment is released. Canister related items which are not expected to be returned (fittings/tubing/etc) or non barcoded media (IE Vacuum gauges) will be charged on the first job related to the shipment.

8.4.2 Clients will often indicate that media is not a sample by writing notes such as ‘VOID’, ‘low vac’, ‘unused’, ‘do not analyze’ or ‘not a sample’ on the sample tag or COC.

8.4.2.1 If the notation indicates an issue with the media, a c.Support incident will be created and a pink “Check Equipment” tag filled out and attached to the media. A secondary review must be completed by another analyst for all sample media (canisters/sorbents/passives). The media is then placed in the Check Equipment area for pick-up by Support Services. (See *SOP #89* section

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3.1 and Work Instructions WI50). The media is tagged with an Equipment Check tag which indicates PM & project ID, the client indicated issue and the EATL finding upon evaluation

8.4.2.2 If the notation does not indicate an issue with the media, after secondary review by another analyst it can be placed on the returns cart for pick-up by Support Services.

8.4.3 For samples not listed on the COC, samples received unmarked and/or not specifically labeled as returns (such as "Bad can", Do not analyze, VOID, etc) the PM will need to determine if they are samples. It is the responsibility of the Receiving Team to email the PM regarding questionable canister and provide the project name/number, Shipping Order Number, type of media **and label information (i.e. sample IDs)**. **Only when the PM confirms via written communication with the client that they are returns can the sample tags be marked with the word "VOID" in red marker and safely placed in the Returns area**. All canisters/sorbents/passives that are confirmed unused require a secondary review by another analyst. If they are determined to be samples, the PM will request a COC and they will be logged in as samples.

8.4.3.1 Canisters can also be checked with a calibrated digital gauge to verify if they are unused. If canisters have a reading of 25-29"Hg and a blank sample tag these can be received as unused. All canisters/sorbents/passives that are confirmed unused require a secondary review by another analyst.

8.4.3.2 Sorbents/Passives that are received as unused will be held until the samples they were received with expire. These will be separated into their own bags and marked Do Not Release until 1 business day after the samples for the job expire. This media will be stored in the same refrigerator as the samples.

8.4.3.3 For more information about Unused Media refer to **WI 50-3**.

8.4.4 For samples received with documented sample IDs without a COC, the PM will need to determine if they are samples to be analyzed. The sample receiving staff sends an email to the appropriate PM with the sample IDs, project information (if available), Shipping Order and type of media. Only when the PM confirms via written communication with the client that they are returns can the sample tags be marked with the word "VOID" in red marker and safely placed in the Returns area. All canisters/sorbents/passives that are confirmed unused require a secondary review by another analyst. If they are determined to be samples, the PM will request a COC and they will be logged in as samples.

8.5 Entering Project Information into the Work order

8.5.1 Most of the project information is auto-filled from the Project Profile into the newly created work order. It is imperative to check the Project Profile against the COC to ensure they are consistent. If not, consult the PM regarding the correct Project Profile for the sample set.

8.5.2 Hold times are programmed into the method in TALS but should be verified (see Work Instructions WI50).

8.5.3 Due Customer Dates are programmed into TALS assuming PST or PDT (as appropriate) but should be verified. Samples that arrive after 3 pm are considered to be received the following day.

8.6 Different colored folders are used to help define RUSH/Short Hold times and special pressurization requirements:

- Green - A green folder is used to alert the pressurization team that unusual pressurization requirements are needed (Special reporting limits, Nonstandard final pressure, etc.)
- Teal - Priority Login (this folder will be placed in over the above folders during triage and pressurization. This folder alerts technicians to a Rush (4day TAT or faster) or Short Hold

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Time for samples (14 days or less until the samples expire).

8.7 External Proficiency Testing (PT) or Performance Evaluation (PE) Sample

External audit PT and PE samples are received periodically from either government agencies or consulting firms. Upon receipt, the Login Analyst notifies the QA Department. The QA Department works with a PM to set-up a Project Profile. The Login Analyst logs-in the samples using the Project Profile and under the direction of QA. All the documentation that is received is placed in the folder. Refer to SOP *QA-SOP69729* in D4 for further information.

8.8 Sample Acknowledgment

8.8.1 When a job has been Login Task reviewed by trained personal a Sample Acknowledgment email is sent to the client to confirm receipt of samples. The Sample Acknowledgment consists of 5 sections:

- Section 1: Email with NCMs noted.
- Section 2: Sample Receipt Summary (sample names, collection dates, etc.)
- Section 3: Chain of Custody
- Section 4: Reporting list showing referenced method.
- Section 5: Outstanding media (if applicable)

8.8.2 The date that the Sample Acknowledgement email was sent is automatically documented by TALS in PM Desktop module.

8.8.3 If the laboratory is notified of an error with respect to information on the COC (i.e.: sampling date/time incorrect, sample IDs incorrect or switched, etc.), the client will be asked to provide a revised COC. If they are unable to do so, the Project Manager will request written documentation (such as an email or FAX) from the client and document in Contacts. A copy of the written documentation will be given to Sample Receiving to make the necessary changes. The laboratory cannot deviate from the information on the COC without this written documentation from the client. ***The laboratory will not make corrections to client information on the original COC, as this is a legal document.***

8.8.4 If the laboratory made an error in transcribing an entry from the COC into the job (i.e.: a misspelling, entering a "5" instead of an "S", etc.), a Client Contact is sufficient to document a change in our system.

9) SAMPLE STORAGE

Samples that do not need to be refrigerated are stored in the Sample Cage in the main laboratory**.** Samples that must remain chilled are placed in the appropriate refrigerator/freezer. See Table 2 below.

Table 2

Location in Sample Cage		**Suggested Contents**
Section A-01		Tedlar Bags, Misc Media Types, typically for ATL Applications
Section A-02 to E-04		1L and 6L Summa canisters
Section G to J		Tedlar Bags, 1L Summa cansiter and PAC250s
Section X to Y		Media being held after analysis or ready to release
Location	**Refrigerators**	**Suggested Contents**
TO-17 Room	4	TO-17 Samples, Rad145 and all other TD samples
Extraction	12	TO-13A, Radiello 130, WMS.
Location		**Suggested Contents**
Extraction - Dessicator		TSP/PM10 filters
EPA 325 Room		EPA 325 samples

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9.1 Sample Tracking

9.1.1 It is the Login Analyst's responsibility to record samples into the Sample Tracking logbook in the appropriate area of the laboratory, depending on the type of sample received. Canister, bag, sorbents, passives and EPA325B samples will be tracked electronically using the Internal Chain of Custody in TALS; all others will be using logbooks. When entering the samples into storage with a logbook the Job number, number of samples, analysis, location where samples will be stored, analyst name, and date/time (military format) sample custody is being transferred must be included into the first "IN" box of the Sample Tracking Logbook.

9.2 Procedure for samples received and not logged in by the end of the day:

9.2.1 Canisters

Samples will remain in the Sample Receiving area overnight.

9.2.2 Coolers

Samples are placed in the appropriate refrigerator, along with a copy of the COC as the samples have not been received into TALS. The original COC is left on the receiving counter and an email is sent to receiving notifying them the sample has been stored.

9.2.3 The goal is to login all samples within 1 business day of receipt. Exceptions are:

- Samples without a COC
- Samples associated with Project issues.
- Samples where the Project Profile is unknown or non-existent. If the Project Profile does not exist, an email with the issue and the PM who was asked to resolve it is placed with the samples. The Sample Login Analyst then follows up with the PM until the issue is resolved and the samples can be taken off hold or logged in.

10) SAFETY PRECAUTIONS AND HANDLING OF HAZARDOUS SAMPLES

Samples may be hazardous to handle. In the following situations, use the procedure listed. Members of the Safety Committee are available to assist with any samples of concern and should be notified of unusual issues. Always err on the side of caution.

10.1 Canisters and Tedlar Bags:

Due to potential health hazards, samples which emit a strong odor are handled in the following manner:

- Samples are immediately placed in a fume hood.
- Samples that do not fit in the fume hood are stored in the Hazardous Waste Shed, to ensure appropriate security of samples.
- The Safety Committee and/or the Lab Manager are contacted to assess the level of hazard associated with the sample(s) and to ensure proper handling.
- The Login Analyst logs the samples into the proper logbook/Sample Tracking module, noting the location where they are temporarily being stored.

10.2 Liquid and Sorbent Media Samples:

- The Sample Login Analyst should always wears protective gloves while unpacking these types of samples.
- If a liquid sample is received in a leaking or broken container, a Safety Committee Member is notified for proper cleanup and handling of the Sample. Note: Clearly marked Temperature Blanks (which are filled with water) can be safely disposed of by the Login Analyst without notifying the Safety Committee.
- A member of the Lab Team or the Safety Committee is consulted if a sorbent sample is received broken, to determine if the sample can be analyzed and ensure proper handling.

11) WORK SHARE SAMPLES

For more information on workshares, reference **WI 50-6**

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11.1 Sending out Work shares

11.1.1 When samples arrive which need to be work shared to another laboratory (this will be noted in the Project Profile), a job is set up as normal. When selecting the group(s) you will select the appropriate analysis depending on what is being requested. Workshare analysis lists in TALS are highlighted in green.

11.1.1.1 If we are analyzing the samples and sending them out after. Please stamp the canister tags with the RELEASE TO SHIPPER stamp. after analysis these will be moved to shipping and then be sent out to the next lab.

11.1.1.1.1 An ICOC transfer will need to be completed by the shipping desktop to create the shipping order that the samples will go out on.

11.1.1.1.2 Print out an COC from new shipping order and relinquish custody. Also relinquish the original COC if we are providing it with the job.

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11.1.1.2 If we are sending out the samples without analysis. Samples will need to be logged in as normal and with the help of the Project Manager we will move them to the shipping department to be packed and sent out.

11.1.1.2.1 An ICOC transfer will need to be completed from the shipping desktop to create the shipping order that the samples will go out on.

11.1.1.2.2 Receiving will Print out a COC from the new shipping order and relinquish custody. Relinquish the original COC if we are providing it with the job to the other lab.

11.2 Receiving Workshares

11.2.1 When receiving a workshare the sample tags will be marked with a project number that does not begin with 650, this should also be noted on the COC provided with the samples.

11.2.2 If the COC/Canisters are not marked with a workshare job number:

11.2.2.1 Check to see if the COC/Sample tag to see if they list a Eurofins Project Manager/Project Number.

11.2.2.2 Send an email to the Project Manager asking for them to log in the workshare and E-Ship the samples. Please make sure to attach the COCs and any additional information you can to the email. (E-shipping is required to transfer custody of the samples from the sending lab to the receiving lab if we already have custody of the canisters)

11.2.2.3 Once the job number is provided, an ICOC transfer will need to be performed to receive the samples at Air Toxics.

11.2.3 If the COC has a job number already assigned to these samples.

11.2.3.1 An ICOC transfer will need to be performed to show that Air Toxics has received the samples.

11.2.3.2 Once an ICOC transfer has taken place, make sure all samples have sample labels (as well as sample tag if these are canisters).

11.2.3.2 Verify the information in the login and that all methods are correct (for canisters look for - Can_Pressure_N2 and Pre_Screen_Air if required).

11.2.3.3 Samples can be moved to their next location - R12, R4, A-01 Screen or Pressurization.

12) ON-HOLD SAMPLES AND CANCELLATION OF WORKORDERS AND SAMPLES

12.1 When a subset of samples from the same sampling event are requested (either on the COC or from the PM) to be placed on hold, both the sample status and method status should be set as "On Hold" (Setting the sample status to "On Hold" will set the method status to "On Hold") as well as a ON HOLD NCM created. The PM will receive a daily report of all the jobs that are on hold. The PM will notify receiving if the samples will be set to active. If the Lab/PM requests it, samples placed on hold can be moved to a separate Job Series (See section 6.2). The PM will notify receiving of samples need to be set to Active/Hold/In-active by client request, they will also advise if the turn around time needs to be updated.

The exception to this procedure is when a client sends duplicate sample (back-up) and requests the duplicate sample to be placed on hold and analyzed if there are any discrepancies with the

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original sample. In this case, all the active and duplicate "on-hold" samples are logged in under the same work order fraction. The production team is responsible for updating the "back-up" sample status to "cancelled" or "active" depending on the circumstances. In order to release the duplicate or back-up sample from the canister module tracking, the status needs to be either active and analyzed or set as In-Active.

12.2 Clients will sometimes cancel analyses after the samples have been received. If they have been given a job number, then the cancellation must be requested by the PM. See Work Instructions WI50 for the Cancellation Procedure (Please note that to cancel a sample or remove requested compounds/entire analysis require an email from the client confirming this).

13) INTERNAL COMMUNICATIONS

13.1 Non-Conformances requiring PM action:

13.1.1 Login Issue: The NCM will be sent electronically to the PM. The PM will contact the client on the same day or as soon as is reasonably possible. The PM will receive instructions and alert the lab/Receiving of any changes that need to be made. The Login Analyst will then continue the login process.

13.1.2 Pressurization Issue: The NCM will be sent electronically to the PM. The PM will contact the client on the same day or as soon as reasonably possible. Once the PM establishes how to proceed information will be sent to the Login Analyst. if immediate action, such as canceling a sample is necessary and the WO will be updated with the necessary adjustments.

13.1.3 The Login Analysts will check for NCM e-mail updates throughout the day, taking the action required.

13.2 Profile Clarifications

13.2.1 Major Issues (These are issues for which the samples cannot be logged in, such as it is not clear what analysis the samples are for or the list requested does not exist)

13.2.1.1 The COC and Project Profile Number (when available) are given to the PM, (either physically or through email) and a note/email placed on the sample set.

13.2.1.2 If client involvement is necessary, the PM will contact the client the same day. The PM will get back to the Login Analyst as quickly as possible with clear instructions on how to proceed.

13.2.1.3 The Login Analyst will proceed with the login process being sure to include the resolution in the Receipt>Comments section of job login.

13.2.2 Minor Issues (These are issues for which the samples can continue through the process, such as media pricing or full vs. short lists.):

13.2.2.1 An email will be sent to the PM regarding the issue and the issue notated in the Receipt>Comments section of job login. The PM will research the issue. The PM will make appropriate changes to the WO, provide clear instructions for the Login Analyst to make appropriate changes or decide that no action will be taken. The course of action will be documented in the Receipt>Comments section of the job login.

NOTE: All notification or confirmation to PM or lab need to have the Job and PID included in the email subject line.

13.2.3 Lab Issues: The Login Analyst will inform the laboratory of any quickly expiring or quick TAT samples through TALS. If there is an extreme time-sensitive issue, the Login Analyst will also verbally alert the manager of the department or a team member who works on the analysis.

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13.3 PM/Lab Requests

13.3.1 Requests involving additional analyses, or list changes must be provided in writing (i.e. email) to the receiving team and should be addressed immediately. Once the changes have been made the lab/PM is notified via email.

13.3.2 Requests that are not time sensitive or relating to analyses that can't be addressed immediately should be addressed before end of the day.

14) THE FLOW OF COCS

14.1 The 2D barcode is placed on the COCs first page, subsequent pages are written at the top of the COC.

14.2 If the samples are canister samples:

12.2.1 The COC is sent to pressurization with the samples in a folder, with the COC and Login Sample Summary.

12.2.2 Once the pressures are entered into a batch in TALS, the COC is given to a Data Delivery Analyst for archiving.

14.3 If the samples are not canister samples the CoC will go directly to a Data Delivery Analyst for archiving

15) SPECIALIZED JOB CREATION

Special jobs will be created like a normal login. The job description will be updated to reflect what the job is for. For more information on procedure refer to WI 50-1 RECEIVING/LOGIN PROCEDURES and WI 50-3 UNUSED MEDIA.

Specialized Job Description Naming Key:

Returned Media Jobs:	Change Job Description to: Returned Media
Unreturned Media Jobs:	Change Job Description to: Unreturned Media
Miscellaneous Charges:	Change Job Description to: Invoicing Only
Client Media Certification:	Change Job Description to: Certification Only

16) REFERENCES/DEFINITIONS

Refer to the Eurofins Environment Testing Northern California, LLC Quality Assurance Manual (*QAM*) Defintions and Terms, Appendix A.

Applicable Work Instructions:

050-1 WI74536 - Sample Receiving/Login Procedures
050-2 WI93136 - Sample Receiving/Login - Triage
050-3 WI88605 - Sample Receiving/Login - Unused Media
050-4 WI91320 - Sample Receiving/Login - Passive/Sorbent
050-5 WI92071 - Sample Receiving/Login - 325B
050-6 WI93135 Sample Receiving/Login - Workshare
050-7 WI93137 Sample Receving/Login - Login Review

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17) APPENDICES

List of Appendices

Appendix A - Eurofins Environment Testing Northern CA, LLC Sample Receipt Checklist

Items

Question	Answer	Failure Reason
COC is present.		
COC is filled out in Ink or pre-printed and legible		
COC is filled out with all the pertinent information		
Canisters are not damaged.		
Canister valves are closed.		
Client requests on COC have been followed.		
"Sticky Notes" from the project were read and followed.		
All necessary tags have been attached to samples (DO NOT CLEAN, etc.)		
Project "other charges" added as needed.		
All NCM items have been narrated.		
The COC paperwork has been scanned and properly attached to Job.		
Sample Confirmation sent after Login review completed.		
Verify Sample ID's aginst Chain of custody.		
Verify Sample labels against Canister asset ID.		
Email sent for Expiring samples.		
Notified Lab of quick TAT samples.		

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QM73860 QUALITY ASSURANCE MANUAL
034-SOP71314 CALIBRATION OF SUPPORT EQUIPMENT
060-SOP2894 CANISTER PRESSURIZATION
089-SOP2896 MEDIA MANAGEMENT
090-SOP2975 SUBCONTRACT ANALYSIS
095-SOP2899 CLIENT CANISTER TRACKING SYSTEM
F3.60-FRM93227 LOGIN REVIEW CHECKLIST
Job Plan-93104 Login Receiving Development Plan and Assigned Competencies
QA-SOP69729 PROFICIENCY TEST SAMPLES

End of document

Version history

Version	Approval	Revision information	
32	25.OCT.2024	2.1.1.1 - updated the area in which we place all the coolers during sorting. 2.1.2.1 - Added information about what a Yes/No on custody seals means. updated information that if you see a COC with a turnaround time of 4 days or less, to notify other login analysts and to place a teal folder with this COC. added requirement for all sorbents/passives to be stamped. added taking a scan of the airbill and including the copy with the work order if unable to detach from package 2.1.3.1.3 - Updated RUSH TAT to be 4 days from 3 days. 2.1.3.1.4 - added that all samples requiring refrigeration be immediately stored unless being actively logged in. 2.4 - updated from 2.3.7 - this should be it's own section as it does not solely relate to courier deliveries. 3.4.4 - clarified the WO number is from the stamp 3.5.5.2 - Clarified turnaround "time" 3.8.2.5 - removed If temperature recording is not applicable, write “NA” for the temperature. as we no longer adjust duplicates. 3.8.2.6 - renumbered to 3.8.2.5 3.14.5 - If login review is not required, put NA on the secondary review line of the login review. 3.21 - removed reference to sample logbook, updated to sample tracking. 6.1 - updated information to include Initial °C, Correction Factor, Final °C, equipment number and time stored of the thermometer. added verbiage of requiring immediate storage in the designated refrigerator if not being actively logged in. Section 6 fixed "work order" 6.2.4 - fixed typo 6.4.2.1 - Added secondary review being required for all media that can contain a sample 6.4.2.2 - added secondary review being required for all media that can contain a sample 6.4.3 - Added secondary review for all media that can contain a sample 6.4.4 - Added secondary review for all media that can contain a sample 6.6 - added Teal Folder usage information 6.7 - referenced QA Stamp in receiving. 6.8 - Added reference to SOP QA-SOP69729 in D4, removed information about setting up due date to be 1 week faster than the end of the study. 7.1.1 - Updated to add sorbents and passives being scanned into sample tracking 7.2.2 - removed mention of a logbook 14.0 - Updating U WO to use the RWO stamp for their work order number. Section 6.1 Updated Information regarding verified equipment used for temperature measurement. Updated Header Information.	
33	18.NOV.2025	Updated header information. Removed revision history as the version history will be used to track changes.	

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Version	Approval	Revision information	
34	30.APR.2026	1 - Changed mention of ATLAS to LIMs system. 4 - rewrote entire section - Added exception to the rule for receiving packages per management. 4.3 - Fixed some verbiage. Added information detailing that all boxes need to be checked for Sorbents/Passives/Tedlars that were sent with canisters. 4.4 - Updated information to match how we check hold times/TAT of samples in TALs. 4.4.5 - Changed mentions of SRC to Sample Acknowledgement. 5 - Entire section rewritten to encompass new LIMs system. 4 - rewrite to update that all jobs require secondary review by another Login Analyst per NELAP standards 6 - Login Review Section added. 7 - Updated information from Sample Discrepancy report to Non-conformances. 8 - Updated for new LIMS system, and added instructions for Job Series 9 - Updated storage for extractions to only be for refridgerator 11 - Section rewritten for Workshares instead of Subcontracts. 12 - Section updated for new procedures in TALS 13 - Updated for TALS 14 - Flow of Folders updated to Flow of COCs 15 - Specialized job creation crunched down for new procedures. 16 - Updated to include new work instructions 17 - Updated for TALS	

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Eurofins Air Toxics
Folsom, CA

STANDARD OPERATING PROCEDURE

SOP #54

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1) SCOPE AND APPLICATION

This is a procedural guide for the application of ASTM Method D1945-14(2019) for the analysis of Methane and fixed gases in natural gas via GC/FID/Dual TCD. The method has been modified to apply to a wide range of environmental concentrations measured in landfill gas, ambient air, soil vapor and stack gas. A list of target compounds and associated reporting limits can be found in *Appendix A.*

2) METHOD SUMMARY

2.1 Description

2.1.1 ASTM Method D1945 describes techniques for the analysis of Methane and fixed gases in natural gas samples by GC/FID/Dual TCD. The approach employs a gas chromatograph (GC) equipped with a flame ionization detector (FID) and dual thermal conductivity detectors

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(TCD). The GC is also equipped with two 10 port gas sampling valves in conjunction with two 6 port column isolation valves. Samples may be collected in Tedlar bags, Summa^{TM} canisters, or any container that is demonstrated to be clean and leak free.

2.1.2 The samples are directly connected to the sampling loop. An aliquot is withdrawn from the container by vacuum, via a syringe injection. Rigid containers are first filled to positive pressure using UHP Helium or Nitrogen (see Section 4.2).

2.1.3 Under *SW-846 Third Edition*, second column confirmation would be required for any positive GC determinations. It is not possible to find a second set of columns and valve configuration that would accomplish this for the natural gases. Porous polymer and molecular sieve technology used in this SOP are very specific for the gases detected. A variance to this requirement for second column confirmation is taken in this SOP. A summary of the method QC can be found in *Appendix A*.

2.2 Deviations

2.2.1 Modifications to the *ASTM Method D1945-14(2019)* used by the laboratory to carry out the analyses of air samples are summarized in Table 1. Laboratory procedures align with calibration and QC procedures outlined EPA environmental gas chromatographic methods.

Table 1. Summary of Method Modifications

Requirement	ASTM D1945-14 (2019)	Laboratory Modifications
Instrumentation	Thermal conductivity-type detector (TCD) or equivalent in sensitivity and stability	Custom Refinery Gas Analyzer with Flame Ionization Detector (FID) and dual TCDs using a multicolumn application to separate and measure required target analytes with a single loop injection.
Sample Injection Volume	Specifies 0.50 mL for Methane.	1.0 mL.
Establishing Linearity	Fixed volume sample loop is charged with target analyte at partial pressure increments from 13 kPa to ambient pressure.	Vapor standards purchased or prepared at varying concentrations to establish a multi-point calibration curve are loaded with sample loop equilibrated to ambient pressure.
Sample collection and introduction	No specifications on acceptable containers provided, references sample cylinders with sample introduction using purging or evacuation methods.	Evacuated specially treated 1L or 6L canisters are utilized for collection. Canister samples require pressurization to positive pressure (2 psig for 6L or 10 psig for 1L) with either high purity nitrogen or helium to facilitate flushing of sample line and gas sample loop. Alternatively, gas sampling bags can be utilized.
Sample Quantitation	A single point calibration is performed using a reference standard closely matching the composition of the	Quantitation is based on the average calibration factor generated from the initial calibration.

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	unknown. Standard is analyzed such that 2 consecutive runs meet method repeatability requirements.	
Sample Analysis	Equilibrate samples to 10-30°C above source temperature at field sampling unless the hydrocarbon dewpoint of the sample is known to be lower than the lowest temperature which the sample has been exposed.	No heating of samples is performed.
Sample Calculation	Response factor is calculated using peak height for C5 and lighter compounds.	Peak areas are used for all target analytes to quantitate concentrations.
Normalization	Sum of original values should not differ from 100.0% by more than 1.0%.	Sum of original values may range between 85-115%; normalization of data not routinely performed. Note that pressurization with Helium should be requested by the client if measured nitrogen (N2) concentrations are needed. If samples are pressurized with N2, nitrogen will be reported as the remaining balance of the sample concentration.
Repeatability	Based on component concentration and expressed as amount, e.g. for % concentrations >10, the repeatability should differ no more than 0.10.	Precision for replicate injections is evaluated against laboratory criterion of +/-25%RPD (Relative percent difference)

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3) HEALTH AND SAFETY

3.1 Normal laboratory safety precautions must be used when handling samples, preparing standards from neat materials, and analyzing samples. Appropriate eye wear, gloves, and lab coat must be worn when handling any chemical used in this method. All manipulation of standards, solvents, and solutions should be done with the utmost care in the hood. SDS for each chemical should be consulted for specific dangers and precautions.

3.2 Personnel must handle high pressure cylinders safely. This includes transport of cylinders fully secured on a cart. During storage, the cylinders must be secured at all times with a chain. When installing a pressure regulator, stand to the side of the cylinder.

3.3 Care must also be taken when handling syringes to ensure that a needle stick does not occur. ***All personnel installing or performing maintenance on a capillary column must wear***

eye protection.

3.4 For information regarding pollution prevention and waste disposal, see Eurofins laboratory *SOP #24*:Storage and Disposal of Hazardous Wastes.

3.5 Samples required for ASTM D1945 analysis may contain high levels of sulfur compounds. If high sulfur is suspected, the bench chemist should notify the safety team and do not proceed with handling and analysis. The team will determine if samples can be handled safely, and assign trained and qualified staff as appropriate.

4) SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

4.1 Sample Containers

An air sample is collected in an evacuated stainless steel Summa™ canister or Tedlar bag. Upon receipt, the canisters will be approximately in the range of 2.5 - 10" Hg vacuum. Canister receipt vacuum/pressure is reported on the first page of the data report. If abnormal conditions exist, the project contact is notified by a member of the Sample Receiving Team or a Project Manager. Depending on the nature of the anomaly, the sample may be placed on hold until approval from the client.

4.2 Sample Handling

Prior to analysis, the canisters are pressurized in accordance with Eurofins laboratory *SOP #60* (Canister Pressurization) and/or per project specific requirements.

Samples requiring quantified Nitrogen results must be pressurized with Helium.

4.3 Sample Storage

Samples are stored in the main laboratory. Analysis must occur within 30 days for canisters. Some projects may require a 14 day hold for canisters. The project profile must be reviewed prior to analysis to verify holding time requirements.

4.3.1 Holding time in the case of Tedlar bags is limited to a maximum of 3 days* as losses of VOCs are observed specifically for compounds with low vapor pressure. If Nitrogen and Oxygen are not target compounds, holding time may be extended to a maximum of 30 days by transferring the sample from a Tedlar bag to a clean, evacuated Summa™ canister prior to the expiration of the 3 day hold. The transfer must be documented using the Tedlar bag transfer form and documented in the case narrative as per Eurofins laboratory *SOP #69*.

* The result of spiking studies conducted by the laboratory indicated a reduction in Helium recoveries 24 hours after spiking into the SKC Tedlar bags. When Helium is a requested target compound, every effort must be made to analyze the Tedlar bag samples as soon as they are received due to potential loss of He. If only ASTM D1945 analysis is required, Flex-foil bags are preferable media than Tedlar bags.

5) INTERFERENCES AND POTENTIAL PROBLEMS

5.1 Argon co-elutes with Oxygen under this method. If Argon is present in the sample matrix, it will be reported as total with Oxygen. There are no other known compounds having the same

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retention times as the compounds of interest in the method.

5.2 Because of the wide range of concentrations of Carbon Dioxide and Methane typical of samples submitted for analysis by this method, a potential for carryover contamination exists for these two compounds. Therefore, when concentrations of Carbon Dioxide and Methane decrease from one sample to the next by greater than a factor of 1000 and the detection is above the reporting limit, the sample with the lower concentration is re-analyzed to ensure the amount reported is not due to carryover.

5.3 Canister samples containing > 0.01% TNMOC (based on screen results) must be red-tagged by the screening analyst. Additionally, if a bag dilution is needed for sample analysis, the analyst should attach a red tag to the sample canister if it had not previously been tagged. This is to ensure that the canister goes through a special cleaning cycle once the canister is released to the Support Services Department. See laboratory *SOP #7*.

5.4 The analytical system is designed to load sample containers at atmospheric or positive pressure. If a sample container has a residual vacuum (less than atmospheric pressure) at the time of loading, the exhaust vent may be pulled into the sample container thereby compromising the sample. In order to eliminate this possibility, the canister pressure is always checked prior to analysis as outlined in section 11.7. However, upon review of the sample run, if the chromatogram shows any sign of contamination from the exhaust line, the sample pressure and analysis need to be confirmed. If the sample was compromised during sample loading, the analyst who ran the sample needs to tag the canister as "contaminated" if shared with other methods. The analyst should also immediately initiate an SDR for all associated fractions.

6) STANDARD PREPARATION, REAGENTS, STANDARDS, AND SUPPLIES

6.1 Stock Standards Purchased

ASTM D1945 vapor phase standards are purchased from Scott Specialty Gas, Airgas VOC blends or another vendor at various concentrations in percent mole in a high-pressure cylinder blend. These primary standards are NIST-traceable with a vendor-supplied certificate of analysis. The standard expires according to the manufacturer's expiration date. If none is provided, the standard expires one year after the date opened. Details on how to prepare these standards are provided in the QA-controlled Work Instructions at each work station.

6.2 Materials

- Certified Calibration Blends (various concentrations) – These standards have been certified to a > 95% level of accuracy. Certification reports are attached to each cylinder of stock standard and a hardcopy is maintained on file.
- Individual pure gas or stock standards.
- Two stage regulators, stainless steel high purity (0 to 20 psig).
- Syringes of various volumes.

7) EQUIPMENT/APPARATUS

7.1 Instrument

- HP 6890 Gas Chromatograph FID/dual TCD

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- Column 1: 4.0 cm length, 0.53mm alumina plot column
- Column 2: 50m length, 0.53mm alumina plot column
- Column 3: 6 feet length, 1/8" hayeSep A 80/100 mesh column
- Column 4: 10 feet length, 1/8" molecular sieve 80/100 mesh pack column
- Column 5a: 6 feet length, 1/8" hayeSep A 80/100mesh column
- Column 5b: 7 feet length, 1/8" molecular sieve 80/100 mesh pack column
- Column 6: 2 feet length, 1/8" molecular sieve 80/100 mesh pack column
- Column 7: 2feet length, 1/8" molecular sieve 80/100 mesh pack column
- Column 8: 2 feet length, 1/8" molecular sieve 80/100 mesh pack column

7.2 Operating Parameters

Since analytical equipment varies in configuration and as a function of intended specific target analytes, operating parameters are optimized on an instrument-by-instrument basis. Instrument specific operating parameters are recorded in the respective Instrument Maintenance Logbook and in the QA-controlled Work Instructions at each work station.

Note: Only trained and qualified laboratory staff are authorized to vary the operating parameters under special circumstances. Any time a change is made, it is documented in the instrument maintenance logbook.

8) CALIBRATION AND QUALITY CONTROL PROCEDURES

8.1 Initial Calibration Procedures

8.1.1 Initial Calibration is achieved using an external standard technique and is performed at least annually. A response factor is generated for each individual target compound based on the area counts vs. concentration of the calibration standard. A minimum of five levels of each analyte is analyzed to generate the initial calibration. The lowest level must be less than or equal to the reporting limit (Limit of Quantitation). Other levels may be added to the calibration per specific client/project request. The initial calibration points must be analyzed from the lowest concentration point to the highest concentration point. If a low point is analyzed after a higher level, a blank must be analyzed prior to the low point.

8.1.2 Calibration standards are purchased from commercial gas suppliers or prepared as bag blend standards in the laboratory. The purchased commercial standards are certified to > 95% accuracy. Certification reports are attached to each cylinder of stock standard and a hardcopy is maintained on file.

8.1.3 The percent relative standard deviation (%RSD) for the Initial Calibration must be less than or equal to 15%. If this cannot be achieved, the Initial Calibration must be repeated.

8.1.4 The reporting limit (Limit of Quantitation – LOQ) must be verified quarterly on each instrument that performs the methods the lab is accredited for by DoD/DOE (Refer to DoD and DOE scopes at O:\QA\Certifications). The LOQ is verified by evaluating the point of the initial calibration that corresponds to the LOQ. The concentration recovered is used to calculate the precision and bias of each compound. A minimum of three points is required to perform the calculations. If there are insufficient points, a primary source standard is analyzed at the LOQ. Precision and bias are determined by calculating the % relative standard deviation (% RSD) and the % bias of the mean concentration recovered. The acceptance criterion for the LOQ verification is ≤30% RSD and ≤50% bias for each compound. If more than 10% of the compound list exceeds the acceptance criteria, the instrument and standard used will be

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evaluated to determine the source of the error. Quarterly LOQ verifications are evaluated by the QA Department and the values are maintained on a secure network drive.

8.2 Initial Calibration Verification (ICV) and Laboratory Control Sample (LCS)

8.2.1 An independently prepared (i.e. same vendor, different lot number or second vendor) standard containing all target compounds is analyzed with each Initial Calibration and with each analytical batch to verify accuracy.

8.2.2 Recovery limits for the ICV and LCS are 85-115%. If this criterion is not met, the ICV or LCS standard will be re-analyzed. If the problem persists, corrective action up to and including re-calibration of the instrument will be performed. An LCS is analyzed in duplicate (LCSD) daily. Evaluation and acceptance criteria of the LCSD are equivalent to the LCS. Refer to section 8.5 for the RPD acceptance criteria between the LCS and LCSD. If run at the end of a batch, the LCSD can serve as an end check. Note that in-house control limits may be required for evaluation of the LCS based on project specifications.

8.3 Continuing Calibration Verification (CCV)

8.3.1 A Continuing Calibration Verification (CCV) standard is analyzed prior to sample analysis and is repeated after every 20 reportable samples (sample duplicates do not count). This is an analysis of the primary source at a concentration equal to or less than half the highest level of the initial calibration. The response factor for each analyte should be within ±15% compared to the Initial Calibration for the initial CCV.

8.3.2 If any analyte fails to meet the criteria, the system is checked for problems. If the system needs maintenance such as cleaning the FID, column re-conditioning etc., the CCV standard must be analyzed twice with an acceptable recovery. The second passing standard serves as confirmation only. The analysis of a passing LCS may also serve as the confirmation standard. In the event the criteria still cannot be met, the corrective action may include re-calibration of the instrument.

8.3.3 The CCV can be repeated at the end of the analytical batch if an LCS was analyzed earlier in the batch. In this case, the CCV would serve as an end check.

Software Verification: A manual verification of the computer-generated results is performed daily on one randomly chosen target compound, one from the FID and one from a TCD using the LCS standard or a sample and documented in the instrument run log.

8.4 Laboratory Blanks

8.4.1 Laboratory Blanks containing 100% UHP Helium or 100% Nitrogen are analyzed prior to the analysis of samples. For Hydrogen and Helium analysis, 100% UHP Nitrogen will be used as the Lab Blank and if Nitrogen is reported for any associated client samples, Helium must be used for the Lab Blank. The concentration of all analytes in the Laboratory Blank must be less than the reporting limit (Limit of Quantitation). If contamination is present, additional Lab Blanks are analyzed until the instrument is clean or maintenance is performed. Sample analysis may not proceed if the Laboratory Blank fails to meet acceptance criteria.

8.4.2 Some projects require an acceptance criteria for the Method Blank as follows (see Project Requirement Tables):

No analytes detected at ≥ ½ the RL. For common laboratory contaminants, no analytes detected ≥ the RL.

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If an analyte in the laboratory blank fails these criteria the associated samples must be reprocessed in another analytical batch unless the analyte resulted in a non-detect. If no sample volume remains for re-analysis, the results will be reported with the appropriate data qualifying code (B flag).

Note: If the above criteria cannot be met please notify the QA Department.

8.5 Laboratory Duplicates

8.5.1 Every daily analytical batch must include an LCS and an LCSD to evaluate instrument precision. The acceptance criteria for the relative percent difference (RPD) between the LCS and LCSD analyses should meet ≤25%. Exceedances are narrated in the final report.

8.5.2 A duplicate sample analysis is performed only when specifically required by the Project Profile and/or Project Requirement Table associated with the workorder. The Relative Percent Difference (RPD) between duplicates must be ≤ 25% for detections greater than 5 times the reporting limit, or re-analysis is performed. Failure to meet this criterion results in a third analysis of the sample. If the criterion still is not met, the cause is investigated in order to return the system to working order. If no problem is found on the system, the data is narrated to note the non-conforming event and a Corrective Action Request (CAR) is initiated to ensure all parties are informed of the lack of method reproducibility for the affected set of samples.

8.6 Field QC Samples

8.6.1 ASTM D1945 does not describe field QC sample collection or acceptance criteria. However, clients may collect Field Blanks, Trip Blanks, and Field Duplicates. While there is no acceptance criteria established, analysts must monitor performance and note anomalies. For example, a positive result in the Field or Trip Blank requires closer inspection to ensure the anomaly wasn't incurred during sample handling and loading. Inspection may include verification of the canister analyzed and verification that the analytical system was clean.

8.6.2 Likewise, a field duplicate sample which shows an inconsistent chromatographic pattern as compared to the paired sample or concentrations differing by more than 40%RPD for many of the detections requires further investigation at the time of sample loading. Verification of the canisters identification and load volume and comparison of the FID screens are all appropriate to verify results.

8.6.3 Notate on the data checklist the anomaly and the items verified. If an anomaly was uncovered, then the field QC should be reanalyzed. If there are no findings then an SDR is generated informing the appropriate project manager following a note on the Data Review Checklist indicating the non conformance. Narrate the presence of a detection in the Trip Blank and Field Blank.

9) CALCULATIONS

The average response factor (RF) from the Initial Calibration Curve is used to quantitate samples and QC results.

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$$RF = \text{AreaCounts} / \text{Concentration (\%)}$$

$$\text{Sample Amount(\%)} = \frac{\text{AreaCounts}_{(\text{sample})}}{\text{ICAL RF}} \times DF$$

9.2 For canister samples pressurized with Nitrogen, the concentration of Nitrogen is calculated by adding all of the sample components and subtracting from 100%.

9.3 Normalization is not typically performed for ASTM D1945 samples. However, if the client requests normalization, it is recommended that Nitrogen not be used to pressurize the samples. Given the large amount of Nitrogen added to the sample, this step introduces possible error in the Nitrogen result. Normalization of the results then propagates this error through to the remaining target concentrations. See *Appendix C* for normalization calculations. If EPA rounding causes normalized results to be 99% or 101%, the Nitrogen concentration will be adjusted by +/- to achieve 100%.

9.4 The C6+ Hydrocarbons area is defined as the summation of C8+ peak areas and peak area following elution of Pentane to the end of the analytical run. The sum of this area is divided by the response factor of Hexane and Heptane to calculate the C6+ result.

9.4.1 *Response Factor for C6+ Hydrocarbons*:

$$RF_{C6+} = \frac{(\text{Area}_{\text{Hexane}} + \text{Area}_{\text{Heptane}})}{(\text{Concentration\}_{\text{Hexane + Heptane}})}$$

9.5 Unknown hydrocarbons can be quantified for purposes of reporting BTU. To calculate on-column unknown results, the area of the unknown peak is divided by the response factor of the nearest straight-chain hydrocarbon eluting after the unknown peak. The on-column result is then multiplied by the sample dilution factor to obtain a final concentration. The reporting limit for unknowns is 0.01%.

10) CALCULATION OF BTU AND SPECIFIC GRAVITY

BTU and specific gravity calculations are based on the ideal gross heating values and specific gravity constants specific to each compound respectively. The BTU and specific gravity values for each component are summed to give a total BTU and specific gravity value for the sample (see *Appendix B* for BTU and Specific Gravity Calculations).

11) SAMPLE ANALYSIS

11.1 Analytical Batch

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The analytical batch* is defined as all samples, up to 20, analyzed within 24 hours on one instrument. All QC and samples must be processed with the method associated with the daily analytical batch.

*Samples per batch are reportable analytical runs excluding QC samples, dilutions, duplicate analysis and confirmation analysis.

11.2 Analytical Sequence

Initial 24-hour period:	***Subsequent 24-hour period:***
Initial Calibration	CCV
ICV	LCS
Laboratory Blank	Laboratory Blank
Up to 20 reportable samples	Up to 20 reportable samples
CCV or LCSD*	CCV or LCSD*

* The LCS may be analyzed earlier, and a CCV or LCSD may be analyzed as an end check.

The "Subsequent 24-hour" sequence is followed every twenty-four hour period in which samples are analyzed, until the system fails quality control acceptance limits.

In the event of a daylight savings transition, a time shift may be observed during analysis of samples. If this occurs, data is acceptable and may be used. The occurrence must be documented in the run log and on the Data Review Checklist of any affected work orders.

11.3 Method Detection Limit (MDL)

11.3.1 An annual Method Detection Limit (MDL) study is performed in 40 CFR Pt. 136 App. B (see laboratory *SOP #39* for more details). The MDL must be less than the reporting limit. If this is not achieved, corrective action, including raising the reporting limit is taken prior to continuing with sample analysis.

11.3.2 The reporting limit (Limit of Quantitation - LOQ) must be greater than the MDL before sample analysis can occur. In general, the reporting limit (LOQ) is typically up to 10 times greater than the MDL but may be up to 50 times greater. If the reporting limit (LOQ) exceeds this range, the Laboratory Manager and/or the QA Department will evaluate the reporting limit to determine the reason and its approval.

11.3.3 The Limit of Detection (LOD) must be analyzed on a quarterly basis. Refer to *SOP #39* for the acceptance criterion.

11.3.4 All current Method Detection Limit (MDL) studies are kept in a folder near the instrument.

11.4 Peak Identification/Retention Time Windows

11.4.1 Retention Time (RT) windows are crucial to the identification of all target compounds. At method set up and after major maintenance (e.g., column change) the elution stability of each analyte is demonstrated by calculating the standard deviation of the mean absolute retention time over a 72-hour period. To proceed with sample analysis, the following condition must be met: SD of 0.01min X 3. A copy of RT windows study is kept by each instrument.

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11.4.2 After an Initial Calibration has been evaluated and meets laboratory criteria, the midpoint is copied by adding an extension onto the file identifier, and then it is requantified as a Continuing Calibration Verification. All calibration points are then requantified and Retention Time Windows for each file are compared to that of the midpoint. If %D criterion for the CCV (see Section 8.3.1) is met, analysis of the Initial Calibration Verification Standard may proceed. On days when an Initial Calibration is not performed, the Retention Time Windows in all subsequent samples and QC must meet laboratory criteria (compared to the CCV analyzed at the beginning of the analytical sequence).

11.5 Quantitative Analysis

Quantitation is based on the response factor generated from the initial calibration. If the response for any peak exceeds the initial calibration range of the GC system, the sample is diluted and re-analyzed, with the exception of Oxygen, Nitrogen (see Section 11.8.2) and C6+ Hydrocarbons (see Section 11.8.3). Sample dilutions should result in the analyte with the highest concentration to be within the upper 60% of the Calibration Curve.

11.6 Manual Integrations

At times performing manual integrations on Initial Calibrations standards, QC, Laboratory Blanks and samples may be necessary. Refer to *SOP #57* for Manual Integrations by GC for proper manual integration procedures and documentation.

11.7 Analytical Procedures

The sample containers are connected to the sampling loop line. Following the QA-controlled work instructions for the specific system, the sample connection is checked for leaks, and the sample is loaded onto the system.

Just prior to sample analysis, the pressure on the individual canister sample must be checked and documented in the run logbook. In the event that the pressure of a 1Lcanister sample is less than 1psi or 6L canister pressure is below ambient, then the canister must be re-pressurized. This information is then documented in the run logbook before proceeding with sample analysis.

11.8 Sample Dilutions

11.8.1 Dilutions may be necessary in order to obtain analyte concentrations within the upper half of the calibrated range of the detectors and to prevent contamination of the system. Because the sample loop is a fixed volume, the samples are diluted prior to injection by adding a measured aliquot of the sample to a Tedlar bag that has a metered volume of UHP Nitrogen (or Helium) added as the diluent gas (bag dilution) or are diluted by syringe. Details on how to perform sample dilutions are recorded in the QA-controlled work instructions at each work station.

11.8.2 When dilution is performed, the Nitrogen and Oxygen results may be compromised due to the predominance of these two compounds in the atmosphere. Consequently, Nitrogen and Oxygen results are reported from undiluted analyses, even if the results are over the calibrated range.

11.8.3 Since the Response Factor from two individual peaks (Hexane and Heptane) is used to quantify C6+ Hydrocarbons as a sum area, the concept of results exceeding the Initial Calibration Curve is not applicable. Therefore it is not necessary to dilute samples for C6+ Hydrocarbons.

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12) CORRECTIVE ACTION PROCEDURES

A request for corrective action (CAR) is initiated any time either the laboratory SOPs or client-prescribed QC protocol are not followed, or in any other instance that sample results are adversely affected. The corrective action is documented in the laboratory's Corrective Action Procedures *SOP #61*.

13) DATA REVIEW

13.1 Analytical Data Review

As the analytical sequence is analyzed throughout the day, the data is reviewed by the analyst or scientist using the following steps:

13.1.1 Check for any project-specific requirements.

13.1.2 Verify holding time.

13.1.3 Verify the CCV, LCS, and LCSD

13.1.4 Verify that the Method Blank has no hits above the reporting limit (with the exceptions outlined in 8.4.1- 8.4.2).

13.1.5 Verify sample results:

a) Verify the retention time.

b) Verify that correct amount of sample was analyzed.

c) Verify the automated peak integration.

d) Verify that result concentrations are within linear range of Calibration Curve (upper 60% for dilutions.)

13.1.6 Initial and date logbook entry to indicate that the data is acceptable.

13.1.7 Describe unusual events on Data Review Checklist.

Note:

- *A secondary review of the analytical runs is required when the bench chemist is not signed off on the analysis.*

13.2 Write-up and Final Report Review

The analyst or scientist performing the data write-up and final client report reduces the data by reviewing the Target data files. The peaks in each sample are reviewed for the correct integration and identification. The integration is modified only when necessary following guidance in laboratory *SOP #57*. The criteria for compound identification are described in section 11.4. The data is evaluated for the project required sublist only.

When the sample Target review is complete, the sample files are transferred to the Atlas database. The client report is compiled in the Atlas workorder editor following laboratory *SOP #78*. Check the following when compiling the report:

- Prepare and review narrative (laboratory *SOP #45*), detailing QC non-compliance as needed.
- Evaluate data package from a data user perspective. Does the data make sense?

When complete sign and date the 'Write-up' field on the Data Review Checklist and email the report to the client. Update the Atlas database to reflect the 'date reported".

13.3 Technical Data Review

The Scientist or designated personnel performs a Technical Data Review on 100% reports if the write-up review analyst or scientist is not signed-off for the method. This review follows all the steps mentioned in the Analytical and Write-Up Data Review (Sections 13.1-13.2).

13.4 Report Review

The Report Review represents a 3rd level of review which is required for DoD/DOE and client specific projects only. Refer to the Data Review Checklist for the specific items requiring review.

13.5 QA Data Review

A thorough QA data review is performed by the QA Department on final data packages requesting 100% review. The QA Review entails verification that project and QC requirements are met. Failure to meet QC and/or project requirements results in a Corrective Action Request (CAR) and documentation. Dilution factors, analyte retention times, peak integration areas, concentration calculations, unit conversions, and Limit of Quantitation (reporting limits) are also checked. Field and Trip Blanks are checked and trends are observed.

14) INSTRUMENT MAINTENANCE

14.1 A possible leak in the system may be indicated by retention time shifts. Maintenance should be performed by trained and qualified laboratory staff. For more information on problems originating with the Hewlett-Packard 6890 GC, refer to the instrument operation and reference manual. Customized hardware and questions about such hardware should be referred to Wasson–ECE Instrumentation or appropriate vendor.

14.2 The bench analyst will document any routine or major maintenance in the bound instrument Maintenance Logbook assigned to each instrument. The date of the maintenance, what work was performed and analyst initials are included.

15) DELIVERABLES

Data reporting packages are prepared as described in laboratory *SOP #78*—Generation of Eurofins Air Toxics Inc. Data Deliverables, Electronic Conversion and Archival.

16) REFERENCES/DEFINITIONS

ASTM Method D1945-14 (2019)

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Standard Method for Analysis of Natural Gas by Gas Chromatography. ASTM Committee D-3 on Gaseous Fuels.

Please refer to the Eurofins Environment Testing Northern California, LLC (Folsom, CA) Quality Assurance Manual (QAM)
Definitions and Terms, Appendix A.

17) APPLICABLE WORK INSTRUCTIONS

WI-008_054 ASTMD-1945_ASTM D-1946
WI-Dilutions Bag and Can Dilution Procedure
WI-Can Leak Canisters with Evidence of Possible Leak Procedure
WI4700 Standard Prep Using Precision Diluter
WI39 MDL Procedure
WI96 ICAL Set-Up In Atlas
WI-ICAL Set-Up in Target

18) APPENDICES

Appendix A. Summary of Method QC

Table A-1 ASTM Method D1945 Analytes, Reporting Limits and QC Acceptance Criteria
Table A-2 Summary of Calibration and QC Procedures for ASTM Method D1945

Appendix B *BTU and Specific Gravity Constants and Calculations for ASTM Method D- 1945.*

Appendix C. *Normalization Calculations*

Table A-1. ASTM Method D1945

Analyte	RL/LOQ (ppbv) (%)	QC Acceptance Criteria		
		ICAL (%RSD)	CCV/LCS/ICV (%R)	Precision Limits (Max. RPD) ***
Carbon Dioxide	0.01	≤ 15%	± 15%	≤ 25%
Carbon Monoxide	0.01†	≤ 15%	± 15%	≤ 25%
Ethene	0.001	≤ 15%	± 15%	≤ 25%
Ethane	0.001	≤ 15%	± 15%	≤ 25%
Acetylene	0.001	≤ 15%	± 15%	≤ 25%

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Isobutane	0.001	≤ 15%	± 15%	≤ 25%
Isopentane	0.001	≤ 15%	± 15%	≤ 25%
Methane	0.0001	≤ 15%	± 15%	≤ 25%
n-Butane	0.001	≤ 15%	± 15%	≤ 25%
Neopentane	0.001	≤ 15%	± 15%	≤ 25%
n-Pentane	0.001	≤ 15%	± 15%	≤ 25%
Nitrogen*	0.50	≤ 15%	± 15%	≤ 25%
NMOC (C6+)	0.01	≤ 15%	± 15%	≤ 25%
Oxygen	0.10	≤ 15%	± 15%	≤ 25%
Propane	0.001	≤ 15%	± 15%	≤ 25%
Hydrogen**	0.01	≤ 15%	± 15%	≤ 25%
Helium	0.05	≤ 15%	± 15%	≤ 25%

* For canisters that have been pressurized with N_2, the amount of N_2 in the sample is determined by subtraction.
** For canisters that have been pressurized with Helium, the Reporting Limit is 1.0%.
† RL is 1.0% when samples contain high methane (approximately 50%) commonly present in Landfill Gas
***For detections at > 5X the Reporting Limit.

Appendix A (continued)

Table A-2. Summary of Calibration and QC Procedures for ASTM Method D1945

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QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial Calibration (ICAL)	Prior to sample analysis and annually.	≤ 15% RSD.	Correct problem, then repeat the Initial Calibration
Initial Calibration Verification and Laboratory Control Sample (ICV and LCS)	After each initial Calibration/ and once per analytical batch.	85-115 % Recovery. * LCS only: If specified by the project, in-house generated control limits may be used.	Check the system and re-analyze the standard. Re-prepare the standard if necessary. If the primary standard is found to be in error, re-prepare the primary and calibrate the instrument.
Continuing Calibration Verification (CCV)	Daily prior to sample analysis and can be used as an End Check.	± 15 Difference.	Check the system and re-analyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met. If the closing CCV fails, the system is checked and the standard is re-analyzed. Re-prepare the standard if necessary. If the second analysis fails, identify and correct the problem, then re-analyze all samples since the last acceptable CCV.
Laboratory Blank	After analysis of standards and prior to sample analysis, or when contamination is present.	Results less than the laboratory Reporting Limit.	Inspect the system and re-analyze the Laboratory Blank.
Laboratory Duplicates- Laboratory Control Sample Duplicate (LCSD)	One per analytical batch.	RPD ≤ 25%.	Narrate exceedances. Investigate the cause and perform maintenance as required and re-calibrate as needed.

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Appendix B

BTU and Specific Gravity Constants* and Calculations for ASTM D1945

Analyte	Ideal Gross Heating Value (BTU/ft^3)	Ideal Gas Relative Density (Specific Gravity)
Hydrogen	342.2	0.0696
Oxygen	NA	1.1048
Nitrogen	NA	0.9672
Carbon Monoxide	320.5	0.9671
Methane	1010	0.55392
Carbon Dioxide	NA	1.5196
Ethane	1769.7	1.0382
Propane	2516.1	1.5226
Iso-butane	3251.9	2.0068
Butane	3262.3	2.0068
Neo-pentane	3985	2.4912
Iso-pentane	4000.9	2.4912
n-Pentane	4008.9	2.4912
NMOC C6+	4747	2.9755
Acetylene	1474	0.899
Ethylene	1600	0.9686

* ASTM D3588/3589 Properties of Natural Gas Compounds at 60º F and 14.696 psia Standard Practice for Calculating Heat Value Compressibility factor and Relative Density (Specific Gravity of Gaseous Fuels).

Calculations

- BTU/ft^3 = Amount (%) X (Ideal Gross Heating Value) X (0.01)
- Specific Gravity = Amount (%) X (Ideal Gas Relative Density) X (0.01)

Appendix C

Normalization Calculations

- *For samples pressurized with N_2:*
  N2 in sample (%) = (100% - (Sum of all other analytes))
- Conversion Factor (CF) = 100/sum of non-normalized Amounts (%)
- Normalized Amount = Non-normalized Amount (%) X CF
- Normalized BTU/ft^3 = Non-normalized BTU/ft^3 X CF
- Normalized Specific Gravity = Non-normalized Specific Gravity X CF

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WI71132 DILUTIONS BAG AND CAN DILUTION PROCEDURE
WI71133 WI-CAN LEAK CANISTERS WITH EVIDENCE OF POSSIBLE LEAK PROCEDURE
WI71137 WI-ICAL SET-UP IN TARGET
007-SOP2904 PREPARATION OF SUMMA® AND TO-CAN CANISTERS FOR SAMPLING
008_054-WI73795 ANALYSIS OF NATURAL GASES BY MODIFIED ASTM METHOD D-1945 AND ANALYSIS OF OXYGEN, NITROGEN, METHANE, ETHANE, ETHENE, CARBON MONOXIDE, CARBON DIOXIDE, HYDROGEN AND NMOC BY MODIFIED ASTM METHOD D-1946
024-SOP2882 STORAGE AND DISPOSAL OF HAZARDOUS WASTES
039-SOP2886 PROCEDURES TO PERFORM AN MDL STUDY
039-WI71130 PROCEDURE FOR DETERMINING THE MDL
045-SOP2955 PREPARATION AND REVIEW OF LABORATORY NARRATIVES
057-SOP2892 MANUAL PEAK INTEGRATION GAS CHROMATOGRAPHY
060-SOP2894 CANISTER PRESSURIZATION
061-SOP71113 NON-CONFORMANCE AND CORRECTIVE ACTION PROCEDURE
069-SOP2922 TRANSFER OF SAMPLE COLLECTED IN A TEDLAR BAG TO A SUMMA (TM) CANISTER
078-SOP2927 GENERATION OF EUROFINS AIR TOXICS DATA DELIVERABLES, ELECTRONIC CONVERSION, AND ARCHIVAL
4700-WI71134 WI4700 STANDARD PREP USING PRECISION DILUTER
WI96-WI71136 WI96 ICAL SET-UP IN ATLAS

End of document

Version history

Version	Approval	Revision information	
30	15.OCT.2024	Updated section 2.2 and Table 1.	
30.1	01.JAN.2025		
31	23.JUL.2025	Updated header information, Removed revision history table as all updates will be documented in the version history. Update Table A-1 Nitrogen Reporting limit to 0.5%. (RTC179)	

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Eurofins Environmental Testing Northern California, LLC

Folsom, CA

STANDARD OPERATING PROCEDURE

SOP #63

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1) Scope and Application
2) Procedure Summary
3) Health and Safety
4) Equipment/Apparatus
5) Procedure
6) Sample Disposal Procedure
7) Definitions
8) Applicable Work Instructions
9) Appendices

1) Scope and Application

The procedures in this SOP describe the manner in which the laboratory tracks samples from the time after they are logged in and pressurized (if required) until analysis is completed and disposal occurs. The purpose of tracking is to maintain chain-of -custody from the time of sample receipt until final disposal.

2) Procedure Summary

2.1 Description

The Sample Receiver or Sample Pressurization and Screening personnel log the entire component of the workorder into a sample storage area* following assignment of a workorder number, laboratory identification numbers, and pressurization (if required). To ensure traceability of results, the unique sample number and workorder number assigned is used to identify the sample in all laboratory data documentation, including logbooks, instrument printouts, and final reports.

Please note that the entire building is considered a "secure area" (see Eurofins Air Toxics *SOP #30 Laboratory Security*).

All barcoded canister and bags must be scanned by the analyst/scientist taking custody of the samples to a designated location. Sample tubes for EPA 325 and TO17 are also scanned using the tube barcodes to their designated area. All other non-barcoded media such as TO13A sample cartridges or Passives SE Radiello/WMS samples must be manually logged in electronically to a specific location prior to analysis by the lab. Removal of the samples for any reason requires either scanning of the barcode of the sample to a specific location or electronically documented to track the movements. This procedure continues to track all samples' transfer and locations throughout the laboratory up until disposal.

*Sample storage area consists of the sample custody cage, designated EPA 325 sample tube storage area and designated 325 shelves, designated refrigerators and designated freezers.

2.2 When a canister, 325 tube, TO17 tube or a bag sample is scheduled for analysis, the analyst obtains custody of the sample by scanning the canister/sticker/tube barcode as well as the barcoded location destination of each individual sample. The scanned information is electronically transmitted to ATLAS systems to reflect the custody of canister, tube, or bag samples at all times. The historical information is maintained in this database from the time of sample receipt until the disposal stage. All other non-barcoded media samples such as TO13A sample cartridges or Passives SE Radiello/WMS samples are manually logged out of Atlas in the same manner.

2.3 Movement of samples from one instrument to another for the purpose of screening or multiple analyses requires electronic documentation. All laboratory staff must use their own secure ATLAS connection login and password prior to using the ATLAS scanning module to record identification of the custodian. Users must also log-out of the ATLAS Tracking Module when not in use to prevent unauthorized access.

3) Health and Safety

The 6L Summa^{TM} canisters are somewhat heavy and could cause injury if they are dropped. To reduce the possibility of dropping canisters during transport using a cart, canisters must be placed on the cart shelf in a single layer. Canisters must never be stacked on top of each other on a cart. In addition to bruising, a valve could be damaged, which could allow potentially toxic sample constituents to escape. Multiple canisters should be moved individually or moved on a cart to prevent any incident. Tedlar bags can be punctured, which could cause sample loss and result in potential exposure.

4) Equipment/Apparatus

List of Equipment

- Computer with ATLAS connection available
- Wireless barcode scanners
- Large RED permanent marker
- When applicable, red stamp: RELEASE TO SHIPPER

5) Procedure

5.1 Client samples are received by the Sample Receiver in the Sample Receiving Department. At this time, a workorder number is created for the samples as a group, and

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individual laboratory identification numbers are assigned to each field sample (see Eurofins Air Toxics *SOP #50*). Note: All samples must be associated with a workorder number prior to allocation throughout the laboratory.

5.2 Requests for multiple analyses will result in fractionation of the workorder into as many separate portions as are needed. Fractionated portions are labeled A, B, C, etc. The workorder is then entered into the laboratory database.

5.3 Samples needing subcontracted work or that need to be sent back to client should have the sample information tags stamped "RELEASE TO SHIPPER" in red.

5.4 Pressurization of the canister media, if required, may take place, and then the Sample Pressurization and Screening personnel move the samples into the sample storage area. At this time, samples are placed in an assigned and identified storage location until needed for analysis.

If samples are taken directly from the pressurization analyst for analysis prior to being logged into the sample storage area, it is the responsibility of the laboratory analyst/scientist to ensure proper custody is maintained by electronically documenting the movement.

5.5 If pressurization and screening are not required, Sample Receiving personnel log/scan the samples into the appropriate sample storage area. Pre-labeled shelves in the sample storage area or refrigerators are assigned to each sample.

5.6 All digital or manual logbooks must include the following tracking information:

a) Workorder number
b) Number of samples
c) Analysis(es) requested
d) Location
e) Date
f) Time (military)
g) Initials of the person holding custody of the samples currently or previously
h) Samples on hold

5.7 Unanalyzed canister and Tedlar bag samples are stored in the sample storage area on shelves designated as "To Be Analyzed". Samples for which analysis has been completed are either disposed immediately (see Section 6) or stored on shelves designated as "Do Not Release" (DNR). Note: samples logged back into the samples storage area where analysis is completed should be placed on the appropriate DNR shelf corresponding to the release date established at login. If a DNR date was not established or the sample is being held for a possible re-run determine a release date based on workorder promise date. (See Appendix A for sample storage organization layout)

5.8 Unanalyzed non-barcoded samples stored in the sample custody refrigerators/freezers are placed on shelves labeled as "Not Analyzed".

5.9 Each individual sample must be scanned or manually logged into ATLAS tracking system before any further movement of the sample/s through the laboratory.

5.10 In order to prevent accidental disposal, a work order that are signed out but has not been analyzed due to unforeseen delays (e.g. instrument failure) must be returned to the assigned location in the sample storage area, and this action must be electronically documented as logged into the sample storage area.

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Verified samples from completed workorders must not be stored on the lab floor or the sample storage area and must properly be released for disposal if no further analysis is required.

5.11 A workorder that is partially analyzed by the end of a shift may be left in the immediate vicinity of the analytical instrumentation only if they are being handed off to another analyst/scientist.

5.12 A workorder that is partially analyzed on one instrument and need to be moved to another instrument must properly be logged back (or scanned) into the sample storage area / ATLAS and back out to the appropriate instrument.

5.13 Barcoded samples for which one analysis has been completed and need further analysis, must be scanned back into the sample storage area and properly log/scan back out to the appropriate instrument/method for further analysis.

6) Sample Disposal Procedure

A sample may be released for disposal only when the following criteria are met:

6.1 The analyses have been completed and are verified as meeting quality criteria documented in the relevant SOPs in addition to verifying client project requirements have been met.

6.2 Runlog(s) are verified for completion of all samples associated with each workorder fraction to ensure all requested methods have been analyzed before final release.

6.3 A qualified analyst or scientist has reviewed the sample run as acceptable. (Demonstration of sample loading proficiency and approval by a Laboratory Management are required qualifications for an analyst or scientist to release samples.)

6.4 If the sample requires multiple analyses and all fractions have been completed as indicated by the date of analysis and the instrument utilized in the Sample Tracking Module, the date of analysis information is manually entered into the system by the qualified laboratory staff. Verification of this information entry into ATLAS prior to sample disposal is confirmed by the ATLAS Tracking Module.

6.5 The sample canister does not have a "Do Not Clean" tag. If this tag is attached to the canister, the canister can be released five days after sample analysis, per specific project requirement, or sooner, but must be approved by the Project Manager prior to release.

6.6 Review of the QC and analytical runs is documented by a check mark and initials in the instrument logbook. Once the review is completed, samples can be released. The ATLAS Tracking System will validate that a date of analysis for all samples associated with each fraction of a workorder has been entered and the sample is checked as "Done" in the "show sample" module in sample tracking prior to their release. Before any sample can be checked off as "Done" in ATLAS, the appropriate runlog(s) must be verified.

Additionally, second runlog verification must be performed prior to entering the date in the "Date Analyzed" column of the ATLAS Tracking System for each workorder fraction. This step is

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critical to ensure each sample in the workorder fraction has individually been verified as analyzed.

6.7 Before entering a date in the 'Date Analyzed' column, verify that all samples are documented as completed in section 2 of the Data Review Checklist (F1.27).

Note 1: New employees in training refer to instruction I 2.17 "New Employee Canister Release Instructions."

6.8 Only the designated color-coded carts can be used for canister transfer between methods, instruments, and for sample release (see appendix B for the code key.) When releasing samples, it's the chemist's responsibility to account for all the canisters on the cart. Each canister must individually be scanned and verified in sample tracking prior to moving the samples to Support services.

6.9 Before canister samples are transferred to the Support Services Department, a **Large** X is marked on the sample tag using a large RED permanent marker along with initials of the chemist to indicate to Support Services the canister has been verified and ready for cleaning (see *SOP 7* Section 5.0). These samples must not be placed back onto the shelves. Released canisters or bags that require additional analysis prior to the disposal step can only be re-activated by designated manager with over-ride privileges. To re-activate a sample, a reason is required to be entered in the correct field for complete documentation. Note that samples needing subcontracted analysis or that need to be sent back to the client will have a red stamp noting "RELEASE TO SHIPPER" on the sample information tag. These samples should be released to storage rack S-01 in the shipping department. The initials of the releaser and date released should be noted on the sample information tag, but should not be marked with a red "X."

6.10 In the event that storage space in the sample's original location within the sample storage area is limited, the samples for which analysis requirements are not yet complete may be located on another shelf. The sample and the new location must be scanned to maintain the chain of custody.

6.11 Various samples are categorized as "single use" (PUF/XAD cartridges, charcoal cartridges, etc.). Tracking of the media will indicate the area it is in before the "Final Release" of the sample. The term "Extractions" or location of the extract (e.g. Box <X>, Fridge <X>) will be used to document this fact.

6.12 In the case of TO-17 tubes, samples are generally re-collected to allow for re-analysis or dilution if needed. Re-collected sample tubes are re-capped with long-term storage fittings and placed in the assigned sample refrigerator and designated shelf (e.g. Refrigerator 4, Shelf 2). Archived samples can be released when Atlas shows that the workorder has been reported, generally with a status of "Filed". Release is documented by scanning the barcodes into Atlas and updating the status accordingly.

6.13 Similar to TO-17, EPA 325 samples are re-collected to allow for re-analysis or dilution and are re-capped with long-term storage caps as soon as practical after the completion of the analytical sequence. Samples are stored at ambient temperature and scanned to their assigned shelf labeled "325" in the designated EPA 325 sample tube storage area. Unless otherwise documented in the project requirements, samples are released when the workorder has been reported. If the customer delays delivering required field parameters to the lab beyond a week after receipt, samples may be released after verifying that all sample runs and QC meet requirements and applicable trigger exceedance evaluation is completed. Release is documented by scanning the barcodes into Atlas and updating the status accordingly.

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7) Definitions

Eurofins Air Toxics Laboratory Quality Assurance Manual (LQAM) Definitions and Terms, Appendix A.

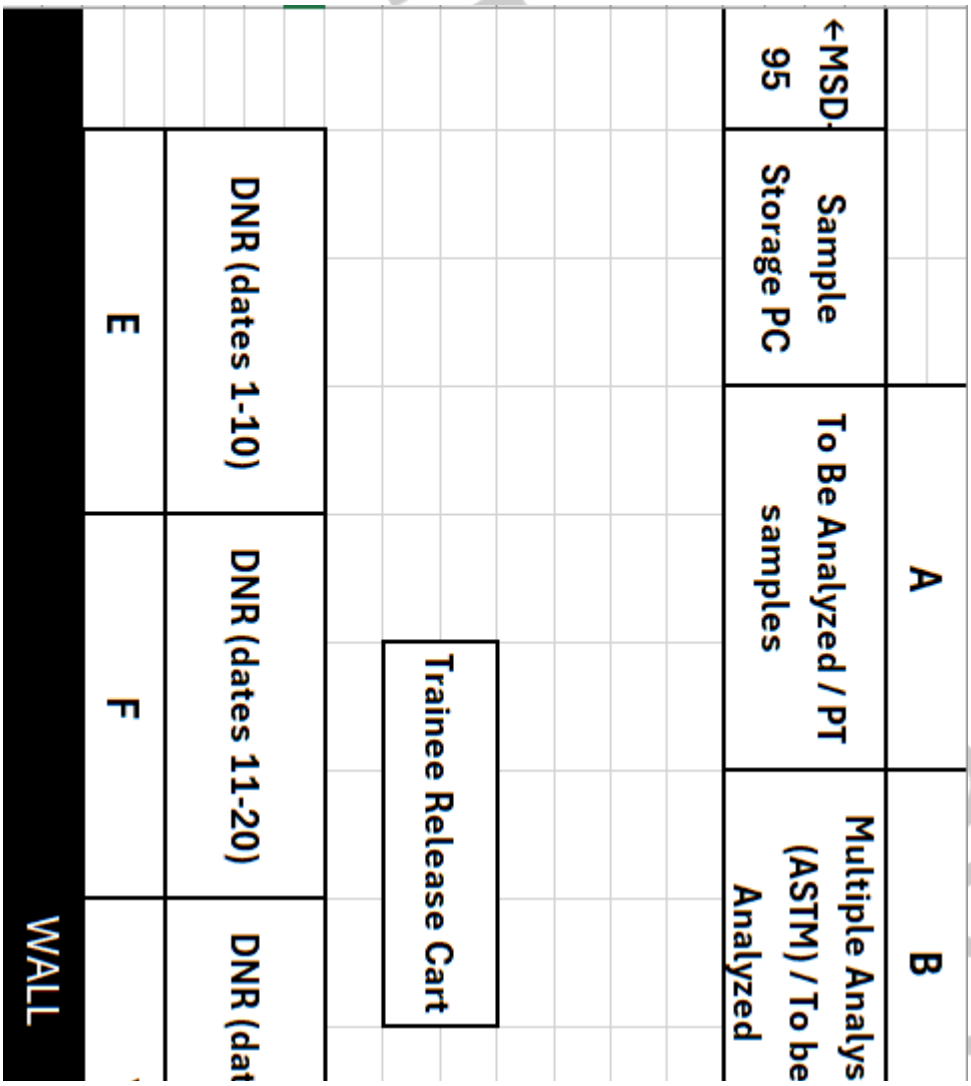
8) Applicable Work Instructions

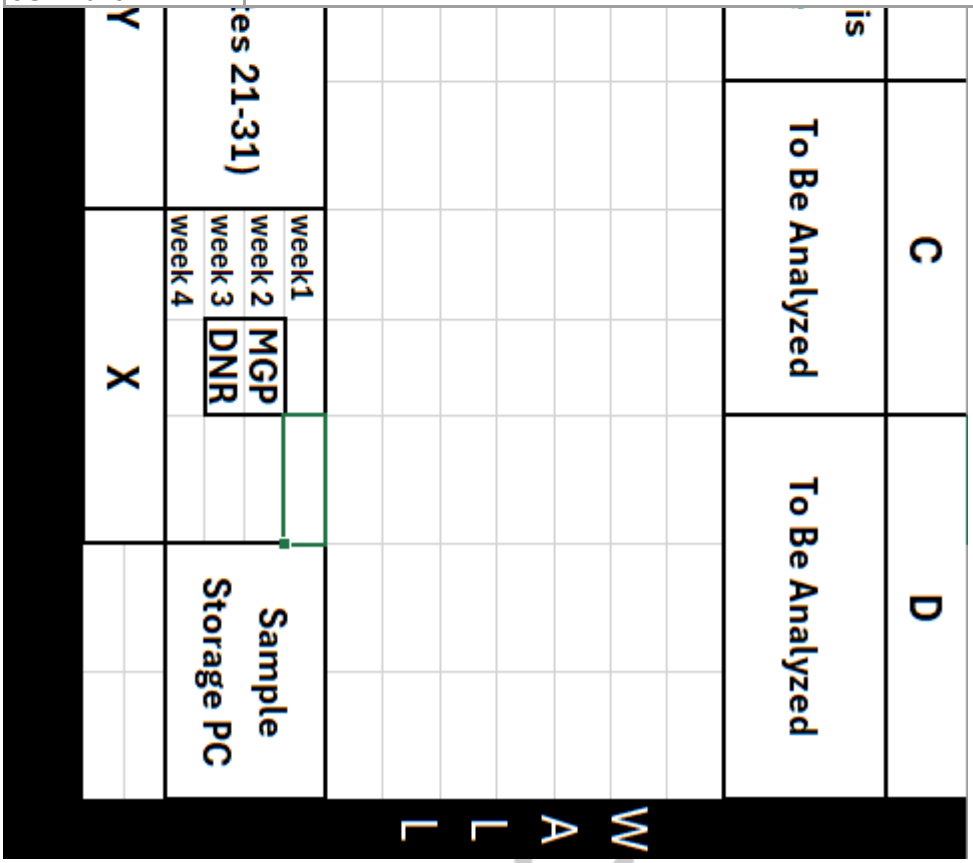
WI63 Media Tracking System

9) Appendices

Appendix A

Sample Storage Area





Appendix B

Cart Colored Code Key

Color	Department
Orange Cart	Transfer
Brown Cart	To Be Analyzed
White Cart	Receiving
Purple Cart	Returned Media
Yellow Cart	Screening [To be Screened]
Green Cart	Screening [Ready for Sample storage]

Attachment:
I 2.17 "New Employee Canister Release Instructions." (.pdf)

007-SOP2904 PREPARATION OF SUMMA® AND TO-CAN CANISTERS FOR SAMPLING
030-SOP2883 LABORATORY SECURITY
050-SOP2966 SAMPLE RECEIVING/LOGIN PROCEDURES

End of document

Version history

Version	Approval	Revision information	
26	18.JUL.2024	No Updates. Migration to D4.	
26.1	02.JAN.2025	No Changes. Just an update to printing settings	
27	23.JUL.2025	Updated header information. Removed revision history section. Version history will track changes.	

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STANDARD OPERATING PROCEDURE

SAMPLE RECEIVING, SHIPPING AND DISPOSAL

APPROVAL

Function	Name	Signature	Date
Laboratory Manager	John Yokoyama		3/18/2024
Technical Director	Sucha Parmar, PhD		3/18/2024

PREFACE

This is a Standard Operating Procedure (SOP). The analyst must read, understand, and follow this procedure explicitly.

A copy of this SOP is permanently placed in the laboratory area where the work is performed. The Department Supervisor, Quality Assurance Coordinator, and President/General Manager of Operations each have a copy of this document. Any changes in the SOP need to be approved by the Quality Assurance Coordinator. Each page of such changes will be initialed, dated, and concurrently incorporated into all copies located in the laboratory.

Revision History

Revision #	Date	Author	Change Reference	Reason for Change
07	01/06/2012	Wesley Horn	All Pages	Periodic Review
08	09/14/2016	Marcus Hueppe	All Pages	Periodic Review
09	10/19/2017	Zandra Baja	Update Section 4.1.1. Temp logging procedures & Fig 1	Periodic Review
10	04/17/2020	Zandra Baja Jose Heredia	All Pages. Added shipping procedures.	Periodic Review
11	3/18/2022	Crystal Moreno	All Pages	Periodic Review
12	3/18/2023	Crystal Moreno	All Pages	Periodic Review
13	3/18/2024	Crystal Moreno	All Pages	Periodic Review

1. SCOPE AND APPLICATION

Sample receiving, login, tracking, storage and disposal procedures (Section 7) provide directions on how to handle, login, track, store and dispose of incoming samples in order to maintain the sample's integrity

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and preserve the client's confidentiality. Shipping procedures (Section 8) provide directions on how to fulfill and ship client's equipment requests.

2. SUMMARY

When AAC receives samples, they are inspected for damage and/or integrity. The samples are assigned a unique laboratory identification number that is predetermined by AAC's LIMS (Lab Track). The identification number is documented on the Chain of Custody (COC), Sample Receipt / Login Report, Sample History Log, each individual sample container, and in the Laboratory Database. The COC is carefully inspected for accuracy and completeness with respect to the samples and the analysis requested. The characteristics of the samples such as temperature are carefully documented. The reception and inspection of the samples is documented in the Sample History Log and the Laboratory Database. The samples are stored in their appropriate conditions until they are ready for analysis. A project folder is constructed and given to the appropriate analyst with all pertinent documents. The samples are disposed of following the laboratories waste disposal procedures.

When AAC receives a request for sampling equipment, the equipment is assembled and verified to be in proper condition. The equipment is appropriately packaged and sent out using the requested shipping method. All shipped equipment is documented in a logbook to track inventory and all records for equipment requests and shipping receipts are retained.

3. TERMS AND DEFINITIONS

COC	Chain of Custody
LIMS	Laboratory Information Management System
NELAC	National Environmental Laboratory Accreditation Conference
mmHgG	millimeters of mercury, gauge
mmHgA	millimeters of mercury, absolute
psiA	pounds per square inch, absolute
SHL	Sample History Log
Pressure, absolute	zero-referenced against a perfect vacuum using an absolute scale; equal to gauge pressure plus atmospheric pressure. Standard atmospheric pressure is equal to 760 mmHgA.
Pressure, gauge	zero-reference against ambient air pressure; equal to absolute pressure minus atmospheric pressure. Standard atmospheric pressure is equal to 0 mmHgG.

4. SAFETY CONCERNS AND WASTE MANAGEMENT

4.1. Due to the potential hazardous risks of the samples, liquid samples should be handled with gloves while wearing safety glasses or goggles and lab coats.

4.2. Sample preparation should be done in a vented laboratory fume hood due to the potentially hazardous risks.

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4.3. Summa Canisters should not be pressurized beyond 40 psiA, which is the maximum allowable pressure for Summa Canisters.

4.4. Safety chains should be used to secure all gas cylinders to laboratory benches or walls without any obstructions.

4.5. All solvents and materials used for preparation of standards or sample preparation, as well as all liquid and solid samples, are emptied into the Organic Waste Drum or other appropriate container. An outside contractor, in accord with proper waste disposal procedures, disposes of the Organic Waste Drum contents. Procedures and waste manifest are in possession of the Technical Director.

5. SAMPLE HANDLING AND PRESERVATION

5.1. Liquid samples are kept together according to project number in the designated refrigerator at ~4°C, except when a sample aliquot is being removed for analysis.

5.1.1. Each refrigerator's temperature is recorded daily in the AAC Temperature Logbook to verify that they are in proper working condition. Refer to the Sample Fridge SOP for temperature monitoring protocols.

5.2. All air samples in Summa Canisters or Tedlar bags are kept at room temperature in the main laboratory.

5.3. The security of the samples are maintained by AAC's policy that anyone other than AAC laboratory personnel must register with the Office Administrator before entering the laboratory and must be escorted by AAC personnel at all times.

5.4. Refer to Table 1 for specific holding times for liquid samples, Tedlar bag samples, and Summa Canister samples.

5.4.1. Holding times for liquid samples vary by the analysis method.

5.4.2. Tedlar bag samples typically have holding times between 24 hours and 72 hours from the time of sampling, unless otherwise specified by the analysis method.

5.4.3. Summa Canister samples typically have holding times from 7 days to 30 days from the time of sampling, unless specified otherwise by the analysis method.

6. EQUIPMENT AND SUPPLIES

6.1. Summa Canisters – the standard size is 6 Liters. Other sizes include 3.2 Liters, 1.4 Liters, 1.0 Liter

6.2. Digital pressure gauge (calibrated)

6.3. IR Temperature sensor (calibrated)

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6.4. Wrenches – 9/16", 1/2", 7/16", and 5/8"

6.5. Logbooks – Equipment Shipping Logbook, Pressure Logbook

6.6. UHP Helium

6.7. Refrigerators capable of maintaining a temperature of ~4°C

6.8. Self-adhesive labels – for sample identification

6.9. Indelible pen – Sharpie preferred

6.10. Folders

6.11. Gloves and goggles

7. SAMPLE RECEIVING PROCEDURES

7.1. Sample Receipt

7.1.1. Upon receipt, the samples are checked against the field COC document(s).

7.1.1.1. If any discrepancies are found (including sample type, total number of samples, etc.), management is immediately notified to contact the client. Any communication with the client regarding the discrepancy is documented and retained in the project folder.

7.1.2. Per NELAC requirements, samples are inspected to verify that they adhere to the Sample Acceptance Policy (Figure 1). SAP inspection items include, but are not limited to:

7.1.2.1. COC accuracy – Verify that the COC contains all information pertinent to analysis, and indicates all sample transfers with signatures, dates, and times.

7.1.2.2. Container identification – Cross-reference the information on the container with information on the COC and account for all of the received samples.

7.1.2.3. Temperature – Most liquid samples should be ~4°C. Use the IR thermometer to check the temperature. Record the sample temperature and the thermometer ID number on the COC.

7.1.2.4. Appropriate container and preservative – Depends on the analysis to be performed. Zero headspace is required for volatile analysis of liquid samples. Inert or passivated containers are REQUIRED for sulfur samples.

7.1.2.5. Sample and container integrity – Check for any leaks or cracks.

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7.1.2.6. Holding times - Verify that the samples are received within the holding times in Table 1 for the specified analysis method stated on the COC.

7.1.3. If any samples do not meet the SAP requirements, it must be noted on the COC and either the Sample History Log or the Sample Receipt / Login Report.

7.1.3.1. Per NELAC requirements, if there is doubt about the suitability of a sample, or if a sample does not conform to the description provided, the Laboratory Manager must be notified immediately to contact the client for further instructions.

The Laboratory Manager will report back to the Laboratory Technician with directions for handling the problems, preferably within 24 hours of sample receipt so that the samples can be processed in a timely manner. Samples are either 1) rejected as agreed with the client and correspondence and/or records of conversations are retained, or 2) the decision to proceed is documented and agreed upon with the client, the condition is noted on the Chain of Custody form and/or lab receipt documents, and the analysis data are qualified in the report.

7.1.4. Verify that all sampling equipment (canisters, flows, manifolds, etc.) is accounted for and in good condition. Note all returned equipment on the COC and the Sample Receipt / Login Report. Any equipment that is missing and/or damaged is also recorded.

7.1.5. In the Equipment Shipping Logbook, mark all returned canisters (including voided samples) with a check mark. Unused cans are marked with a check mark and circled.

7.1.5.1. Any canister returned unused must be vacuum checked.

7.1.6. A Sample History Log (Figure 2) is filled out to record the above information. The SHL is generated using Microsoft Excel and is stapled to the inside of the project folder.

7.2. Sample Log-in

7.2.1. The information on the COC is entered into the LIMS system (Lab Track). The LIMS system assigns unique predetermined laboratory identification numbers to each sample. The first two digits are the last number of the year (2019=19), the next four digits are the project number, followed by a dash (-) then a sequential number for each sample.

7.2.1.1. For example, 192187-4360 represents year 2019, project number 2187, and sample number 4360.

7.2.1.2. If more than one container from the same sample is received, each container is assigned an individual alphabetical character (e.g. 4360A, 4360B, etc.)

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7.2.2. The project number is written at the top of the COC and the sample numbers are written next to each sample listed on the COC. Samples are organized in the order they are listed on the COC, then self-adhesive labels with the full lab ID numbers (project and sample number) are affixed to each sample container.

7.2.3. A Sample Receipt / Login Report is generated through Lab Track (Figure 3) and a project folder is created. The project folder includes: (1) Sample History Log, (2) Sample Receipt / Login Report (from Lab Track), (3) Canister Pressure Log (if applicable, from Lab Track or Microsoft Excel for pre-padded canisters), (4) Original copy of the COC, (5) any other documents pertaining to the project.

7.2.3.1. Each folder must have the client name, project number, date received, and Rush (if applicable) written on the folder tab.

7.2.3.2. If the project requires the samples to be analyzed by multiple departments of the lab, then additional project folders are created. The first project folder is labeled "1 of x" and contains the original COC. Additional folders are labeled "2 of x" etc. and must contain a copy of the COC.

7.2.4. Each project folder is given to the appropriate department(s).

7.3. Canister Pressurization

7.3.1. A calibrated digital pressure gauge is used to check the return vacuum/pressure of the canister. The gauge reading is recorded on the canister tag. If necessary, the canister is pressurized with UHP Helium according to the requested analysis and the final gauge reading is recorded on the canister tag. The lab tech initials and the date the gauge readings were taken are recorded on the canister tag.

7.3.1.1. For EPA 3C, 18, or 25C analysis and most other GC/FID or GC/TCD methods, canisters are pressurized to ~140 mmHgG (~900 mmHgA).

7.3.1.2. For EPA TO-14 or TO-15 analysis, canisters are pressurized to ~254 mmHgG (~1014 mmHgA).

7.3.1.3. All smaller Summa Canisters (3.2 L, 1.4L, and 1.0L) are pressurized to ~760 mmHgG (~1520 mmHgA) regardless of the requested analysis.

NOTE: For SCAQMD 25.1 and SCAQMD 25.3 sample receipt and pressurization procedures, refer to the corresponding SOP.

7.3.2. The initial and final gauge readings are converted to absolute pressure (see 10.1) and recorded in the Pressure Logbook. The pressures are then entered into the LIMS system and a Canister Pressure Log is generated (Figure 4).

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7.3.2.1. For canisters that were pre-padded with Helium (see 10.2), the Canister Pressure Log is generated using Excel (Figure 5).

7.4. Tracking, Archival and Disposal

7.4.1. The Laboratory Technician tracks the sample's location throughout the receiving area then distributes the samples to the appropriate department(s). Each department then tracks the sample's location until analysis is completed. After analysis, the sample is moved to an area assigned for archival and disposal.

7.4.2. Liquid samples are stored at ~4°C for a period of at least 90 days after being received in the laboratory. Liquid and solid wastes are disposed of in the Organic Waste Drum located in the rear fume hood room (see 4.5).

7.4.3. Tedlar bag samples are kept for a period of at least 1 week after the client has received the final laboratory report. Tedlar bag samples are emptied using a vacuum pump in the fume hood before being returned to the client or discarded.

7.4.4. Summa Canister samples are kept for a period of at least 1 week after the client has received the final laboratory report. The Laboratory Manager must give approval before any Summa Canister samples are disposed of. Summa Canister samples are disposed of and cleaned according to the Canister Cleaning SOP.

7.4.5. Samples may be stored for a longer period of time at the client's request.

7.5. Subcontract Laboratory Analysis

7.5.1. If any analysis is requested that is not performed by AAC, the work may be subcontracted out to another laboratory. Proper custody and transfer procedures are employed and documented in the same manner as in-house analyses.

7.5.2. The Project Manager provides the name and address for the subcontract laboratory to be used.

7.5.2.1. Any work requiring accreditation must be subcontracted to an accredited laboratory. If there are no labs with the required accreditation with the ability to perform the requested analysis, a non-accredited lab may be used and the discrepancy must be noted in the case narrative. NELAC approved laboratories can be found at: https://lams.nelac-institute.org/Search

7.5.3. Any samples sent out to a subcontractor for analysis are properly packaged and shipped. The samples are accompanied by a Subcontract COC filled out by AAC.

8. SHIPPING PROCEDURES

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8.1. Equipment Preparation

8.1.1. Project Managers provide a copy of the email which states the quantity and type of equipment requested as well as the preferred shipping method.

8.1.2. Summa Canisters are vacuum checked prior to shipping. Summa Canisters must have an initial vacuum of at least -750.0 mmHgG (10 mmHgA).

8.1.2.1. For clients who request a helium prepad, pre-fill the Summa Canister with Helium to the requested volume (see 10.2)

8.1.3. Flow controllers and attachments are leak checked. Flows are verified to be operating at the appropriate speeds. All plugs and attachments are securely fastened and placed into shipping boxes with necessary padding.

NOTE: For SCAQMD 25.1 and SCAQMD 25.3 equipment preparation procedures, refer to the corresponding SOP.

8.1.4. For any liquid media or other shipments, the equipment is checked to ensure all requested items have been provided. A cooler is selected and filled with the appropriate amount of padding and refrigeration.

8.1.5. All equipment to be shipped (cans, flows, etc.) are recorded in the Equipment Shipping Logbook as well as the Inventory Excel document on Share.

8.2. Shipping

8.2.1. The shipping methods used are FedEx, UPS, and OnTrac. For Courier or Pickup, see 8.6.
8.2.2. If the client does not provide an account number for shipping, AAC's account is used. All login information for AAC's shipping accounts is securely stored with the Shipping Department.
8.2.3. Any shipments using AAC's account require approval from the Technical Director or Laboratory Manager. A Billing Memo must be completed and placed in the Technical Director's mailbox.

8.3. FedEx Shipments

8.3.1. Go to www.fedex.com and click on Log In. Enter AAC's username and password.
8.3.2. Click on Shipping > Create a Shipment and fill out the appropriate information.
8.3.2.1. If shipping dangerous goods, use the FedEx Ship Manager program on the desktop. Hazmat shipping requires several details. All guidelines must be followed and the finished product must be reviewed and approved by the Laboratory Manager.
8.3.2.2. Same Day pickups must be scheduled before 2:30 pm. Same Day pickup is not

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available for Ground shipments.

8.3.3. When all information has been entered, click Continue. Print out the shipping label, then click on the shipping history tab to print out a receipt.

8.3.4. The receipt is stapled on top of the email request and placed in the FedEx binder.

8.4. UPS Shipments

8.4.1. Go to www.ups.com and click on Log In. Enter AAC's username and password.
8.4.2. Click on Shipping > Create a Shipment
8.4.3. Select from client list or enter a new client
8.4.4. Select service type
8.4.5. Select Packing: Your packing
8.4.6. Check Schedule a pickup (Must be scheduled before 3:30 pm)
8.4.7. Click Ship Now button
8.4.8. Print out shipping label and shipment receipt.
8.4.9. The receipt is stapled on top of the email request and placed in the UPS binder.

8.5. OnTrac Shipments

8.5.1. Go to www.ontrac.com and click on WebOnTrac Login. Enter AAC's account number, username, and password.
8.5.2. Enter the client's information or select from Address Book
8.5.3. When all information has been entered, click Submit & Print
8.5.4. Flip the sign attached to the Shipping and Receiving window around so that it reads "Yes ONTRAC Thanks" from the outside.
8.5.5. Print the shipping receipt: Click on View/Delete in the top left section under Shipments and enter today's date. Click View and then Print.
8.5.6. The receipt is stapled on top of the email request and placed in the California Overnight folder.

8.6. Courier (MYSIS) or Client Pickup

8.6.1. For pickup by AAC's courier (MYSIS), fill out the MYSIS form and make a copy. Retain the copy and give the original to the courier with the equipment.
8.6.2. If the client is picking up, go to the "Pickup Log" Excel document on Share.
8.6.3. Create a new Pick-Up Form: Right click on any existing tab, select Move or Copy..., then click (move to end) and check the box "Create a copy." In the new tab, delete the previous information and fill out today's date, client information, and equipment information.
8.6.4. Print two copies of the Pick-Up Form and sign both. Once the client arrives, make sure they sign both copies and give them one.
8.6.5. The other copy is stapled to the email request and placed in the Pick Up Log binder.

9. QUALITY CONTROL

9.1. It is the responsibility of the technician to perform the procedures according to this SOP and

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complete the documentation required for review.

9.2. It is the responsibility of all personnel who work with samples to note any anomalies or out-of-control events associated with the samples. Any discrepancies must be noted and corrective action taken and documented.

10. CALCULATIONS

10.1. Gauge pressure to Absolute pressure – The digital pressure gauge gives a reading relative to atmospheric pressure. For example, at standard atmospheric pressure, a gauge reading of 0 mmHg Gauge is equivalent to 760 mmHg Absolute. Similarly, a gauge reading of -760 mmHg Gauge is equivalent to 0 mmHg Absolute.

To convert from mmHg Gauge (mmHgG) to mmHg Absolute (mmHgA), we assume the lab is at standard atmospheric pressure and add 760 to the gauge reading.

$$(-mmHgG) + 760 = mmHgA$$

10.2. Helium prepad – Assume a Summa Canister at full volume has an absolute pressure of 760 mmHgA. Calculate the ratio of the prepad volume to the full volume of the canister then multiply by 760 mmHgA. Finally, subtract 760 to get the gauge reading needed for the requested prepad.

$$mmHgG_p = \left(\frac{V_p}{V_S} x\ 760\ mmHgA\right) - 760\ mmHgA$$

where:

$mmHgG_p$ = Prepad pressure, mmHgG
V_P = Volume of helium prepad, L
V_S = Volume of Summa Canister

10.3. mmHgA to psiA

$$psiA = 0.0193 \times mmHgA$$

10.4. psiA to mmHgA

$$mmHgA = 57.7149 \times psiA$$

10.5. mmHgA to inHg

$$inHg = 0.0394 \times mmHgA$$

10.6. inHg to mmHgA

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$$mmHgA = 25.4 \times inHg$$

10.7. The desired flow rate of the flow controller is calculated based on the following equation. This is what the flow meter should read when adjusting/measuring the flow controller.

$$\text{Final flow rate} = \frac{mL}{\text{min}} = \frac{(V_T \times 0.8333)}{T_T}$$

where:

V_T = Total volume of the containers/canisters

T_T = Total sampling time in minutes

Note: The canister is not filled to ambient pressure in order to ensure the integrity of the sample upon receipt. When using passive flow controllers the final vacuum of the canister should be less than -5 inHg so that the integrity of the sample is maintained, i.e. if the sample vacuum is allowed to go to ambient (0inHg) there is no way to tell when the sample stopped collecting. Also the negative pressure allows us to determine if there were any leaks from the time of sampling to receipt. Therefore, the flow rate is set to fill the canister to 25/30 or 83.33% of its volume.

11. REFERENCES

https://en.wikipedia.org/wiki/Pressure_measurement#Absolute,_gauge_and_differential_pressures_%E2%80%94_zero_reference

12. TABLES AND FIGURES

Table 1 – Sample Holding Times and Media

ANALYTES/METHODS	MEDIA	PRESERVATION	MAX HOLDING TIME

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ANALYTES/METHODS	MEDIA	PRESERVATION	MAX HOLDING TIME
Total Reduced Sulfurs (ASTM D5504, SCAQMD 307.91)	Tedlar bag Silonized Canister	No metal, ambient	24 hrs 7 days
VOCs (TO-14, TO-15, TO-12, PAMS)	Tedlar bag Summa Canister	Ambient	72 hrs 30 days
EPA 25C/3C	Tedlar bag Summa Canister	Ambient	72 hrs 30 days
ASTM D-1945/1946	Tedlar bag Summa Canister	Ambient	72 hrs 30 days
RSK-175	Glass Vial	~4°C	7 days if unpreserved 14 days if preserved
SCAQMD 25.1	Trap Summa Canister	Keep on dry ice Ambient	ASAP 30 days
SCAQMD 25.3	Glass Vial Summa Canister	~4°C Ambient	Purge within 24 hrs of sampling Analyze within 10 days of sampling
Polyaromatic Hydrocarbons (TO-13)	PUF Cartridge	~4°C	Extract within 7 days of sampling Analyze within 40 days of extraction
Alcohols (EPA 308)	Glass, silica gel tube	~4°C	ASAP
Aldehydes & Ketones (EPA TO-11A)	DNPH coated cartridge	~4°C, dark	Extract within 14 days of sampling Analyze within 30 days of extraction
Aldehydes & Ketones (EPA 0011)	Glass (amber) DNPH solution	~4°C, dark	Use solution within 5 days of prep Extract within 7 days of sampling Analyze within 30 days of extraction
Aldehydes & Ketones (EPA TO-5)	Glass (amber) DNPH solution	~4°C, dark	Use solution within 48 hours of prep
Aldehydes & Ketones (CARB 430)	Glass (amber) DNPH solution	~4°C, dark	Use solution within 48 hours of prep Extract within 9 days of prep Analyze within 39 days of prep
Formaldehyde (EPA 316, 323)	Glass	~4°C, dark	14 days
NCASI 105.01	Glass	~4°C, dark	Extract BHA solution within 21 days Analyze extract within 35 days of sampling Analyze aqueous within 21 days of sampling
Methanol (NCASI 94.03)	Glass	~4°C, dark	At least 30 days
NCASI 94.02	Glass	~4°C, dark	10-21 days
NCASI 99.02	Impinger Canister	~4°C, dark Ambient	2 weeks 3 weeks
Phenols & Cresols (TO-8)	Glass (amber)	~4°C, dark	48 hours
Organic Acids	Glass	~4°C	7 days
Ammonia (CTM-027)	HDPE	~4°C	14 days
Anions (EPA 26)	P	~4°C	ASAP
Particulates (TSP, PM-10, EPA IO-3.1, etc)	Filter	None	14 days
Condensable & non-Condensable Particulates	G, Filter	Cool, ~4°C	14 days

Figure 1 – Sample Acceptance Policy

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Atmospheric Analysis & Consulting, Inc

Sample Acceptance Policy

Per NELAC requirements, AAC has established a Sample Acceptance Policy (SAP). All samples submitted to AAC for analysis must be accompanied by a completed Chain of Custody. All submissions will be inspected according to the following SAP criteria.

1. Completeness of Chain of Custody documentation including but not limited to:
    a. Sample identification
    b. Location and/or description of sample collection
    c. Date and time of sample collection
    d. Collector's name
    e. Preservation type (if any)
    f. Sample type
    g. Any special remarks concerning the sample

2. Sample Labeling
    a. Uniquely identified samples
    b. Water resistant labels
    c. Use of indelible ink

3. Sample Integrity
    a. Use of appropriate sample containers
    b. Adherence to specified holding times
    c. Sufficient sample volume to perform the necessary tests

Any deviations from the SAP will be documented on the final report.

AAC SAP Rev 02 Page 1 of 1 Effective 04/14/2020

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Figure 2 – Sample History Log

1534 Eastman Avenue, Suite A
Ventura CA, 93003
(805) 650-1642
www.aaclab.com

Sample History Log

Client: _____ Lab Number: | | |
Project: _____ Date/Initials: | | GR |

Note: This form is used for all samples received by AAC. The use of this form for custody seals is strictly meant to indicate presence/absence, not compliance or nonconformity.

Yes	No	N/A		
☐	☐	☐	1.	Did the client supply a COC (chain of custody)?
☐	☐	☐	2.	Is the COC filled out correctly?
☐	☐	☐	3.	Did the client supply all samples identified on COC?
☐	☐	☐	4.	Are samples properly labeled with client sample ID?
☐	☐	☐	5.	Are all samples marked with the appropriate test?
☐	☐	☐	6.	Are samples/sample containers in good condition?
☐	☐	☐	7.	Were the samples received within the suggested holding periods?
☐	☐	☐	8.	Were the Summa Canisters received with valve closed and fittings properly secured?
☐	☐	☐	9.	Client returned any additional equipment sent with samples?
☐	☐	☐	10.	Was a Trip Blank received? (Method 25.3)
☐	☐	☐	11.	Were the samples received at the adequate temperature?
☐	☐	☐	12.	Were custody seals on outside of cooler/box?
☐	☐	☐	13.	Do the samples have appropriate preservation according to method/SOP or client specified information?
			14.	Sample Receipt / Log-In Report Review

Did the client return all equipment? (Cans, Flows, Etc): _____

Were any of the samples returned damaged or incorrectly assembled? _____

_____

Any other discrepancies? (Include lab sample ID numbers): _____

_____

Analyst Checklist

	Initial		Initial
Parameters	_____	Corrective Action form if failed?	_____
Methods	_____	Any Irregularities?	_____
Dilution Factor	_____	Surrogate Recovery	_____
QC Pass/Fail	_____	Date Completed	_____

Final Approval

Check Performed By: _____
Date: _____
Emailed: _____

Reporting

Hard Copy? ☐ Yes ☐ No Mailed: _____ By: _____
EDD? ☐ Yes ☐ No Date/Time Received: _____ By: _____
Date/Time Completed: _____ By: _____

AAC SHL Rev 04 Page 1 of 1

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Figure 3 – Sample Receipt / Login Report

Atmospheric Analysis & Consulting, Inc

SAMPLE RECEIPT / LOG-IN REPORT

Client Name:
Project Name:
AAC Project No.:

Sampled By:
Received By:
Turn Around Time:
Lab Due Date:
Final Due Date:

Sample Receipt Date Time	Clients ID	Sampling Date/Time	Sample #	Matrix	Analysis Requested

REMARKS:

Total Samples:

1

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Figure 4 – Canister Pressure Log

Atmospheric Analysis & Consulting, Inc.

CANISTER PRESSURE LOG

Client: Project No.:

Date:

Canister #	Sample #	Initial Pressure mmHg	Final Pressure mmHg

1

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Figure 5 – Canister Pressure Log (with Helium Pre-Pad)

Atmospheric Analysis & Consulting, Inc

CANISTER PRESSURE LOG

Client: Project No.:

Date:

Canister #	Sample #	Intial Vacuum Check mmHg	(P1) Pre-Pad mmHg	(P2) Return Pressure mmHg	(P3) Final Pressure mmHg	DF

10/31/2019 1:08 PM

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STANDARD OPERATING PROCEDURE

SAMPLE LOGIN USING LABTRACK

APPROVAL

Function	Name	Signature	Date
Laboratory Manager	John Yokoyama		3/18/2024
Technical Director	Sucha Parmar, PhD		3/18/2024

PREFACE

This is a Standard Operating Procedure (SOP). The analyst must read, understand, and follow this procedure explicitly.

A copy of this SOP is permanently placed in the laboratory area where the work is performed. The Department Supervisor, Quality Assurance Coordinator, and President/General Manager of Operations each have a copy of this document. Any changes in the SOP need to be approved by the Quality Assurance Coordinator. Each page of such changes will be initialed, dated, and concurrently incorporated into all copies located in the laboratory.

Revision History

Revision #	Date	Author	Change Reference	Reason for Change
01	04/17/2020	Zandra Baja	All Pages	Initial Release
02	3/18/2022	Crystal Moreno	All Pages	Periodic Review
03	3/18/2024	Crystal Moreno	All Pages	Periodic Review

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1. LABTRACK LOG-IN PROCEDURE

1.1. Open Lab Track.
1.2. Close the small pop-up screen.
1.3. In the upper left hand corner, click on the arrow next to "Sample Login" and select "Batch Login."
1.4. Press the "Batch Login" icon.
1.5. The "Project No Login" window should pop up.
  1.5.1. LabTrack will assign an AAC Project No for the batch of samples. Write this on the COC.
  1.5.2. Enter the project name as "Description."
  1.5.3. Enter Client.
  1.5.4. Enter your name under "Recd By." Use your first initial and last name.
  1.5.5. Enter Lab Due Date as mm/dd/yyyy
    1.5.5.1. For Normal TAT, the Lab Due Date is 5 work days after the receipt date.
  1.5.6. Enter Final Due Date mm/dd/yyyy
    1.5.6.1. For Normal TAT, the Final Due Date is 10 work days after the receipt date.
  1.5.7. Enter Remarks, if applicable. (# of canisters returned, special comments on the COC, etc.)
  1.5.8. Click the Save button.
1.6. "Project No Sample Login" window should pop up.
  1.6.1. Fill in the Details according the information on the COC.
  1.6.2. Analysis Date: Leave blank
  1.6.3. TAT Days: Use Normal (10day) turnaround time if it is not specified on the COC.
  1.6.4. Sampled Date (and Time, if applicable): mm/dd/yyyy hhmm
  1.6.5. Clients ID: Sample IDs as recorded on the COC.
  1.6.6. Site: Leave blank
  1.6.7. Canister #: As recorded on the COC and canister ID tag(s), or leave blank.
  1.6.8. Matrix: Select the sample container
  1.6.9. Sampled By: Client
  1.6.10. Recvd Date: From COC, mm/dd/yyyy
  1.6.11. Recvd Time: From COC, hhmm
  1.6.12. Enter Remarks, if applicable. (Specify canister #s for voided or unused cans)
  1.6.13. When all fields are filled out, click "Sched Tests"
1.7. A window should pop up asking "How Many Samples In This Batch or Set?"
  1.7.1. Enter the number of samples listed on the COC and click OK.
1.8. A new window should pop up saying "# Samples Saved. Click OK to Continue."
  1.8.1. Click OK
1.9. A new window "Schedule Tests" should pop up.
  1.9.1. Add the appropriate Test Method(s) then click Save.
  1.9.2. A new window pops up asking "Save These Tests ?" Click Yes.
  1.9.3. Another window pops saying "Test(s) Scheduled for New Samples." Click OK.
1.10. Once the tests are scheduled, return to the "Project No Sample Login" window and click Cancel.
1.11. To get a print out of the Sample Receipt / Log-In Report, press the "AAC Report" icon and enter the project number.
  1.11.1. Verify that all the information is correct. If it is, then press Print. If not, go to 2.1.
  1.11.2. Write the assigned AAC Sample #s next to each sample on the COC.
  1.11.3. Create sample ID stickers for each sample.
1.12. If the batch that was logged in included Summa Canisters, press the "Pressure Log" icon and enter

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the project number.

1.12.1. Verify that all the information is correct. If it is, then press Print. If not, go to 2.1.

2. TROUBLESHOOTING FOR LABTRACK

2.1. To correct Sample ID, Sample date & time, Matrix, Pressure, Canister number, TAT, Unused or Voided Canister #s, etc.:

2.1.1. Click on Microsoft Access and open the database file AAC1.MBD.
S:Labtrack\Database\AAC1.MBD

2.1.2. Open the Samples table.

2.1.3. Fix the appropriate information.
NOTE: If Unused or Voided Canister #s were not added to the Remarks in 1.6.12, go to the last sample of the batch and enter them in the Remarks column.

2.1.4. Close the Samples table.

2.2. To add a Test analysis to an existing batch:

2.2.1. Must be done after completing the login procedure in Section 1.

2.2.2. Go to Samples > Schedule Test [shortcut: Ctrl+T]

2.2.3. Enter the sample number, and click OK.

2.2.4. The "Schedule Tests" window should pop up.

2.2.5. Select a Test to add.

2.2.6. Click Save.

2.3. If by accident the cancel button was pressed during sample login:

2.3.1. Switch the Batch Login button to Sample Login then go to 2.1.

2.3.2. When all samples are logged in, go to 2.4.

2.4. To delete a Test result:

2.4.1. Must be done after completing the login procedure in Section 1.

2.4.2. Click on Microsoft Access and open the database file AAC1.MBD.
S:Labtrack\Database\AAC1.MBD

2.4.3. Open the Results table.

2.4.4. Delete the appropriate test (according to sample number).

2.5. If samples that were logged in do not show up on the Sample Receipt / Log-In Report:

2.5.1. Click on Microsoft Access and open the database file AAC1.MBD.
S:Labtrack\Database\AAC1.MBD

2.5.2. Open the Batches table.

2.5.3. Copy the Batch # for the AAC Project No you want the samples to be associated with.

2.5.4. Close the Batches table and open the Samples table.

2.5.5. Paste the Batch number in the Batch column next to each sample that should be associated with that AAC Project No.

2.5.6. Close the Samples table.

2.5.7. The samples should now appear on the Sample Receipt / Log-In Report.

3. REFERENCES

LabTrack Manual "The Original Electronic Lab Notebook – Configuration Guide" Version 1.2

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ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

Prepared by: Neil Christiana Date: 10/16/2025

Approved by: Karen Watson Date: 10/17/2025

Annual Review

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TITLE: ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

REFERENCES: SW846 8260D

1.0 SCOPE AND APPLICATION, SUMMARY

1.1 Scope and Application

1.1.1 This method is used to determine the concentrations of various volatile organic compounds in water utilizing a gas chromatograph equipped with a mass spectrometer detector. This SOP was written primarily for the analytes listed in Table 1.

1.1.2 Unlike conventional full scan 8260, this method utilizes the instrument's selected ion monitoring (SIM) capabilities. By monitoring for a few select ions the sensitivity can be increased 10 to 20 fold.

1.1.3 Utilizing a heated purge greatly improves the purge efficiency of 1,4-dioxane from water.

1.1.4 The Lower Limit of Quantitation (LLOQ) or Reporting limits (RL) are based on the sample amount and the lowest calibration standard. LLOQs may vary depending on matrix complications and sample volumes. The LLOQ for 1,4-dioxane by this method is 1.0 ug/l for aqueous samples. The LLOQs for the additional analytes listed in Table 1 are 0.02 to 0.5ug/l for aqueous samples.

1.1.5 The Method Detection Limit (MDL) for each analyte is evaluated on an annual basis for each matrix and instrument. MDLs are pooled for each matrix, and the final pooled MDLs are verified. The verified MDLs are stored in the LIMS and should be at least 2 to 3 times lower than the LLOQ. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported LLOQ.

1.1.6 The LLOQ for each analyte is evaluated on an annual basis for each matrix and instrument. The LLOQ verifications are prepared by spiking a clean matrix at 0.5 to 2 times the current LLOQ level. This LLOQ verification is carried through the same preparation and analytical procedures as the samples. Recovery of the analytes should be within the established limits. The DOD QSM requirements for Limit of Detection (LOD) and Limit of Quantitation (LOQ) verifications are different. See SOP QA020, current revision for complete requirements for MDL, LOD, LOQ, and LLOQ.

1.1.7 Compounds detected at concentrations between the LLOQ and MDL are quantitated and qualified as estimated values and reported with either a "J" or "I"

qualifier. Some program or project specifications may require that no values below the LLOQ be reported.

1.1.8 For DOD projects refer to DoD QSM Table B-22 for additional method requirements and data qualifying guidance.

1.2 Summary

1.2.1 This method is adapted from SW846 method 8260D.

1.2.2 Samples are received, stored, and analyzed within the appropriate holding times.

1.2.3 Sample preparation is performed in accordance with SGS Orlando SOP OP021, current revision.

1.2.4 The samples are analyzed on a gas chromatograph equipped with mass spectrometer detector.

1.2.5 The peaks detected are identified by comparison to characteristic ions and retention times specific to the known target list of compounds.

1.2.6 Library searches cannot be performed on data acquired in SIM mode because data was only acquired for selected ions.

1.2.7 Manual integrations are performed in accordance with SOP QA029, current revision.

2.0 PRESERVATION AND HOLDING TIME

2.1 Preservation

Aqueous Samples:

2.1.1 Samples should be preserved to a pH < 2. The pH must be checked and recorded immediately after the sample analysis. If the sample is not preserved to a pH < 2, it must be noted on the report.

2.1.2 The samples must be stored in capped vials, with minimum headspace, at ≤ 6 °C, without freezing in an area free of solvent fumes. The size of any bubble caused by degassing upon cooling should not exceed 5-6mm.

2.2 Holding Time

2.2.1 Aqueous samples are to be analyzed within 14 days of collection, unless otherwise specified by the contract. Samples that are not preserved must be analyzed within 7 days of collection; however, the preservation deficiency must be noted in the report.

3.0 INTERFERENCES

3.1 Data from all blanks, samples, and spikes must be evaluated for interferences.

3.2 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory blanks. The use of non-TFE tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

3.3 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal into the sample during shipment and storage. A trip blank can serve as a check on such contamination.

3.4 Contamination by carry-over can occur whenever high level and low-level samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for carry-over.

3.5 SIM may provide a lesser degree of confidence in compound identification unless multiple ions are monitored for each compound. In general, SGS Orlando monitors 3 ions per compound.

3.6 Historically 1,4-dioxane was used as a stabilizer for various chlorinated solvents such as trichloroethene (TCE) and tetrachloroethene (PCE). Samples that contain 1,4-dioxane often contain trichloroethene and/or tetrachloroethene at orders of magnitude higher concentrations. Because of this, it is best to analyze samples for 1,4-dioxane on a system dedicated to only the analysis of 1,4-dioxane. If the system analyzes all SIM analytes, an instrument blank must be analyzed to show that the system is free of TCE and PCE contamination.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or samples loaded on an instrument within the same 12-hour shift, whichever comes first.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Blank Spike Duplicate (BSD): A replicate analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The blank spike duplicate recoveries are used to document the precision and bias of a method. Note: Only to be analyzed for DOD samples when an MS/MSD is not available.

4.4 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. For all MS methods, a CCV must be analyzed at the beginning of each analytical run. For DoD QSM projects, an additional CCV must be analyzed at the end of the run.

4.5 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.6 Internal Standards: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Internal standards for mass spec methods are often deuterated forms of target analytes. Internal standards are used to compensate for retention time and response shifts during an analytical run.

4.7 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point must be at a level equal to or below the LLOQ.

4.8 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor must be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.9 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.10 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.11 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.12 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

4.13 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.14 Surrogate: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Surrogates are used to measure the purge efficiency.

4.15 Trip Blank: A sample of analyte-free matrix taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organic samples.

5.0 REAGENTS

5.1 Reagent water – distilled or deionized water free of interferences

5.2 Methanol – purge-and-trap grade or equivalent

5.3 Hydrochloric acid (HCl) – ACS reagent grade or equivalent

5.4 Inert Gas – UHP Helium or UHP Nitrogen

5.5 Volatile stock standards – Various mixes, traceable to Certificate of Analysis

5.6 4-Bromofluorobenzene (BFB) – instrument tuning mix

5.7 Surrogate standards – (varies based on analytes being reported)

1,2-Dichloroethane-d_4
Toluene-d_8

5.8 Internal standards – (varies based on analytes being reported)

Fluorobenzene
Chlorobenzene-d_5
1,4-Dioxane-d_8

6.0 APPARATUS

6.1 Gas Chromatograph – Agilent Technologies 6890, 7890 or 8890

6.1.1 Gas Chromatograph

The analytical system that is complete with a temperature programmable gas chromatograph and all required accessories, analytical columns, and gases.

6.1.2 The injection port is designed for split-splitless injection with capillary columns. The injection port must have an appropriate interface for sample introduction.

6.2 Mass Spectrometer– Agilent Technologies 5973, 5975 or 5977

The mass spectrometer must be capable of scanning from 35-300 amu every second or less, utilizing 70-volt (nominal) electron energy in the electron impact ionization mode. It must also be capable of producing a mass spectrum that meets all the

criteria in section 7.5.1.1 when injecting 50 ng (or less) of Bromofluorobenzene (BFB).

For this method it also must be capable of operating in Select Ion Mode (SIM). The selected ions are nominal ions but may have small mass defect, usually less than 0.2 amu, in their spectra. The acquisition table must be set to include these mass defects. The dwell time may be automatically calculated by the laboratory's GC/MS software. The total scan time must be less than 1,000 msec and produce at least 5 to 10 scans per chromatographic peak.

The mass spectrometer must be capable of analyzing multiple groups for up to 30 specific ions. Use the primary ion for quantitation and the secondary ions for confirmation. The start and end of each group must be time programmable and can be determined from the full scan analysis. Each group of specific ions is referred to as a descriptor.

6.3 Purge and Trap

6.3.1 The following autosampler models are used for purging, trapping and desorbing the sample onto GC column.

- EST Evolution/EV2 sample concentrator with Centurion Water multisampler

6.3.2 The sample purge vessel must be designed to accept 5 ml samples with a water column at least 3 cm deep.

6.3.3 The multisampler or concentrator is equipped with a heater capable of maintaining the purge chamber at 60 °C to improve purging efficiency.

6.3.4 The desorber must be capable of rapidly heating the trap to the manufacturer recommended desorb temperature.

6.4 Data System – Agilent Technologies MS Chemstation rev. EA 02.0x or FA 01.0x.

6.4.1 A computer system interfaced to the mass spectrometer that allows for the continuous acquisition and storage of all mass spectral data obtained throughout the duration of the chromatographic program.

6.4.2 The computer utilizes software that allows searching any GC/MS data file for ions of a specific mass and that can plot such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP).

6.4.3 The software must allow for integrating the abundances in any EICP between specific time or scan number limits. See Table 2.

6.4.4 Data is archived to a backup server for long term storage.

6.5 Trap – Vocarb 3000 (K) or equivalent: Carbopack B, Carboxen 1000, Carboxen 1001
The trap should be conditioned according to the manufacturer‘s recommendations.

6.6 Columns – RTX-VMS or equivalent: 20m X 0.18mm 1.0um.
– RTX-VMS or equivalent: 40m X 0.18mm 1.0um

6.7 Gas-tight syringes and class “A” volumetric glassware for dilutions of standards and samples.

7.0 PROCEDURE

7.1 Standards Preparation

Standards are prepared from commercially available certified reference standards. All standards must be logged in the Volatile Standards Logbook. All standards shall be traceable to their original source. The standards must be stored at temperatures between –10 °C and –20 °C, or as recommended by the manufacturer. Calibration levels, spike and surrogate concentrations, preparation information, and vendor part numbers can be found in the MSVOA STD Summary in the Active SOP directory.

7.1.1 Stock Standard Solutions

Stock standards are available from several commercial vendors. All vendors must supply a “Certificate of Analysis” with the standard. The certificate will be retained by the lab. Hold time for unopened stock standards is until the vendor’s expiration date. Once opened, the hold time is reduced to six months (one month for gases and one year for internal/surrogate) or the vendor’s expiration date (whichever is shorter).

7.1.2 Intermediate Standard Solutions

Intermediate standards are prepared by quantitative dilution of the stock standard with methanol. The hold time for intermediate standards is one month (one week for gases and six months for internal/surrogate) or the vendor’s expiration date (whichever is shorter). Intermediate standards may need to be remade if comparison to other standards indicates analyte degradation or concentration changes.

7.1.3 Calibration Standards

Calibration standards for the volatile organics are prepared at a minimum of five concentration levels through quantitative dilutions of the intermediate standard. The low standard concentration is at or below the LLOQ, and the remaining standards define the working range of the detector.

Calibration standard concentrations are verified by the analysis of an initial calibration verification (ICV) standard.

7.2 Instrument Conditions

Gas Chromatograph/ Mass Spectrometer

Carrier gas flow (Helium)	0.8-1.0 ml/min
Transfer line temperature	220 - 280 °C
Analyzer temperature	150 °C

Oven program – 45 °C for 2.5 minutes (RTX-VMS 40m)
10 °C/min to 80 °C for 0 minutes
15 °C/min to 185 °C for 0 minutes
30 °C/min to 240 °C for 2.5 minutes

Oven program – 35 °C for 2.5 minutes (RTX-VMS 40m)
4 °C/min to 60 °C for 0 minutes
25 °C/min to 220 °C for 0 minutes
30 °C/min to 240 °C for 1.2 minutes

Oven program – 35 °C for 1.0 minutes (RTX-VMS 20m)
10 °C/min to 80 °C for 0 minutes
18.5 °C/min to 150 °C for 0 minutes
30 °C/min to 220 °C for 1.0 minutes

GC conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

MS Descriptors – Monitor 3 characteristic ions (when possible) for each target analyte, and 2 characteristic ions for each surrogate and internal standard. Each descriptor may have up to 30 ions; however, the more ions in a descriptor, the less the sensitivity. Therefore, it is beneficial to use multiple descriptors for longer analytes lists. Refer to the specific instrument methods for actual descriptors.

7.3 Purge and Trap Device conditions

	EST Autosampler
Purge Gas	He or N2
65mL/min for 6.5min or 40 ml/min for 11min	65mL/min for 6.5min or 40 ml/min for 11min
Sample Temp.	Ambient - 60 C
Trap Temp.	< 35 C
Purge Time	6 or 11 min
Desorb Time / Temp	0.5-2.0 min @ 245 C
Bake Time / Temp	3-6 min @ 250 C

Purge and Trap conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

7.4 Sample Preparation

7.4.1 Water Samples

A 5ml aliquot of sample is loaded onto the purge-and-trap device and purged for 6 or 11 minutes at 60°C. Detailed procedures are described in SOP OP021, current revision.

7.5 Gas Chromatographic Analysis

Instrument calibration consists of two major sections:

Initial Calibration Procedures
Continuing Calibration Verification

7.5.1 Initial Calibration Procedures

Before samples can be run, the GC/MS system must be tuned, the injection port inertness must be verified, and the instrument must be calibrated.

7.5.1.1 Tune Verification (BFB)

The instrument must be hardware tuned per manufacturer's instructions. Verify the instrument tune by injecting 50ng or less of BFB solution onto the instrument. This is generally accomplished by purging a rinse containing BFB. The resulting BFB spectra must meet the criteria in the following table.

BFB KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
95	50-200% of mass 174
96	5-9% of mass 95
173	<2% of mass 174
174	50-200% of mass 95
175	5-9 % of mass 174
176	95-105% of mass 174
177	5-10% of mass 176

Evaluate the tune spectrum using three mass scans from the chromatographic peak and a subtraction of instrument background. This procedure is performed automatically by the MS Chemstation software by running "autofind" on the BFB peak.

Select the scans at the peak apex and one to each side of the apex. Calculate an average of the mass abundances from the three scans.

Background subtraction is required. Select a single scan in the chromatogram that is absent of any interfering compound peak and no more than 20 scans prior to the elution of BFB. The background subtraction must be designed only to eliminate column bleed or instrument background ions. Do not subtract part of the tuning compound peak.

Alternatively, the average spectra over the entire peak may be used.

All subsequent tune evaluations must use the same procedure that was used for the Initial Calibration.

If the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are met.

Analysis must not begin until the tuning criteria are met. The injection time of the acceptable tune analysis is considered the start of the 12-hour clock. The same mass spec settings must be used for the calibration standards and samples that were used for the tune evaluation standard. The exception being that the tune evaluation standard must be acquired in full scan mode and all others in SIM mode.

7.5.1.2 Internal Standard Calibration

A minimum 5-point calibration curve is created for the volatile organic compounds and surrogates using an internal standard technique. SGS Orlando routinely performs a 6-point calibration to maximize the calibration range.

Historically, many analytical methods have relied on linear models of the calibration relationship, where the instrument response is directly proportional to the amount of a target compound. The linear model has many advantages including simplicity and ease of use. However, given the advent of new detection techniques and because many methods cannot be optimized for all the analytes to which they may be applied, the analyst is increasingly likely to encounter situations where the linear model neither applies nor is appropriate. The option of using non-linear calibration may be necessary to address specific instrumental techniques. However, it is not EPA's intent to allow non-linear calibration to compensate for detector saturation or avoid proper instrument maintenance.

NOTE: Because of this concern, select programs including SC DHEC do not support the use of non-linear regressions.

The low point may be omitted from the calibration table for any compound with an LLOQ set at the level two standard. Additionally, the high point may be omitted for any compound that exhibits poor linearity at the upper end of the calibration range.

An entire level may be omitted provided that a minimum of 5 points remain. There must be technical justification to omit an entire level. This must be documented in the run log.

Response factors (RF) for each analyte are determined as follows:

$$RF = (A_{analyte} \mathbf{X} C_{istd})/(A_{istd} \mathbf{X} C_{analyte})$$

$A_{analyte}$ = area of the analyte
A_{istd} = area of the internal standard
$C_{analyte}$ = concentration of the analyte
C_{istd} = concentration of the internal standard.

The mean RF and standard deviation of the RF are determined for each analyte. The percent relative standard deviation (%RSD) of the response factors is calculated for each analyte as follows:

%RSD = (Standard Deviation of RF X 100) / Mean RF

If the %RSD $\leq$ 20%, linearity through the origin can be assumed and the mean RF can be used to quantitate target analytes in the samples.

Note: For DoD QSM samples, the average response factor must be ≥0.01 for each reported analyte.

Alternatively, a calibration curve of response vs. amount can be plotted. This method allows for the use of average response factors, linear regressions, and non-linear regressions. Linear regressions may be unweighted or weighted as $1/x$ or $1/x^2$. If the correlation coefficient (r) is $\geq$0.995 (r^2 $\geq$0.990) then the curve can be used to quantitate target analytes in the samples. Regardless of which calibration model is chosen, the laboratory should visually inspect the curve plots to see how the individual calibration points compare to the plot.

Either of the two techniques described below may be used to determine whether the calibration function meets acceptable criteria. These involve refitting the calibration data back to the model. Both % Error and Relative Standard Error (RSE) evaluate the difference between the measured and the true amounts or concentrations used to create the model.

Calculation of the % Error

% ERR = (xi-x'i) / xi * 100

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

Percent error between the calculated and expected amounts of an analyte must be ≤ ±20% for the mid-point standard (80-120% of True Value) and ≤ ±50% at the analyte LOQ. For DOD samples, the percent error must be ≤ ±35% at the analyte LOQ.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n} \left[\frac{x_i' - x_i}{x_i}\right]^2 \Big/ (n-p)}$$

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

p = Number of terms in the fitting equation. (average = 1, linear = 2, quadratic = 3)

n = Number of calibration points.

The %RSE acceptance limit criterion is ≤20%.

7.5.1.3 Initial Calibration Verification (ICV)

The validity of the initial calibration curve must be verified through the analysis of an initial calibration verification (ICV) standard. The ICV must be prepared from a second source at a mid-range concentration.

The %D for all analytes of interest should be ≤ 30%. If the %D > 30%, the analysis of samples may still proceed if the analyte failed high and the analyte is not expected to be present in the samples. However, if a reportable analyte is detected in a sample and the %D for that analyte was greater than 30% in the ICV, the sample will need to be reanalyzed on a system with a passing ICV for that analyte.

If the ICV does not meet criteria, a fresh standard must be prepared. If this ICV meets criteria, proceed with sample analysis. If the ICV still does not meet criteria, analyze an ICV prepared from a third source or different lot. Determine which two standards agree. Make fresh calibration standards and an ICV from the two sources that agree. Recalibrate the instrument.

7.5.2 Continuing Calibration Verification (CCV)

7.5.2.1 EPA 8260D requires the tune to be analyzed only once before initial calibration. The BFB is analyzed by purging a blank that contains BFB. Evaluate the resultant peaks against the criteria in section 7.5.1.1. The injection time of this standard starts the 12-hour window. For analytical runs in which a BFB is not analyzed, the 12- hour windows begins at the injection of the CCV.

7.5.2.2 Analyze a continuing calibration check standard. The CCV must be at or below the mid-point of the calibration curve.

7.5.2.3 The percent difference (%D) for each analyte of interest will be monitored. The |%D| should be $\leq$ 20% for each analyte.

If the first continuing calibration verification does not meet criteria, a second standard may be injected. If the second standard does not meet criteria, the system must be recalibrated unless an assignable cause can be identified and corrected through documented instrument maintenance or repreparation of standards. If the second standard meets criteria then the system is considered in control and results may be reported.

Rationale for second standard such as instrument maintenance, clipped column, remade standard, etc. must be documented in the run log or maintenance log. Reanalysis of second standard without valid rationale may require the analysis of a third standard (in which case both the second and third standard would have to pass).

If the |%D| is greater than 20%, then documented corrective action is necessary. This may include recalibrating the instrument and reanalyzing the samples, performing instrument maintenance to correct the problem and reanalyzing the samples, or qualifying the data. Under certain circumstances, the data may be reported, i.e., the CCV failed high, the associated QC passed, and the samples were ND.

NOTE: For any DoD QSM project, if samples must be reported with a target analyte having a %D > 20%, then the data must be qualified accordingly, regardless of whether the analyte was detected or not.

NOTE: Any target analytes that are detected in the samples must have an acceptable initial calibration curve and acceptable CCV standards; otherwise, the samples must be reanalyzed, or the data must be qualified.

7.5.2.4 For DoD QSM compliance, two additional, daily CCVs must be analyzed

7.5.2.4.1. A CCV at or below the LOQ must be analyzed (instrument sensitivity check)

The %D for all target compounds in this CCV should be ≤ 35%. If the %D > %35 for any target compound, recalibration may be necessary. If the problem persists, raising the LOQ to a concentration where the criteria can be met may be necessary.

S/N ≥ 10:1 for all quantitation ions and ≥ 3:1 for all other characteristic ions.

7.5.2.4.2. A mid-point CCV must be analyzed after every 12 hours of analysis time and at the end of each run.

The %D for all target compounds in this CCV should be ≤ 50%. If the %D > %50 for any target compound, then the samples must be reanalyzed at least once at the appropriate dilution. If the %D > %50 for the analytes in the reanalysis, the department supervisor shall review the data and determine what further action is necessary. This may include reanalyzing the samples at a higher dilution or qualifying the data.

NOTE: If samples are ND and an analyte in the above CCVs fails high, then the sample does not need to be reanalyzed.

7.5.2.5 If any of the internal standard area change by a factor of two (-50% to +100%) or retention time changes by more than 10 seconds from the midpoint standard of the last initial calibration or from the daily CCV, the mass spectrometer must be inspected for malfunctions and corrections made, as appropriate. Corrective action may include re-calibration (initial Calibration) of the instrument.

7.5.3 Sample Analysis

7.5.3.1 Samples are analyzed in a set referred to as an analysis sequence or batch. A batch consists of the following:

Tune Evaluation Mix
Initial Calibration Standards (or CCV)
QC Samples
Samples

NOTE: CCV is followed by Blank Spike and Method Blank. Since Blank Spike level is identical to CCV the Method Blank (which follows the Blank Spike) meets the intent of 8260D sec. 11.4.2 CCB demonstrating total system freedom of contaminants.

7.5.3.2 Five microliters of internal standard/ surrogate solution is added to every 5ml of sample in the sparge vessel. Generally, 5ml of sample are transferred to the sparge vessel.

7.5.3.3 After purging, the system will automatically reverse flow and rapidly heat the trap to desorb the sample analytes onto the GC column.

7.5.3.4 Qualitative identification

The target compounds shall be identified by analysts with competent knowledge in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. The criteria required for a positive identification are:

The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target compound at a compound-specific retention time will be accepted as meeting this criterion.

The sample component must elute at the same relative retention time (RRT) as the daily standard. The RRT of sample component must be within ± 0.06 RRT units of the standard.

All ions monitored in the standard mass spectra must be present in the sample spectrum.

The relative intensities of these ions must agree within ± 30% between the daily standard and sample spectra, (e.g., for an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80%).

Structural isomers that produce very similar mass spectra must be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

If peak identification is prevented by the presence of interferences, the sample must be diluted so that the interference does not mask any analytes.

7.5.3.5 Quantitative analysis

When a target compound has been identified, concentration will be based on the integrated area of the quantitation ion, which is normally the base peak.

The sample matrix may produce an interference with the primary ion. This may be characterized by an excessive background signal of the same ion, which distorts the peak shape beyond a definitive integration. The interference could also, severely inhibit the response of the internal standard ion.

If the analyte response exceeds the linear range of the system, the extract must be diluted and reanalyzed. It is recommended that samples be diluted so that the response falls into the middle of the calibration curve.

7.6 Maintenance and Trouble Shooting

7.6.1 Refer to SOP GC001, current revision for routine instrument maintenance and trouble shooting.

7.6.2 All instrument maintenance must be documented in the appropriate "Instrument Repair and Maintenance" log. The log will include such items as problem, action taken, correction verification, date, and analyst.

7.6.3 Repairs performed by outside vendors must also be documented in the log. The analyst or Department Supervisor responsible for the instrument must complete the log if the repair technician does not.

7.6.4 PC and software changes must be documented in the "Instrument Repair and Maintenance" log. Software changes may require additional validation.

8.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), blank spike duplicates, matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix. **Note: For DOD QSM samples, a BS/BSD must be analyzed when sufficient sample is not available for an MSD.**

Blank spike, blank spike duplicate, matrix spike, and matrix spike duplicate samples are compared to statistically generated control limits. These control limits are reviewed and updated annually. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

9.0 QUALITY ASSURANCE / QUALITY CONTROL

Accuracy and matrix bias are monitored by the use of surrogates and by the analysis of a QC set that is prepared with each batch (maximum of 20 samples) of samples. The QC set consists of a method blank (MB), blank spike (BS), matrix spike (MS), and matrix spike duplicate (MSD).

9.1 Internal Standards

9.1.1 Fluorobenzene, Chlorobenzene-d_5, and 1,4-Dioxane-d_8 may be used as the internal standards for this method. The response of the internal standard in all subsequent runs must be within a factor of two (-50% to +100%) of the internal standard response in the opening CCV for each sequence. On days that an initial

calibration is performed, the internal standard response must be compared to the internal standard response for the mid-point standard.

9.1.2 If the internal standard response is not within limits, the following are required.

9.1.2.1 Check to be sure that there are no errors in calculations, integrations, or internal standards solutions. If errors are found, recalculate the data accordingly.

9.1.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.1.2.3 If no problem is found, prepare a second aliquot of sample and reanalyze the sample. If there is insufficient sample for reanalysis, footnote this on the report.

9.1.2.4 If upon reanalysis, the responses are still not within limits, the problem is considered matrix interference. The sample may need to be diluted or the results qualified.

9.2 Surrogates

9.2.1 1,2-Dichloroethane-d_4 and Toluene-d_8 may be used as the surrogate standards to monitor the efficiency of the purge-and-trap system. Note: Only Toluene-d_8 is used for the monitoring of 1,4-Dioxane, 1,2-Dibromoethane, 1,2,3-Trichloropropanne and 1,2-Dibromo-3-chloropropane.

A known amount of surrogate standard is added to each sample including the QC set prior to purging. The percent recovery for each surrogate is calculated as follows:

% Recovery = (Sample Amount / Amount Spiked) X 100

The percent recovery must fall within the established control limits for all surrogates for the results to be acceptable.

9.2.2 If any surrogate recovery is not within the established control limits, the following are required.

9.2.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, surrogate solutions or internal standard solutions. If errors are found, recalculate the data accordingly.

9.2.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a

more accurate recovery by analyzing the sample on a different column type.

9.2.2.3 If no problem is found, reanalyze the sample. **NOTE:** If the recoveries are high and the sample is non-detect, then reanalysis may not be necessary. For any DoD QSM projects, the resulting data must be qualified accordingly. If there is insufficient sample for reanalysis, footnote this on the report.

9.2.2.4 If upon reanalysis, the recovery is still not within control limits, the problem is considered matrix interference. Surrogates from both sets of analysis must be reported on the final report.

9.3 Method Blank

9.3.1 The method blank is de-ionized water to which the surrogate standard has been added. An appropriate aliquot of methanol must also be added. The method blank is then purged along with the other samples to determine any contamination from the system or ambient sources. The method blank must be free of any analytes of interest or interferences at ½ the required LLOQ level to be acceptable. Common laboratory contaminants such as methylene chloride must be below the LLOQ if present. Samples associated with a contaminated method blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples or qualifying the results with a “B” or “V” qualifier.

9.3.2 If the MB is contaminated but the samples are non-detect, then the source of contamination must be investigated and documented. The sample results can be reported. For any DoD QSM projects the resulting data must be qualified accordingly.

9.3.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination must be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. This must be approved by the department supervisor.

9.3.4 If the MB is contaminated but the samples results are < 10 times the contamination level, the source of the contamination must be investigated and documented. The samples must be reanalyzed for confirmation. If there is insufficient sample to reanalyze, or if the sample is reanalyzed beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

9.4 Blank Spike and Blank Spike Duplicate

9.4.1 The blank spike is de-ionized water to which the surrogate standard and spike standard have been added. An appropriate aliquot of methanol must also be added. The blank spike is then processed along with the other samples to monitor the efficiency of the purge-and-trap procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = (Blank Spike Amount / Amount Spiked) X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable.

NOTE: A secondary check against 70-130% limits must be performed for all analytes reported to SC DHEC.

9.4.2 If the blank spike recoveries are not within the established control limits, the following are required.

9.4.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions, or internal standard solutions. If errors are found, recalculate the data accordingly.

9.4.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

9.4.2.3 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable. For any DoD QSM projects, the resulting data must be qualified accordingly.

9.4.2.4 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples or qualifying the results as estimated.

9.4.2.5 If there is insufficient sample to reanalyze, or if the sample is reanalyzed beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

9.4.3 Precision

Blank spike and spike duplicate recoveries for each analyte are used to calculate the relative percent difference (RPD) for each compound.

RPD = (| BS Result – BSD Result | / Average Result) X 100

The RPD for each analyte should fall within the established control limits. If more than 33% of the RPDs fall outside of the established control limits, the department supervisor shall review the data and determine if any corrective action is necessary. RPD failures are generally not grounds for batch reanalysis.

9.5 Matrix Spike and Matrix Spike Duplicate

9.5.1 Matrix spike and spike duplicates are replicate sample aliquots to which the surrogate standard and spike standard have been added. The matrix spike and spike duplicate are then processed along with the other samples to monitor the

precision and accuracy of the purge-and-trap procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = ([Spike Amount – Sample Amount] / Amount Spiked) X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable.

9.5.2 If the matrix spike recoveries are not within the established control limits, the following are required.

9.5.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions, or internal standard solutions. If errors are found, recalculate the data accordingly.

9.5.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.5.2.3 If no problem is found, compare the recoveries to those of the blank spike. If the blank spike recoveries indicate that the problem is sample related, document this on the run narrative. Matrix spike recovery failures are not grounds for reanalysis but are an indication of the sample matrix effects.

9.5.3 Precision

Matrix spike and spike duplicate recoveries for each analyte are used to calculate the relative percent difference (RPD) for each compound.

RPD = (| MS Result – MSD Result | / Average Result) X 100

The RPD for each analyte should fall within the established control limits. If the RPDs fall outside of the established control limits, the department supervisor shall review the data and determine if any corrective action is necessary. RPD failures are generally not grounds for batch reanalysis.

10.0 CALCULATIONS

The concentration of each target compound in the original sample is calculated as follows:

Water (ug/l) = ($CONC_{inst}$) X DF

$CONC_{inst}$	=	Instrument concentration calculated from the initial calibration using mean RF or curve fit.
DF	=	Dilution Factor

11.0 SAFETY AND POLLUTION PREVENTION

11.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedures), current revision. Safety glasses, a lab coat, and appropriate gloves should be worn when handling samples.

The toxicity of each reagent and target analyte has not been precisely defined; however, each reagent and sample must be treated as a potential health hazard. Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) are available for all reagents and many of the target analytes. Exposure must be reduced to the lowest possible level. Personal protective equipment must be used by all analysts.

11.2 Pollution Prevention

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

12.0 REFERENCES

SW846 Method 8000D Revision 4, July 2014

SW846 Method 8260D Revision 4, June 2018

DOD Quality Systems Manual (QSM), latest revision.

TABLE 1

Routine Target Analytes

Benzene	cis-1,3-Dichloropropene
Carbon Tetrachloride	trans-1,3-Dichloropropene
Chloroform	1,4-Dioxane
1,1-Dichloroethane	Methyl Chloride
1,2-Dichloroethane	Methylene Chloride
1,1-Dichloroethylene	Tetrachloroethylene
cis-1,2-Dichloroethylene	1,1,1-Trichloroethane
trans-1,2-Dichloroethylene	Trichloroethylene
1,2-Dichloropropane	Vinyl Chloride
1,2-Dibromoethane	1,2,3-Trichloropropane
1,2-Dibromo-3-chloropropane	

TABLE 2

Characteristic Ions

Analyte	Quant. Ion	Q1	Q2	Q3
Fluorobenzene ISTD	96	70		
Methyl Chloride	50	52		
Vinyl Chloride	62	64		
1,1-Dichloroethene	61	96	98	63
Methylene Chloride	49	84	86	51
trans-1,2-Dichloroethene	61	96	98	63
1,1-Dichloroethane	63	65		
cis-1,2-Dichloroethene	96	61	98	63
Chloroform	83	85	47	
Carbon Tetrachloride	117	119	121	82
1,1,1-Trichloroethane	97	99	61	
Benzene	78	51		
1,2-Dichloroethane-d4 SURR	65	67	102	
1,2-Dichloroethane	62	49	64	
Trichloroethene	95	130	97	132
1,2-Dichloropropane	63	62	41	76
cis-1,3-Dichloropropene	75	77	39	
Chlorobenzene-d_5 ISTD	117	82		
Toluene-d_8 SURR	98	100		
trans-1,3-Dichloropropene	75	77	39	49
Tetrachloroethene	166	164	129	131
1,1,2-Trichloroethane	83	97	61	99
1,2-Dibromoethane	107	109	188	
1,2,3-Trichloropropane	75	77		
1,2-Dibromo-3-chloropropane	75	155	157	39
1,4-Dioxane-d_8 ISTD	96	64		
1,4-Dioxane	88	58	43	

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
04/2024	11	Entire document	Removed references to 8260B and 8260C
04/2024	11	Entire document	Removed all references to soil/solid analysis and associated prep SOPs
04/2024	11	1.1.1	Removed specific reference to 1,4-dioxane
04/2024	11	1.1.8	Removed QSM 5.1 and QSM 5.3
04/2024	11	3.6	Added “if the system analyzes all SIM analytes…”
04/2024	11	5.5	Changed 1,4_dioxane stock standard to volatile stock
04/2024	11	6.1	Added GC Model 8890
04/2024	11	6.2	Added MSD Model 5977
04/2024	11	6.3.1	Removed 4552 multisampler
04/2024	11	6.4	Updated chemstation software revisions
04/2024	11	7.1.1 and 7.1.2	Updated the expiration date of internal/surrogates
04/2024	11	7.3	Updated upper sample temperature to 60C
04/2024	11	7.5.1.1	Updated BFB Tune criteria Table and added “this is generally accomplished by purging…”
04/2024	11	7.5.1.2	Updated %RSD criteria from 15% to 20%, added 15% DoD comment;
04/2024	11	7.5.1.3	Changed %D criteria from 20% to 30% for non-DoD programs
04/2024	11	7.5.2.1	Updated BFB analysis frequency and injection technique
04/2024	11	11.1	Updated safety section to include QA 033 reference
04/2024	11	11.2	Updated pollution prevention statement.
04/2024	11	Appendix of Significant Changes	Added

Revision Date	Revision Number	Affected Section(s)	Revision Description
11/2024	12	Entire Document	Updated QSM 5.x to QSM 5.4
11/2024	12	7.5.3.1	Clarified CCB vs. MB sequence
09/2025	13	1.1.8	DoD 5.4 Table B-4 to QSM Table B-22
09/2025	13	Multiple	Removed references to OI Analytical P&T components
09/2025	13	7.5.1.2	Removed DoD note for %RSD, added note for minimum RF
09/2025	13	7.5.2.1	Updated BFB tune frequency
09/2025	13	7.5.2.3	Added language about assignable causes to CCV reanalysis. Removed DoD note.
09/2025	13	7.3	Updated Purge Flow and Time
09/2025	13	7.5.2.4.1	Added DoD CCV at or below LOQ
09/2025	13	4.3	Added definition of Blank Spike Duplicate and renumbered.
09/2025	13	Sec 8	Added DoD Note for BS/BSD
09/2025	13	9.4.3	Added
10/2025	14	1.1.4	Updated RL lower range from 0.1ug/L to 0.02ug/L
10/2025	14	7.5.1.2	Changed RE criteria for low point standard from 35% to 50%; Added DOD note for low point standard to be 35%
10/2025	14	9.2.1	Added Note for Tol-d8 specific monitoring
10/2025	14	Table 1 and Table 2	Added 1,2-Dibromoethane, 1,2,3-Trichloropropane and 1,2-Dibromo-3-chloropropane

ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Director. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: GC001, OP021, QA020, QA029, QA033, and SAM108, current revisions.

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

Prepared by: Jordynn Rice Date: 04/22/2026

Approved by: Svetlana Izosimova Date: 04/22/2026

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

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TITLE: METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

REFERENCES:

TNI 2016 Standards
DoD/DoE QSM 6.0
SW846 6010D, 2014
WV 47CSR32

INSTRUMENT: THERMO 6500, SERIAL # 20100903 SSTRACE 1
AUTOSAMPLER: CETAC 240 POSITION, SERIAL # 031038A520 SSTRACE 1

SUGGESTED WAVELENGTH (S): TABLE 2

1.0 SCOPE AND APPLICATION SUMMARY

SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation. Please refer to current version of DoD/DoE QSM 6.0 for quality control criteria.

1.1 This method is applicable for the determination of metals in water, sludges, sediments, and soils. Elements that can be reported by this method include: Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Titanium, Thallium, Tin, Vanadium, and Zinc.

1.2 Sample matrices are pretreated following SW846 methods for digestion of soil, sediment, sludge, or water samples. Refer to specific metals department digestion SOP's for more information on digestion techniques.

1.3 This inductively coupled argon plasma optical emission spectrometer (s) (ICP-OES) uses an Echelle optical design and a Charge Injection Device (CID) solid-state detector to provide elemental analysis. Control of the spectrometer is provided by PC based iTEVA software. In the instrument, digested samples are introduced into the Thermo 6500 ICP, passed through a nebulizer and transported to a plasma torch. The element-specific emission spectra are produced by a radio frequency inductively coupled plasma. The spectra are dispersed by a spectrometer, and the intensities of the emission lines are monitored with the solid-state detector.

1.4 Reporting limits (RL) are based on the extraction procedure. Reporting limits may vary depending on matrix complications, volumes and by client needs, but the reporting limits must always be verified with a low check which meets the criteria outlined in this SOP. Solid matrices are reported on a dry weight basis. Refer to table 1 of this SOP for SGS - Orlando typical reporting limits. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits.

1.5 Method Detection Limit: MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is distinguishable from method blank results. Experimentally determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B, Rev. 2. For further details on the procedure refer to SOP QA020, current revision

1.6 LLOQ verification. LLOQ is the lowest point of quantitation. The LLOQ is initially verified by the analysis of 7 replicate samples, spiked at the LLOQ, and processed through all preparation and analysis steps of the method. The mean recovery should be within +/- 35 percent of the true value with an RSD $\leq$ 20 percent.

1.7 Ongoing Lower limit of quantitation (LLOQ) check sample. The lower limit of quantitation check sample should be analyzed on a quarterly basis to demonstrate the desired detection capability. The LLOQ sample is carried through the entire preparation and analytical procedure. The mean recovery should be within +/- 35 percent of the true value with an RSD $\leq$ 20 percent.

1.8 Compounds detected at concentrations between the RL and MDL are quantitated and qualified as estimated values and reported with either a “J” or “I” qualifier. Some program or project specifications may require that no values below the RL be reported.

1.9 Instrument Detection Limits (IDL). It is suggested that IDL’s be completed upon initial instrument installation, whenever instrument conditions have significantly changed, or at a minimum annually. Instrument detection limits can be estimated as the mean of the blank results plus 3 times the standard deviation of 10 replicate analyses of the reagent blank solution. (use zero for the mean if the mean is negative) Each IDL measurement shall be performed as though it were a separate analytical sample. IDLs shall be determined and reported for each wavelength used in the analysis of the samples.

2.0 PRESERVATION AND BOTTLEWARE

All samples should be preserved with nitric acid to a pH of <2 at the time of collection. All sample pH are checked in sample receiving and within the metals department. Samples that are received with a pH >2 must be preserved to pH <2 and held for 24 hours prior to metals digestion to dissolve any metals that absorb to the container walls. Refer to SOP SAM101, current revision for further instruction.

Final pH of TCLP extracts are checked and recorded in SGS - Orlando Extractions Department. Please refer to TCLP (1311) fluid determination logbook and SPLP (1312) fluid determination logbook for further information. TCLP extracts received from SGS - Orlando Extractions Department are prepared as soon as possible, no longer than 24 hours from time of receipt. If precipitation is observed during the sample preparation process the sample(s) are immediately re-prepped on dilution until no precipitation is observed.

Samples received for dissolved metals analysis should be filtered and preserved to pH<2 as soon as possible and held for 24 hours prior to digestion. Refer to SGS - Orlando Sample Filtration Logbook for further information.

All soil samples must be stored in a refrigerator at $\leq$ 6°C without freezing upon receipt. Refer to SOP SAM101, current revision for further instruction.

All bottle ware used by SGS - Orlando is tested for cleanliness prior to shipping to clients. Analysis results must be less than one half the reporting limit (LLOQ) to be acceptable. Refer to SOP QA051, current revision for further instruction.

3.0 HOLDING TIME AND BATCH SIZE

All samples must be prepared and analyzed within 6 months of the date of collection. Refer to appropriate SGS - Orlando digestion SOP, current revision for batch size criteria.

4.0 INTERFERENCES

Several types of interferences can cause inaccuracies in trace metals determinations by ICP. These interferences are discussed below.

4.1 Spectral interferences are caused by overlap of a spectral line from another element, unresolved overlap of molecular band spectra, background contribution from continuous or recombination phenomena, and background contribution from stray light from the line emission of high concentration elements. Corrections for these interferences can be made by using interfering element corrections, by choosing an alternate analytical line, and/or by applying background correction points. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak.

Note: Refer to section 17.0 of this SOP for further instruction regarding interfering element correction factor generation.

4.2 Physical interferences can be caused by changes in sample viscosity or surface tension, by high acid content in a sample, or by high dissolved solids in a sample. These interferences can be reduced by making sample dilutions.

4.3 Matrix interferences in high solid samples can be overcome by using an internal standard. Yttrium/Indium mix is used for the Thermo 6500 ICP. The concentration must be sufficient for optimum precision but not so high as to alter the salt concentration of the matrix. The element intensity is used by the instrument as an internal standard to ratio the analyte intensity signals for both calibration and quantitation.

4.4 Chemical interferences are not pronounced with ICP due to the high temperature of the plasma, however if they are present, they can be reduced by optimizing the analytical conditions (i.e., power level, torch height, etc.).

5.0 APPARATUS

5.1 Currently there are two solid state ICPs available for use in the lab. Both are Thermo 6500 ICP units. These units have been optimized to obtain lower detection limits for a wide range of elements. Since they are solid state systems, different lines may be included for elements to obtain the best analytical results. However, the lines which are normally included in the normal analysis program are shown in Table 2.

5.2 Instrument auto samplers. For random access during sample analysis.

5.3 Class A volumetric glassware and pipettes.

5.4 Polypropylene auto sampler tubes.

5.5 Eppendorf Pipette (s) - Pipette (s) are checked daily for accuracy and to ensure they are in good working condition prior to use. Volumes are checked at 100% of maximum volume (nominal volume). Pipettes are checked within the metals department and results are stored electronically in the “Pipette Calibration Log.” Refer to SOP QA006, current revision for further information regarding pipette calibration. BIAS: mean must be within 2% of nominal volume. Precision: RSD must be $\leq$ 1% of nominal volume based on three replicates.

5.6 Fisher Brand 0.45-micron (um) filter or equivalent. Filter lots are checked for cleanliness through the Method Blank process. All Method Blank analytical results must be less than one half the reporting limit to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated filters must be re-filtered through acceptable filters.

5.7 Fisher Brand disposable 10 ml syringes or equivalent. Syringe lots are checked for cleanliness through the Method Blank process. All Method Blank results must be less than one half the reporting limit to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated syringes must be re-filtered through acceptable syringes.

5.8 Data System

Microsoft Windows XP Professional Version 2002
Instrument software SST1 – Thermo iTEVA version 2.8.0.97
Instrument software SST2 – Thermo iTEVA version 2.7.0.87

5.8.1 A computer system interfaced to the Thermo 6500 ICP that allows for the continuous acquisition and storage of all data obtained throughout the duration of the analytical run sequence.

5.8.2 Data is archived to a backup server for long term storage.

6.0 REAGENTS

All chemicals listed below are trace metal grade unless otherwise specified. These standards and reagents must be accompanied by the Certificate of Analysis (CoA). The CoA is examined for accuracy and completeness of the information, including verification of the reagent/standard normality/concentration. For further details refer to SOP QA017, current revision. Refer to Acid Certificate of Analysis Electronic Logbook for Certificates of Analysis and compliance with the specifications of the grade listed. Refer to the Metals Department Electronic Standard Prep Logbook for the make-up and concentrations of standards and stock solutions being used within this SOP. Some of the information included in the logbook is as follows: standard name, elements in mix, manufacturer, lot number, parent expiration date, acid matrix, stock concentration, volume of standard added, total volume, final prepared concentration, prep date, initials, MET number, and prepared standard expiration date. Standards and prepared reagents must be prepared every 6 months or before stock standard expiration date, whichever comes first**.** Refer to tables 3 through 7 of this SOP for concentration levels of standards used. Unless otherwise approved, the calibration curve must be determined by a blank and a series of six non-zero standards representing the elements of interest.

6.1 Reagent Water – Water that has been generated by any method which shall meet method specified requirements. TNI 2016 definition. Reagent water is used exclusively for laboratory purposes. Refer to SOP QA037, current revision for more information regarding testing and monitoring.

6.2 Yttrium and Indium internal standard, made from ICP quality standard.

6.3 Hydrochloric acid, trace metals grade.

6.4 Nitric Acid, trace metals grade.

6.5 Analytical Quality Control Solutions

ICP quality standard stock solutions are available from Inorganic Ventures, Spex, Plasma Pure, Ultra, Environmental Express, or equivalent.

All the solutions below are prepared by adding either mixed or single element metals solutions to a solution prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation; which is 3% HNO_3 + 5% HCL unless instructed otherwise by supervisor.

Standards must be prepared so that there is minimal spectral interference between analytes.

Note: All Ag stock and intermediate solutions must be stored away from direct sunlight.6.5.1 Calibration Standards. These can be made up by diluting the stock solutions to the appropriate concentrations. The calibration standards should be prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation. Standards must be prepared so that there is minimal spectral interference between analytes.

6.5.2 Blank (Calibration, ICB, CCB)

6.5.3 Initial Calibration Verification solution.

This standard solution must be made from a different source than the calibration curve. The concentrations for each element must be within the range of the calibration curve and should be approximately at the midpoint of the curve. This solution is used to verify the accuracy of the initial calibration. Levels for the ICV standard are shown in Table 4.

6.5.4 Continuing Calibration Verification solution.

The metals concentrations for this standard should be at approximately the mid-point of the calibration curve for each element. This standard should be prepared from the same source that is used for the calibration curve. Levels for the CCV standard are shown in Table 5.

6.5.5 Spectral Interference Checks (SIC). Two types of SIC checks are used. Individual element SIC are performed when the instrument is initially set up, and every six months thereafter. The mixed element SIC solution is used daily to check that the instrument is free from interference from elements typically observed in high concentration and to check that interference corrections (IEC) are still valid.

Single element interference checks – At a minimum, single element SIC checks should be performed for the following elements: Aluminum 500 mg/l; Barium 4 mg/l; Calcium 500 mg/l; Copper 4 mg/l; Iron 500 mg/l; Magnesium 500 mg/l; Manganese 4 mg/l; Molybdenum 4 mg/l; Sodium 1000 mg/l; Nickel 4 mg/l; Selenium 4 mg/l; Silicon 50 mg/l; Tin 4 mg/l; Vanadium 4 mg/l and Zn 4 mg/l.

Mixed element SIC solution – The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 200 mg/l; Magnesium 500 mg/l. Levels for the SIC and mixed SIC can be found on tables 9 and 10.

6.5.6 CRIA Standard Solution

The CRIA standard contains the elements of interest at levels equal to SGS - Orlando quantitation limits (RL). Please refer to Table 6 for list of elements of interest and concentration levels for the CRIA. If special client reporting limits are requested, then low checks corresponding to those reporting limits must also be analyzed.

6.5.7 Matrix Spike, Matrix Spike duplicate, and Spike Blank Solution.

This solution is prepared by adding either mixed or single element metals solutions to a solution containing 3 percent nitric acid and 5 percent hydrochloric acid and diluting to a fixed final volume with this acid mixture. Spiking solution (s) must be added to the spike blank, matrix spike, and the matrix spike duplicate prior to digestion. Levels for the MS and MSD and Spike Blank standard are shown in Table 7.

6.6 Liquid Argon or Argon Gas. (99.999% purity)

7.0 ANALYTICAL PROCEDURE

Note: Please refer to section 8 and or QC criteria summary page of this SOP for further detail on quality control criteria. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements.

7.1 General procedure on how to operate the Thermo 6500 is described below. Refer to the Thermo 6500 operation manual for further details.

7.2 Before starting up the instrument, make sure that the pump tubing is in good condition, the torch assembly, the nebulizer, and the spray chamber are clean, the dehumidifier (if used) is filled with DI water up to the level between Minimum and Maximum, and that there are no leaks in the torch area.

7.3 Turn on the recirculating cooler. Verify that the argon is turned on and there is enough for the entire days analytical run.

7.4 Tighten the pump platens and engage the peristaltic pump. Make sure sample and internal standard solutions are flowing smoothly.

7.5 Put a new solution of acid rinse into the rinse reservoir. The composition of the rinse solution may be periodically changed to minimize sample introduction problems and sample carryover. If internal standard is being used, make sure that sufficient amount of internal standard is prepared for the entire analytical run.

7.6 Start up the instrument following the sequence show below.

7.6.1 Double click the **iTEVA Control Center** Icon on the desktop. Type ***admin*** in User Name field, and then click **OK**.

7.6.2 Once the iTEVA Control Center window is opened, click on **Plasma** Icon at status bar area. Then click on **Instrument Status** to check the interlock indicators (torch compartment, purge gas supply, plasma gas supply, water flow, and exhaust should be in green; drain flow and busy should be in gray) and the Optics Temperature. (It should be around 38°C.) Click on the Close box.

7.6.3 Click **Plasma On**. When the plasma is on, click close. Let the instrument warm up for 15 to 20 minutes before starting the analysis. New tubing may take an hour to stabilize.

7.7 Torch Alignment and Auto Peak

7.7.1 If the torch has been cleaned, then the torch alignment procedure must be performed.

7.7.2 Open the method and then click on **Sequence** tab, then click on **List View** Icon until you reach rack display.

7.7.3 Go to S-6 position (you can assign any position in the rack for torch alignment), then right click to select **Go** to empty sample S:6. (Now, the auto sampler tip moves from Rinse to this position).

7.7.4 Click on **Analysis** tab, then select **Torch Alignment** from Instrument drop down menu. There will be a pop up dialog box present. Click **Run**. Then there will be another dialog pop up box (This is a reminder for Torch Alignment Solution (2 ppm Zn)), click **Ok**. Now, the instrument is initializing an automated torch alignment. It takes about 7 minutes to complete this step. Progress is indicated in the progress bar.

7.7.5 After torch alignment is complete, click **Close**. Click on **Sequence** tab, then followed by **List View** Icon.

7.7.6 Go to Rinse position at rack display, right click to select Go to rinse and let it rinse for approximately 5 minutes.

7.7.7 Perform Auto Peak

7.7.8 It is recommended that the Auto Peak Adjust procedure be performed daily prior to calibration. A standard that contains all of the lines of interest is used and the system automatically makes the appropriate fine adjustments. (High standard solution should be used for this process.)

7.7.9 Click **Sequence** tab, then click on **List View** Icon until the rack is displayed.

7.7.10 Go to S-5 position (you can assign any position in the rack for auto peak adjust), then right click to select **Go** to empty sample S:5. (Now, the auto sampler tip moves from the Rinse position to this position). Click on **Analysis** tab. All elements result is shown in the display area. From Instrument drop down menu, select **Perform Auto Peak**. There will be a pop up dialog box present. Highlight “All Elements,” and then click **Run**. Then there will another pop up dialog box (This is a reminder for Auto Peak Solution), click **Ok**. Now, the instrument is performing auto peak adjust. It takes about 5 minutes to complete this process. The Auto Peak dialog box will show a green check mark in front of “All Elements”, which indicates Auto Peak is complete.

7.8 Open the method and start up the run.

7.8.1 Click on **Analyst** Icon at the workspace. Go to the method and choose Open from the drop down menu. Select the method with the latest revision number.

7.8.2 Go to **Method** tab at the bottom of left hand corner to click on **Automated Output** at the workspace area. Type a filename in Filename field in the data display area (i.e. : SA101010M1, starts with SA, then followed by MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs.) Click on **Apply to All Sample Types**.

7.8.3 Click on **Sequence** tab at the bottom of left hand corner. From Auto Session drop down menu bar, click on **New Auto sampler** to create a sequence. This will pop up a dialog box, then click on **New** and fill in number of samples (i.e.: 100) in the Number of Samples field and the sample I.D. (leave this field empty) in Sample Name field. Type a sequence name (i.e. : SEQ101010M1, starts with SEQ, then MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs) in the Sequence Name field. Click Ok, then put in "0" as settle time between sequences and click **Ok**.

7.8.4 Right click on **Untitled** (Cetac ASX-520 Enviro 5 Named Rack is the rack that is currently used) at the workspace area, click on **Auto-Locate All** to locate all sample positions.

7.8.5 Double click on **Untitled** again, then click on the sequence name (i.e. : SEQ101010M1), on the data display area, type the sequence in Samplename column, dilution factor (if needed) in CorrFact column, check the box in front of Check column, and select an appropriate check table.

7.8.6 Once done with creating sequence, go to **Method** drop down menu and save all changes as **Save As**. There will be a Save a Method dialog box present, go to the save option to check on "Overwrite Method and bump revision number" box, and then click **Ok**.

7.8.7 Go to Sequence tab, click on List View Icon from tool bar, then click on Connect Autosampler to PC and Initialize Icon.

7.8.8 See table 8 for a typical run sequence.

7.9 Calibrate the instrument as outlined below. See table 3 for calibration standards concentrations. This calibration procedure is done a minimum of once every 24 hours. The calibration standards may be included in the auto sampler program or they may be run manually from the **Calibrate Instrument (graduated cylinder)** icon located on the Analyst tab. The instrument may be calibrated using a single point standard and a calibration blank or a multipoint calibration. If a multipoint calibration is used a minimum of six standards are required. All curves must be determined from a linear calibration prepared in the normal manner using the established analytical procedure for the instrument. Refer to instrument manual for further detail. Three exposures will be used with a percent relative standard deviation of less than 5 percent. The resulting correlation coefficient must be **≥0.995**. If the calibration curves do not meet these criteria, analysis must be terminated, the problem corrected, and instrument re-calibrated. Correlation coefficients, slopes, and y-intercepts for each wavelength are printed and included in each analytical data package.

7.10 Initial Calibration Verification Standard (ICV).

After each calibration, a standard from a different source than the calibration standard shall be analyzed.

7.11 After analyzing the ICV, the ICB must be analyzed.

7.12 Before analyzing any real world samples the CRIA must be analyzed.

7.13 Before analyzing any real world samples, the Mixed element SIC solution must be analyzed. The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 500 mg/l; Magnesium 500 mg/l.

7.14 After the initial analytical quality control has been analyzed, the samples and the preparation batch matrix quality control shall be analyzed. This includes the Method blank, blank spike, duplicate, matrix spike, matrix spike duplicate, serial dilution, and post digestion spike. Each sample analysis must be a minimum of 3 readings using at least a 5 second integration time. Between each sample, flush the nebulizer and the solution uptake system with a blank rinse solution for at least 60 seconds or for the required period of time to ensure that analyte memory effects are not occurring.

7.15 Analyze the continuing calibration verification solution (CCV) and the continuing calibration blank (CCB) after initial calibration, every tenth sample and at the end of the sample run.

7.16 The upper limit of quantitation may exceed the highest concentration calibration point and can be defined as the “linear range”. Sample results above the linear range shall be diluted under the linear range and reanalyzed. Following calibration, the laboratory may choose to analyze a standard (or mixed standard solution) at a higher concentration than the high standard used in the calibration curve.

7.17 After the instrument is optimized and all initial QC has been run, click on **Run Auto-Session** Icon to start the analytical run sequence.

7.17.1 If you need to add or delete samples once the run is started, follow the steps shown below.

7.17.2 Click on **Sequence** tab, then click on **List View** Icon at the tool bar. There is the sequence table shown on the display area.

7.17.3 Click on **Add Samples** Icon. This will pop up a dialog box, and then fill in number of samples that need to be added. Click **Ok**. By doing this, samples will be added to the end of the current sequence without a rack location.

7.17.4 On the Samplename column type in the sample I.D., correction factors, and check tables. **Click on Auto Locate All.**

7.17.5 The added samples will be analyzed at the end of the original sequence run order unless they are assigned a different run order.

7.17.6 Deleting Samples

7.17.7 Click on **Sequence** tab, and then click on **List View** Icon under the sequence display area.

7.17.8 Highlight all samples that need to be deleted and then click on the **Delete Samples** icon.

7.18 When the analysis is completed export the data to LIMS following the procedure outlined below.

7.18.1 Double click on **ePrint** Icon on desktop. There will be a **LEADTOOLS ePRINT** pop up box, click on **Finish Jobs** and **OK** boxes.

7.18.2 Double click the **PDF** Icon on the desktop; the PDF file will be present as Document_#. Right click on that file, select **rename** to change the filename to an assigned analytical run I.D. (i.e.: MA9000). This is the raw data file for MA9000.

7.18.3 Drop the raw data to the **LIMS Data Drop** icon located on the desktop.

7.18.4 By completing the above steps, the raw data (i.e.: MA9000) can be viewed and/or printed from the Raw Data Search function.

7.18.5 Go to **Analysis** tab, right click on sample header, and select export all samples. A pop up dialog box will come up, type in the analytical run I.D. (i.e.: SA101010M1) and click **Ok**. Go to **LIMS Export** folder located on the desktop, click on analytical run and change extension from .TXT to .ICP. Open the analytical file and make any necessary changes, such as deleting any samples that need to be re-run on dilution. **Save** the file. Drop the data file to the **LIMS Data Drop** icon located on the desktop. This will then send the export file to LIMS for review.

7.19 The data can be evaluated by running an automated data evaluation program, which will help to generate quality control summary pages. Each run must be evaluated as quickly as possible to make sure that all required quality control has been analyzed. With each data package include: cover sheet, copies of all prep sheets, autosampler run sequence, dilution sheets, and raw data. Label each folder with MA#, instrument run I.D., instrument used, and date.

7.20 At the end of the analysis day the ICP must be shutdown using the following sequence.

7.20.1 Place the auto sampler tip in the rinse cup and rinse in a mixed solution of approximately 5 percent nitric acid and 5 percent hydrochloric acid for 10 minutes and then in DI water for 20 minutes.

7.20.2 Turn off the plasma by clicking on the **Plasma** Icon and then by clicking **Plasma Off.**

7.20.3 Close all iTeva programs/windows.

7.20.4 Release the tension on the sample pump platens.

7.21.5 Turn off recirculating chiller.

8.0 QUALITY CONTROL

This section outlines the QA/QC operations necessary to satisfy the analytical requirements for method SW846 6010D. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements. Check with the area supervisor or lab manager for any non-compliant quality control for further information.

8.1 Initial Calibration Verification Standard (ICV).

After each calibration, a standard from a different source than the calibration standard shall be analyzed. For the ICV, all elements to be reported must be within 10 percent of the true value for 6010D. If the ICV is outside these criteria then the analysis must be terminated, problem corrected, and the instrument re-calibrated.

8.2 Continuing Calibration Blank/Initial Calibration Blank.

Analyze the Initial calibration blank solution at the beginning of each run and the continuing calibration blank after every tenth sample and at the end of the sample run. The ICB/CCB must be less than one half the reporting limit for each element. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit for all samples to greater than two times the background concentration.

Note: West Virginia state specific requirement for ICB/CCB - must contain analyte at <MDL

8.3 Low Standard Check (CRIA). Also referred to as LLCCV, LOQ, LLOQ

Before analyzing any real world samples, the CRIA must be analyzed. The CRIA contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning each analytical run. For all elements, the results must be within 20 percent of the true value. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits (CRIA Requirement). If the initial CRIA fails no samples associated with the failing CRIA can be reported, and the CRIA should be reanalyzed for the failing elements.

8.4 ICSA (Mixed SIC Solution) and Single Element Interference checks

Before analyzing any real world samples, the Mixed element SIC solution must be analyzed. The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 500 mg/l; Magnesium 500 mg/l.

The daily mixed element SIC solution is analyzed daily after calibration. The concentration measured for any target analytes must be less than +/- the reporting limit. For spiked elements,

the analyzed results must be within 20 percent of the true value for SIC check and within 10 percent for linear range check. If these criteria cannot be met then sample analysis may not proceed until the problem is corrected, or the reporting limit is raised to twice the concentration observed in the SIC solution. The only exceptions are those elements that have been demonstrated and documented as contaminants in the SIC solutions.

Single element interference checks – At a minimum, single element SIC checks should be performed for the following elements on initial instrument setup and every six months: Aluminum 500 mg/l; Barium 4 mg/l; Calcium 500 mg/l; Copper 4 mg/l; Iron 500 mg/l; Magnesium 500 mg/l; Manganese 4 mg/l; Molybdenum 4 mg/l; Sodium 1000 mg/l; Nickel 4 mg/l; Selenium 4 mg/l; Silicon 50 mg/l; Tin 4 mg/l; Vanadium 4 mg/l and Zn 4 mg/l.

The absolute value of the concentration observed for any unspiked analyte in the single element SIC checks must be less than 2 times the reporting limit. The concentration of the SIC checks are suggested, but become the highest reportable concentration in the sample analysis and cannot be higher than the highest established linear range. Samples with concentrations of elements higher than the SIC check must be diluted until the concentration is less than the SIC check solution. Reanalysis of a diluted sample is required even if the high concentration element is not required to be reported for the specific sample, since the function of the SIC check is to evaluate spectral interferences on other elements.

Refer to section 17.0 of this SOP for Interfering Element Correction (IEC) procedure.

8.5 Continuing Calibration Verification.

Analyze the continuing calibration verification solution after the initial calibration, after every 10^{th} sample, and at the end of the analytical run. If the CCV solution is not within 10 percent of the true value for method 6010D the CCV must be reanalyzed to confirm the initial value. If the CCV is not within criteria after reanalysis no samples can be reported in the area bracketed by the failing CCV.

8.6 Method Blank.

The laboratory must digest and analyze a method blank with each batch of samples. The method blank must contain elements at less than one half the reporting limit for each element. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit. Samples associated with the contaminated blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-digesting and reanalyzing the samples, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit to greater than two times the background concentration. All samples associated with an out of compliance method blank shall be qualified and footnoted in LIMS as well as the case narrative.

8.7 Blank Spike Sample and Blank Spike Duplicate

The laboratory must digest and analyze a spike blank sample with each batch of samples. Blank Spikes must be within 20 percent of the true value for method SW846-6010D. If the lab control is outside of the control limits for a reportable element, all samples must be re-digested and reanalyzed for that element. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results may be reported with no flag. For solid standard reference materials (SRMs) ± 20 percent accuracy may not be achievable, and the manufacturer's established acceptance criteria should be used for all soil SRMs.

Blank spike duplicates (BSD) are analyzed only when sufficient sample is not available for either a Matrix Spike Duplicate or Matrix Duplicate. The acceptance criteria for accuracy is the same as the Blank Spike. The precision acceptance criteria is ≤ 20% RPD.

Blank Spike and Blank Spike Duplicate recoveries are calculated as shown below:

$$\frac{\text{(Spike Result)}}{\text{(Amount Spiked)}} * 100 = \text{BS Recovery}$$

Duplicate relative percent difference are calculated as shown below:

$$\frac{\text{(Blank Spike Result – Blank Spike Duplicate Result)}}{\text{(Blank Spike Result + Blank Spike Duplicate Result)/2}} * 100 = \%\ \text{RPD}$$

8.8 Matrix Spike and Matrix Spike Duplicate Recovery.

The laboratory must digest and analyze a matrix spike and matrix spike duplicate with each batch of samples. The matrix spike recovery is calculated as shown below and must be within 20 percent of the true value for method SW846-6010D. If a matrix spike is out of control, then the results must be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and must be footnoted to that effect.

Note: Both the matrix spike amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\textbf{}\frac{\textbf{(Spiked Sample Result - Sample Result)}}{\textbf{Amount Spiked}}\textbf{ x 100 = matrix spike recovery}$$

8.9 Matrix Duplicate/Matrix Spike Duplicate Relative Percent Difference.

The laboratory must digest a duplicate with each batch of samples. The relative percent difference (RPD) between the duplicate and the sample must be assessed and must be ≤ 20 percent for sample results at or above the reporting limit. If the RPD is outside the 20 percent criteria the results must be qualified in LIMS. RPD's are also calculated in LIMS for sample results below the reporting limit. RPD's outside the 20 percent criteria are not

considered failing and LIMS automatically footnotes these as “RPD acceptable due to low duplicate and sample concentrations.”

Note: Both the duplicate amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

8.10 Serial Dilution Analysis and Post Digestion Spike.

One sample per preparation batch, or whenever matrix interferences are suspected for a batch of samples, a serial dilution (SDL) must be prepared. For the serial dilution, a 1:5 dilution must be made on the sample. The results of the 1:5 dilution shall agree within 20 percent of the true value as long as the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 25 times greater than the RL). If the results are outside these criteria then matrix interference should be suspected, and the proper footnote entered into LIMS. A post digestion spike (PDS) must be performed if the SDL fails. The PDS must recover within $\pm$ 25 percent for method SW846-6010D. If the PDS is outside these limits, then matrix interference must be suspected, and the proper footnote entered into LIMS.

$$\frac{\text{(Sample Result - Serial Dil. Result)}}{\text{Sample Result}} \times 100 = \text{Serial Dilution RPD}$$

8.11 Linear Calibration ranges.

The upper limit of quantitation may exceed the highest concentration calibration point and can be defined as the “linear range”. Sample results above the linear range shall be diluted under the linear range and reanalyzed. Following calibration, the laboratory may choose to analyze a standard (or mixed standard solution) at a higher concentration than the high standard used in the calibration curve. The standard must recover within 10 percent of the true value, and if successful, establishes the linear range. The linear range standards must be analyzed in the same instrument run as the calibration they are associated with but may be analyzed anywhere in the run. Samples following a sample with high concentrations of analyte (s) must be examined for possible carryover. Verification may be done by rinsing the lines with an acid solution and then reanalyzing the sample. A limit check table is built into the autosampler file so that samples exceeding the standardization range are flagged on the raw data.

8.12 Sample RSD

For samples containing levels of elements greater than five times the reporting limits, the relative standard deviation for the replicates should be less than 5%. If not, reanalyze the sample. If upon reanalysis, the RSD’s are acceptable then report the data from the reanalysis. If RSD’s are not acceptable upon reanalysis, then the results for that element should be footnoted that there are possible analytical problems and/or matrix interference indicated by a high RSD between replicates.

8.13 Interelement Spectral Interference Correction Validity

For the interelement spectral interference corrections to remain valid during sample analysis, the interferent concentration must not exceed its linear range. If the interferent concentration exceeds its linear range or its correction factor is big enough to affect the element of interest even at lower concentrations, sample dilution with reagent blank and reanalysis is required. In these circumstances, analyte dilution limits are raised by an amount equivalent to the dilution factor.

8.14 Internal Standard (Yttrium/Indium)

For any readings where the internal standard is outside of the range 60-125 percent of the internal standard level in the reference standard (Initial Calibration Blank), then the sample must be diluted until the internal standard is within range and all sample results must be footnoted in LIMS.

8.15 MSA (Method of Standard Additions)

SGS Orlando uses the internal standard technique as an alternative to the MSA per SW846-6010D section 4.4.2. However, in certain circumstances MSA may be needed by some project specific requirements. SGS Orlando may perform an MSA when sample matrix interference is confirmed through the post digestion spike process or may qualify the results in LIMS. SGS Orlando will use a single addition method as described in SW846-7000B.

8.16 Percent Relative Error

The laboratory shall use and document a measure of relative error in the calibration;

i. For calibrations evaluated using an average response, the determination of the relative standard deviation (RSD) is the measure of the relative error.

ii. For calibrations evaluated using correlation coefficient or coefficient of determination, the laboratory shall evaluate relative error by either:

a. Measurement of the Relative Error (%RE)

Relative error is calculated using the following equation:

$$\% \text{ Relative Error} = \frac{X'_i - X_i}{X_i} \times 100$$

X_i = True value for the calibration standard
X'_i = Measured concentration of the calibration standard

This calculation shall be performed for two calibration levels: the standard at or near the mid-point of the initial calibration and the standard at the lowest level.

The Relative Error at both of these levels shall meet the criteria specified in the method. If no criteria for the lowest calibration standard is specified in the method, the criteria, and the procedure for deriving the criteria shall be specified in the SOP.

SGS Orlando has established the % Relative Error as follows:

LLCCV must be within 20%.

MidPoint must be within 10%.

If these criteria cannot be met then rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.

9.0 GLASSWARE CLEANING

All glassware must be washed with soap and tap water and then rinsed with 5 percent nitric acid. It must then be rinsed at least 3 times with DI water. Refer to SOP GN196, current revision for further information regarding glassware cleaning.

10.0 DOCUMENTATION REQUIREMENTS

Refer to the Laboratory Quality Assurance Manual for documentation requirements. All raw data is printed to PDF format and archived to a backup server for long term storage.

11.0 HEALTH AND SAFETY

11.1 The analyst should follow normal safety procedures as outlined in the SGS Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedure), current revision. which includes the use of safety glasses and lab coats. Gloves should be worn. In addition, all acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

11.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of chemicals specified in this method. Safety Data Sheets (SDS) are available for all reagents and solvents used in the lab. Technicians should review the SDS prior to using any new reagents or solvents.

12.0 CALCULATIONS

For water samples, the following calculations must be used. Refer to the QC section for the calculations to be used for the QC samples.

Original sample concentration of metal (ug/l) =

$$\frac{\text{(conc. in the digestate (ug/l))} \times \text{(final digestate volume (ml))}}{\text{(initial sample volume (ml))}}$$

For soil samples, the following calculations must be used.

Concentration of the metal in the dry sample (mg/kg) =

$$\frac{\text{(conc. in the digestate (mg/l)} \times \text{final digestate volume(L))}}{\text{(sample wt. (kg))} \times \text{(\% solids/100)}}$$

13.0 INSTRUMENT MAINTENANCE

Recommended periodic maintenance includes the items outlined below. All maintenance must be recorded in the instrument maintenance log.

13.1 Change the pump tubing as needed.

13.2 Clean the filter on the recirculating pump approximately once a month and dust off the power supply vents as needed.

13.3 Clean or replace the nebulizer, torch assembly, and injector tube as needed.

13.4 Change the sampler tip as needed.

13.5 Clean the recirculating pump lines and internal sock filter every 3 months or as needed.

13.6 Clean the radial view quartz surface weekly or more often if needed.

14.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

14.1 Pollution Prevention

Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids must be followed. All

method users must be familiar with the waste management practices described in Section 14.2.

14.2 Waste Management

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

15.0 GENERIC DEFINITIONS

15.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or 24 hours whichever comes first.

15.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

15.3 Blank Spike Duplicate (BSD): A replicate blank spike, spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The blank spike duplicate recoveries are used to document precision. This may also be called a Laboratory Control Sample Duplicate (LCSD). Blank Spike duplicates are only required when sufficient sample is not available for a matrix spike/matrix spike duplicate.

15.4 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. A CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

15.5 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

15.6 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point must be at a level equal to or below the reporting level.

15.7 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor must be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

15.8 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the performance of a method in a given sample matrix.

15.9 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the precision and performance of a method in a given sample matrix.

15.10 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

15.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample

15.12 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

16.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Statistical control limits are stored in the LIMS for QA purposes only. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

17.0 GENERATION OF INTERFERING ELEMENT CORRECTION FACTORS

17.1 It is recommended that all IEC's be verified and updated approximately every 6 months or whenever instrument conditions change significantly. It is also recommended that elements with frequent high concentrations or with large IEC's should be checked more frequently.

17.2 Calculate the IEC correction factors and enter them into the method (refer to Thermo 6500 instrument manual). Calculate the correction factor using the equation shown below. This correction factor must be added to the correction factor already in place in the method for a given element.

$$\text{IEC} = \frac{\text{Concentration Result of the element with the interference}}{\text{Concentration result of the interfering element}}$$

17.3 Verify the new correction factors by reanalyzing the ICSA/ICSAB solutions and/or the SIC solutions or by reloading and recalculating the previously stored results. If the reanalysis is not within QC limits, make additional changes to the IEC factors and then re-verify both the individual and combined solution values.

17.4 Save and update the method.

17.5 Interfering element correction factors are saved as raw data along with the run printouts on a daily basis so that the IEC's for a given run are traceable.

QC Criteria Summary

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration: r = coefficient of correlation	Daily	≥0.995	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument, or document why the data are acceptable.
Percent Relative Error (%RE)	Each initial calibration	80 – 120 % of the lowest cal. standard's true value. 90-110% of the calibration standard at or near the mid-point's true value	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.
Initial Calibration Verification standard (ICV)	One per calibration	90 – 110% of the standard's true value	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable.
Continuing Calibration Verification standard (CCV)	After initial calibration, every tenth sample, and at end.	90 - 110% of the standard's true value	Rerun standard, and/or recalibrate instrument and reanalyze all samples run since the last acceptable CCV, or document why the data are acceptable.
Blanks (MB)(ICB)(CCB)	(MB) One per batch (ICB) After initial calibration (CCB) After initial calibration, every 10th sample, and at the end.	< ½RL; West Virginia projects ICB/CCBs evaluated to <MDL DoD projects Abs value < ½ RL	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.
Blank Spike (BS or LCS)	One per batch	80-120% For DoD, assess against DoD criteria.	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable.

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Blank Spike/Blank Spike Duplicate (BS/BSD or LCS/LCSD)	One per batch only when sufficient sample is not available for MS/MSD/DUP	80-120% For DoD, assess against DoD criteria.	Determine and correct the problem, reanalyze samples and BS/BSD, or document why data are acceptable.
Sample RSD MS/MSD/DUP	NA 5% of matrix	Elements >5x RL, RSD<5% 80-120%, %RPD ≤20%	Reanalyze sample, or document why the data are acceptable. If the results are outside these criteria then matrix interference should be suspected, and the proper footnote entered into LIMS. For DoD, assess against DoD criteria.
Linear Calibration Range (LCR)	Highest calibration standard or LCR analyzed within daily run.	± 10% of the standard's true value	See section 8.11 for more detail
Low level CCV (CRIA)	One per calibration	80-120% of the standard's true value.	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable.
Mixed Interference Solution (SIC)	One per calibration	Concentration measured for any target analyte must be < RL. For spiked elements, results must be within 20% of standard's true value. DoD/DoE requirement: ICSA recoveries must be within the absolute value of 1/2LOQ for non-spiked analytes	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable.

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Serial Dilution (SDL)	One per batch	The results of the 1:5 dilution shall agree within 20 percent of the true value as long as the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 25 times greater than the RL).	If the results are outside these criteria then matrix interference should be suspected, and the proper footnote entered into LIMS.
Internal Standard	All samples and standards	60-125% referenced against ICB	Dilute sample until internal standard are within range. Footnote data accordingly in LIMS.
Post Digestion Spike	One per batch	80-120%	Add appropriate flag in LIMS

Table 1: Reporting Limit By Element

Analyte	Water Reporting Limit(LLOQ) (ug/L)	Soil Reporting Limit(LLOQ)(mg/kg)	TCLP Reporting Limit(LLOQ) (mg/L)/MCL
Tin	50	5	
Aluminum	200	20	
Antimony	5	1	
Arsenic	10	0.5	0.10 / 5.0
Barium	200	20	10 / 100
Beryllium	4	0.5	
Cadmium	5	0.4	0.05 / 1.0
Calcium	1000	500	
Chromium	10	1	0.10 / 5.0
Cobalt	50	5	
Copper	25	2.5	
Iron	300	10	
Lead	5	1	0.5 / 5.0
Magnesium	5000	500	
Manganese	15	1.5	
Nickel	40	4.0	
Potassium	5000	500	
Selenium	10	1	0.5 / 1.0
Silicon	10	N/A	
Silver	10	1	0.10 / 5.0
Sodium	5000	500	
Thallium	10	1	
Vanadium	50	5	
Zinc	20	2	
Molybdenum	50	2.5	
Strontium	10	0.5	
Titanium	10	0.5	

Table 2: Thermo 6500 Analysis Lines

Element	Wavelength
Al	396.1
As	189.042
Ca	317.933
Fe	259.9
Mg	279.078
Mn	257.610
Pb	220.353
Se	196.026
Tl	190.864
V	292.402
Ag	328.068
Ba	455.4
Be	313.042
Cd	226.502
Co	228.616
Cr	267.716
Cu	324.753
K	766.491
Na	589.5
Ni	231.604
Sb	206.838
Si	412
Zn	206.2
Mo	202.030
Sn	189.900
Sr	407.7
Ti	334.9

Table 3: Calibration Levels

Element	CRIA	LowA	Low	LowMid	Mid	High
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Al	200	5000	10000	20000	40000	80000
As	10	250	500	1000	2000	4000
Ca	1000	5000	10000	20000	40000	80000
Fe	300	5000	10000	20000	40000	80000
Mg	5000	5000	10000	20000	40000	80000
Mn	15	250	500	1000	2000	4000
Pb	5	250	500	1000	2000	4000
Se	10	250	500	1000	2000	4000
Tl	10	250	500	1000	2000	4000
V	50	250	500	1000	2000	4000
Ag	10	31.2	62.5	125	250	500
Ba	200	250	500	1000	2000	4000
Be	4	250	500	1000	2000	4000
Cd	5	250	500	1000	2000	4000
Co	50	250	500	1000	2000	4000
Cr	10	250	500	1000	2000	4000
Cu	25	250	500	1000	2000	4000
K	5000	5000	10000	20000	40000	80000
Na	5000	5000	10000	20000	40000	80000
Ni	40	250	500	1000	2000	4000
Sb	5	250	500	1000	2000	4000
Zn	20	250	500	1000	2000	4000
Mo	50	250	500	1000	2000	4000
Si	10	250	500	1000	2000	4000
Sn	50	250	500	1000	2000	4000
Sr	10	250	500	1000	2000	4000
Ti	10	250	500	1000	2000	4000

Table 4: ICV Standard Levels

Element	Concentration
	ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Si	2000
Sn	2000
Sr	2000
Ti	2000

Table 5: CCV Standard Levels

Element	Concentration
	ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Si	2000
Sn	2000
Sr	2000
Ti	2000

Table 6: CRIA Standard Levels

Element	CRIA
	ug/l
Al	200
As	10
Ca	1000
Fe	300
Mg	5000
Mn	15
Pb	5
Se	5
Tl	10
V	50
Ag	10
Ba	200
Be	5
Cd	5
Co	50
Cr	10
Cu	25
K	5000
Na	5000
Ni	40
Sb	5
Zn	20
Mo	50
Si	10
Sn	50
Sr	10
Ti	10

Table 7: Blank Spike, Matrix Spike, and Matrix Spike Duplicate Levels

Element	Concentration
	ug/l
Al	27000
As	2000
Ca	25000
Fe	26000
Mg	25000
Mn	500
Pb	500
Se	2000
Tl	2000
V	500
Ag	50
Ba	2000
Be	50
Cd	50
Co	500
Cr	200
Cu	250
K	25000
Na	25000
Ni	500
Sb	500
Zn	500
Mo	500
Si	2000
Sn	500
Sr	500
Ti	500

Table 8: Typical Run Sequence

Blank
Cria/RL
LowA
Low
LowMid
Mid
High
HIGH STD Readback
ICV
ICB
CRIA
ICSA
ICSAB
CCV
CCB
MB
SB
SAMPLE1
DUPLICATE
SERIAL DILUTION
MATRIX SPIKE
MATRIX SPIKE DUPLICATE
POST DIGESTION SPIKE
SAMPLE2
SAMPLE3
CCV
CCB
SAMPLE4
SAMPLE5
SAMPLE6
SAMPLE7
SAMPLE8
SAMPLE9
SAMPLE10
SAMPLE11
SAMPLE12
SAMPLE13
CCV
CCB

Table 9: ICSA (Mixed SIC) Solution Levels

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	500
Mg	500
Mn	0
Pb	0
Se	0
Tl	0
V	0
Ag	0
Ba	0
Be	0
Cd	0
Co	0
Cr	0
Cu	0
K	0
Na	0
Ni	0
Sb	0
Zn	0
Mo	0
Si	0
Sn	0
Sr	0
Ti	0

Table 10: ICSAB Solution Levels

Element	Concentration
	mg/l
Al	500
As	1.0
Ca	500
Fe	200
Mg	500
Mn	0.5
Pb	1.0
Se	1.0
Tl	1.0
V	0.5
Ag	1.0
Ba	0.5
Be	0.5
Cd	1.0
Co	0.5
Cr	0.5
Cu	0.5
K	0
Na	0
Ni	1.0
Sb	1.0
Zn	1.0
Mo	1.0
Si	1.0
Sn	1.0
Sr	1.0
Ti	1.0

Table 11: Single Element Interference Check Solution Levels

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	500
Mg	500
Mn	4
Pb	0
Se	4
Tl	0
V	4
Ag	0
Ba	4
Be	0
Cd	0
Co	0
Cr	0
Cu	4
K	0
Na	1000
Ni	4
Sb	0
Zn	4
Mo	4
Sn	4
Si	50
Sr	0
Ti	0

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
12/2020	05	"Revised Sections"	Added Revision History and removed Revised Sections.
4/5/2022	06	1.1	Added elements
4/5/2022	06	1.5	Updated MDL procedure
4/5/2022	06	5.8	Updated software version
4/5/2022	06	6.0	Updated calibration curve information
4/5/2022	06	6.1	Added reagent water
4/5/2022	06	Table 3	Updated to include additional calibration standards
4/5/2022	06	7.12	Removed reference to CRIA at end
4/5/2022	06	8.3	Removed reference to CRIA at end
4/5/2022	06	8.16	Created % RE section
4/5/2022	06	References	Added TNI 2016 and DoD QSM 5 series to references
4/5/2022	06	Control Document Cover	Added "Digital"
4/5/2022	06	General	Added SOP acknowledgement Form
4/5/2022	06	Table 8	Revised to include additional calibration standards
4/5/2022	06	General	Added QC Criteria table
4/5/2022	06	6 and 7	Remove QC criteria references. See section 8 and QC Summary for QC criteria.
4/5/2022	06	6	Formatting

Revision Date	Revision Number	Affected Section(s)	Revision Description
4/5/2022	06	7	7.14 Added matrix quality control standards, removed section 7.16
4/52022	6	8.4	Added in single element interference check criteria
4/5/2022	6	11	Updated health and safety
4/5/2022	6	6.5	Added acid matrix concentration
8/2024	7	Entire Document	Updated QSM 5 series to QSM 5.4
8/2024	7	Appendix of Significant Changes	Changed Revision History name to Appendix of Significant Changes
3/2025	8	References	Added WV 47CSR32
3/2025	8	8.2 and QC Criteria table	ICB/CCB are to be assessed to <MDL for West Virginia projects.
8/2025	9	QC criteria table	Clarified DoD/DoE requirements for ICSA/ICSB recoveries
9/2025	10	Entire document	Changes QSM 5.4 to QSM 6.0
9/2025	10	QC summary	Added DoD blank criteria
9/2025	10	QC summary	Added PDS criteria
9/2025	10	8.7	Added BSD criteria
9/2025	10	15.3	Added BSD definition
9/2025	10	QC Summary	Added BSD QC criteria
4/2026	11	References and Entire Document	Changed DoD to DoD/DoE
4/2026	11	Instrument	Remover Thermo 6500 SSTRACE 2 and its autosampler
4/2026	11	1.1 and Table 1	Corrected Silica to Silicon

Revision Date	Revision Number	Affected Section(s)	Revision Description
4/2026	11	Table 10	Added table 10, renamed existing 10 into 11
4/2026	11	Tables 2,3,4,5,6,7,9,10, 11	Added Silicon as Si to the concentration tables

METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: QA006, QA017, QA020, QA033, QA037, QA051, SAM101, and SAM108, current revisions.

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

Prepared by: Jordynn Rice Date: 08/27/2025

Approved by: Elizabeth Kent Date: 09/06/2025

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

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DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

REFERENCES:

EPA 300.0, Revision 2.1, 1993
SW846 9056A, Revision 1, 2007
DoD QSM 6.0

1.0 SCOPE AND APPLICATION

1.1 This method is for the measurement of anions such as bromide, chloride, fluoride, nitrate, nitrite, and sulfate by ion chromatography. The method is applicable to potable and non-potable water, solids after extractions, and neutral leachates.

2.0 SUMMARY OF METHOD

2.1 This method addresses the sequential determination of the anions: fluoride, chloride, nitrite-N, bromide, nitrate-N, and sulfate found in aqueous and solid samples. A small volume of aqueous sample is injected into an ion chromatograph to flush and fill a constant-volume sample loop. The sample is then injected into a flowing stream of carbonate-bicarbonate eluent. The sample is pumped through two different ion exchange columns, then a conductivity suppressor device, and into a conductivity detector. The two ion exchange columns, a precolumn or guard column and a separator column, are packed with an anion exchange resin. Ions are separated into discrete bands based on their affinity for the exchange sites of the resin. The suppressor is an ion exchange-based device that reduces the background conductivity of the eluent to a low or negligible level and simultaneously converts the anions in the sample to their more conductive acid forms. The separated anions in their acid forms are measured using an electrical conductivity cell. Anion identification is based on the comparison of analyte signal peak retention times relative to those of known standards. Quantitation is accomplished by measuring the peak area and comparing it to a calibration curve generated from known standards.

3.0 REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 Reporting Limit. The reporting limits for this method are supported by the lowest concentration of standards in the initial calibration. Detected concentrations below this concentration are not reported unless MDL reporting is being done. Reporting limits were set as follows:

Analyte	Reporting Limit
Fluoride	0.10 mg/L
Chloride	2.00 mg/L
Nitrite-N	0.10 mg/L

Analyte	Reporting Limit
Bromide	0.50 mg/L
Nitrate-N	0.10 mg/L
Sulfate	2.00 mg/L

3.2 Method Detection Limit. Determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B, Rev. 2, 2016. This value represents the lowest reportable concentration of an individual compound that meets the method qualitative identification criteria. Refer to SOP QA020, current revision, for further details.

4.0 DEFINITIONS

4.1 **Batch:** A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or samples loaded on an instrument within the same 12-hour shift, whichever comes first.

4.2 **Blank Spike (BS):** An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 **Continuing Calibration Verification (CCV):** A check standard used to verify instrument calibration throughout an analytical run. CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

4.4 **Holding Time:** The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.5 **Initial Calibration (ICAL):** A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the reporting level.

4.6 **Initial Calibration Verification (ICV):** A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.7 **Linear Calibration Range (LCR):** The calibration range over which the instrument response is linear.

4.8 **Matrix Spike (MS):** A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.9 **Matrix Spike Duplicate (MSD):** A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.10 **Method Blank (MB):** An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.11 **Method Detection Limits (MDLs):** MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is distinguishable from method blank results. Refer to SOP QA020, current revision.

4.12 **Preservation:** Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

4.13 **Reagent Blank:** The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. For methods requiring no preparation step, the reagent blank is equivalent to the method blank.

4.14 **Reagent Grade:** Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents, which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.15 **Reagent Water:** Water that has been generated by any process, which shall meet method-specified requirements.

4.16 **Reference Material:** A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

4.17 **Sample Duplicate (DUP):** A replicate sample which is used to document the precision of a method in a given sample matrix.

5.0 HEALTH & SAFETY

5.1 The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedures), current revision. Safety glasses, a lab coat, and appropriate gloves should be worn at when handling samples.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. Safety Data Sheets (SDS) are available for all standards and reagents.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIME

6.1 Samples must be cooled to a temperature above the freezing point of water to 6°C at the time of collection.

6.2 Bromide, Chloride, Fluoride, and Sulfate must all be analyzed within 28 days. Nitrite and Nitrate must be analyzed within 48 hours for aqueous samples. For solids, the same hold time applies, after the samples are prepared (see section 10.1.)

Note: State of West Virginia requires 48 hours from collection to completion for NO2/NO3, regardless of matrix.

7.0 APPARATUS AND MATERIALS

7.1 Ion Chromatograph with a guard column, an analytical column, a suppressor column, and a conductivity detector. This SOP is written for the use with the Metrohm 930 Compact IC Flex and associated 858 Autosampler. System is equipped with an Ultrafiltration cell that filters all samples to 0.20 µm. The eluent used is dependent upon column selection and should be based off the supporting literature. Any augmentation/changes made to the suggested eluent should be properly recorded in the solution prep log, and Section 8 of this document updated accordingly. The columns used are listed below. Alternate columns may be used if all method requirements can be met.

Maintenance and troubleshooting procedures are described in detail in Metrohm Operation Manual. Most basic procedures include checking connections for leaks, cleaning and/or replacing tubing, monitoring, and recording the pressure. See Sec.12.0.

7.1.1 Suppressors, Primary suppression is accomplished by use of the Metrohm MSM Chemical Suppression Module, and CO2 suppression is accomplished by use of the Metrohm MCS module.

7.1.2 Guard Column, Metrosep A Supp 4/5 Guard (or equivalent). Metrohm PN 61006500.

7.1.3 Analytical Column, Metrosep A Supp 5-150 (or equivalent). Metrohm PN 61006520.

7.1.4 Data System, MagIC Net version 3.2 on IC4 and version 4.2 on IC6. Data system's revisions will be updated during annual SOP revisions. Data system changes prior to the date of revision are to be recorded in Maintenance log.

7.2 Top loading balance, capable of weighing to 0.01g. Calibrated and serviced annually by outside vendor and verified daily with Class 1 weights. Refer to SOP QA005, current revision.

7.3 Analytical balance capable of accurately weighing to the nearest 0.0001 g. The balance calibration must be verified each day before use with Class 1 certified weights. At a minimum the balance undergoes annual maintenance and recertification by qualified outside contractor, or whenever performance becomes suspect. Refer to SOP QA005, current revision.

7.4 Centrifuge Centra CL2, or equivalent

7.5 Class 1 weights

7.6 Volumetric glassware, Class A. Alternately, 50mL digestion tubes may be used to prepare solutions in smaller volumes provided these tubes are certified Class A equivalent.

7.7 IC vials and caps (Metrohm PN SNG-IC31000)

7.8 Volumetric pipettes, Class A or auto pipettors. Note: If auto-pipettes are used, make sure that the calibration is checked before use as specified in SOP QA006, current revision.

7.9 Nylon 0.45µm membrane filters or equivalent.

7.10 Disposable syringes, for sample filtering of soil extracts and extremely solid-laden aqueous samples. Pre-filtration is not necessary for most samples. The IC system has inline filtration of all samples to 0.20 µm.

7.11 Ultrafiltration membrane-Nylon 0.20 µm/47mm. (Metrohm PN 62714020), or equivalent.

7.12 Conductivity meter to pre-determine dilutions for possible interferences. This screening step may be omitted if sample history is known, and or sample matrix appears to be relatively clean. The system will auto-dilute any over range samples, so pre-screening is not critical unless samples are suspected to be of an extreme nature (i.e.: brines, plating baths, etc.). If needed, samples can be pre-diluted prior to going on the instrument provided that manual dilution is recorded properly in the software to ensure correct sample concentration is reported. See Attachment B.

8.0 REAGENTS AND STANDARDS

All chemicals should be made from ACS grade reagents/standards unless otherwise noted. Deionized water must be used whenever water is required. Commercially purchased reagent and standards must be accompanied by Certificate of Analysis (CoA). CoA is examined for accuracy and completeness of the information, including verification of the reagent/standard concentration and expiration date. For further details on reagent/standard traceability refer to SOP QA017, current revision.

8.1 Individual Parent Stock Solutions: It is suggested that 1000mg/L individual anion standards be purchased commercially for Fluoride, Chloride, Nitrite (as N), Bromide, Nitrate (as N), and Sulfate. If needed, prepared stocks can be made using the appropriate amount of a respective ACS grade salt. Reference the available methods/literature for proper amounts. Note that two sources are required for each anion standard. 1st Source is used for calibration, a 2nd Source for initial calibration verification.

8.2 Combined Anion Working Stock Calibration Solution: 1st Source. A single Combined Anion Working Calibration Stock solution is used for the calibration of the instrument. The Combined Anion Working Stock is the same concentration as Standard 10 for the calibration curve. This standard can be made of commercially available individual parent anion standards, or solutions prepared from salts (Section 8.1). Prepare fresh for each calibration.

Appropriate expiration dates must be applied to all standards and reagents. Concentrated solutions from salts greater than 100mg/L may be kept for 1 month, while working solutions (i.e.: CCV and BS) should be prepared fresh daily for solutions containing NO2 and NO3. Prepare as indicated below.

To prepare 50mL of Combined Anion Working Stock Calibration

Analyte	Final Concentration	Vol. of 1000 mg/L Parent Stock for 50 ml	Concentration of Parent Stock
Fluoride	10 mg/L	0.50 ml	1000 mg/l
Chloride	100 mg/L	5.0 ml	1000 mg/l
Nitrite-N	10 mg/L	5.0 ml	100 mg/l
Bromide	20 mg/L	1.00 ml	1000 mg/l
Nitrate-N	10 mg/L	5.0 ml	100 mg/l
Sulfate	100 mg/L	5.0 ml	1000 mg/l

8.2.1 The Combined Anion Working Stock Calibration Standard (8.2) is loaded directly onto the instrument for calibration. Per the selected method, the instrument software will prepare the calibration curve by diluting the Working Stock solution (up to 100x). The suggested final concentrations and their corresponding dilutions for the method are listed in the table below, but alternate ranges can be used to meet various reporting requirements. **Standard 100 is the Calibration Blank and consists of DI Water.**

Standard ID	Std 100	Std 1	Std 2	Std 3	Std 4	Std 5	Std 6	Std 7	Std 8	Std 9	Std 10
Dilution Factor	1	100	50	40	20	10	5	2.5	2	1.25	1
Concentration mg/L											
Fluoride	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Chloride	0.0	1.0	2.0	2.5	5.0	10	20	40	50	80	100
Nitrite-N	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Bromide	0.0	0.20	0.40	0.50	1.0	2.0	4.0	8.0	10	16	20
Nitrate-N	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Sulfate	0.0	1.0	2.0	2.5	5.0	10	20	40	50	80	100

**Note that all calibration points may not be used for the final working calibration. The number of points used are based on the curve fit used and the corresponding method requirements. It is suggested that a minimum of six points with a quadratic curve fit and 1/x weighting be applied when possible. Use of this calibration model is dependent upon regulatory guidance from the state where the sample is collected. Note that PA, SC, and WV do not allow for Quadratic curve fit. All other states allow for this curve fit per 40 CFR Part 136, section 136.6 b.4.x.A which specifically calls out EPA 300.0 as a method in which the curve fit is one of a non-linear response.

8.3 Continuing Calibration Verification (CCV) 1st Source. Continuing Calibration Verification is prepared from the Individual Parent Stock solutions (8.1). Suggested concentrations are as follows:

CCV	
Anion	**mg/L**
Fluoride	2.5
Chloride	50
Nitrite-N	2.5
Bromide	10
Nitrate-N	2.5
Sulfate	50

8.4 Initial Calibration Verification (ICV) and Blank Spike (BSP, LCS) 2nd Source. The ICV can be made at the same concentrations that the CCV is but MUST be from a different source than the CCV. It must be within the range of the curve. Alternatively, it can be purchased from an outside supplier.

8.4.1 The ICV and the Blank Spike can also be purchased as a combined anion mix. The concentrations for the combined anion mix is shown below. To make the ICV and Blank Spike, add 1.25ml of the combined anion mix to a 50ml Class A volumetric flask, and bring up to volume with DI water (The combined anion mix is purchased commercially through Absolute Standards, cat. 50202).

Combined Anion Mix	
Anion	**mg/L**
Fluoride	100
Chloride	2000
Nitrite-N	100
Bromide	400
Nitrate-N	100
Sulfate	2000

8.5 Stock Eluent (100x Concentration-320mM Na2CO3, 100mM NaHCO3): In a 1000mL Class A flask, add approximately 300mL of DI water. Using oven dried reagent, dried at 105˚C, (temperature should not exceed 110 ºC) weigh 33.916 +/- 0.0005 g of Na2CO3 and 8.401+/- 0.0005 g of NaHCO3, and add to flask. Bring this solution to volume. Store tightly closed to eliminate CO2 adsorption. Stable for at least 1 month at room temperature, and up to 6 months if refrigerated.

8.6 Working Eluent Solution (3.2mM Na2CO3, 1.0mM NaHCO3): Dilute Stock Eluent –Sec. 8.5 using 20mL of stock in a 2000mL Class A flask and bring up to volume with DI water. This solution is stable for several weeks if proper care is given to avoid CO2 absorption.

8.7 Suppressor Regenerant Solution-500mM H_2SO_4: Pipet 28 mL of concentrated H_2SO_4 into 100 mL DI and dilute to final volume of 1000mL with DI. Solution can be augmented with up to 100mM Oxalic Acid (12.607g/L Oxalic Acid Dihydrate) if analyzing samples suspected to be high in heavy metals. This solution is stable for 6 months.

9.0 INTERFERENCES

9.1 Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. This interference is especially important at low concentrations.

9.2 The acetate anion elutes early during the chromatographic run and can cause elution times of other anions to vary when large amounts of acetate are present. High levels of acetate also can cause interference with the fluoride peak. Therefore, this method is not recommended for leachates containing acetic acid.

Large amounts of an anion can interfere with the peak resolution of an adjacent anion. High concentrations of an anion can also cause the peak to be misidentified on the chromatograph due to the large width of the peak. Sample dilution and fortification can be used to correct most interference problems connected with peak resolution.

10.0 SAMPLE PREPARATION PROCEDURE

10.1 For soil samples, follow the preparation outlined below.

10.1.1 Mix the sample well and remove any artifacts as discussed in SOP QA034, current revision. Weigh approximately 5g of sample and add 50mL of DI water. Record the weight to the nearest 0.01g on preparation log.

10.1.2 For matrix spikes, make sure to spike the aliquot of the sample directly and then add the volume of DI water needed to make the volume of liquid being added to the soil sample equal to 50 mL including the volume of the spike solutions. In most cases this will be 48.75 mL of DI.

10.1.3 Prepare blank QC (Method Blank and Blank Spike) using a clean solid matrix, using approximately 5g aliquot and 50mL of DI water. Record the weight to nearest 0.01g.

10.1.4 Check with the lab supervisor if there is insufficient sample to use a 5g aliquot. Smaller aliquots may be used if a homogeneous portion of the sample can be obtained. The sample must always be extracted with 10 times the sample weight of DI water.

10.1.5 Mix the samples and QC for 10 minutes on the wrist action shaker.

10.1.6 Centrifuge samples and QC for 10 minutes at 2000 RPM. Decant supernatant of centrifugation procedure directly into sample tube if clear of suspended material. Samples still containing suspended matter or turbidity may be further filtered using 0.45µm syringe filters.

For aqueous samples containing large amounts of particulate matter, or extreme turbidity, pre-filter samples through 0.45µm filters pouring into sample vials. Matrix spikes must be spiked before filtration. Pre-filter method blanks and blank spikes to act as QC check of the filters, only if there are samples in the batch that have been filtered. Record which samples have been filtered and the lot number of the filters in the run log. An unfiltered Method Blank and unfiltered Blank Spike are required for every batch of samples.

11.0 ION CHROMATOGRAPHY ANALYSIS PROCEDURE

11.1 A general knowledge of MagIC Net software is needed for effective operation of the instrument. This document assumes the operator has had training on the software and has a general understanding of instrumental analysis and concepts as they relate to ion chromatography (separation theory, linear regression, calibration principles, etc.).

11.2 Instrument Calibration

11.2.1 It is recommended that a new calibration be run a minimum of once per month. (It is required that a calibration be run once per quarter). Calibrations standards may be varied from the one stated in this SOP depending on the levels of each anion that are to be reported. A minimum of 5 standards and a blank are required and a low standard must be at or below the reporting limit for each anion. A correlation coefficient of 0.995 or greater is required. Percent relative error for the mid-level and lowest calibration standards must be within laboratory-derived limits (See Table 1). If the correlation coefficient or the percent relative error criteria are not met, then the instrument must be recalibrated prior to the analysis of samples. Force to Origin (aka Force to Zero) is not permitted.

11.2.1.1 Using weighed regression 1/concentration is also acceptable. Same correlation coefficient of 0.995 or better is required for this calibration model. *For greater details refer to SOP QA042, current revision (see also section 8.2.1 for additional information regarding acceptable calibration models).*

11.2.2 The IC is calibrated using external standard quantitation.

11.2.3 Establish ion chromatographic operating parameters per instrument manufacturers suggestion.

11.2.4 Establish the linear calibration range semi-annually. This is done by examining a calibration curve made with standards below and above the expected range. Determine at what concentrations the calibration is no longer linear.

11.2.5 Load the calibration standards via the autosampler. All calibration standards must be scheduled as sample type “Standard”.

11.2.6 The results are used to prepare a calibration curve for each analyte.

11.2.7 Immediately following calibration, a low-level standard at the reporting limit must be analyzed. This low check must have the levels in standard 1 or at the reporting limit for the calibration outlined in this SOP and recoveries must be in the range of 60–140%. On a daily basis, it is recommended that a mid-level 2nd Source check standard (ICV) be analyzed prior to analysis of client samples. Recoveries must be within the range of 90-110% (At a minimum, this check (ICV) must be analyzed immediately following each new calibration). Continuing calibration checks (CCV) and continuing calibration blanks (CCB) must be ran every 10 samples as well to provide bracketing QC for all reportable samples. The continuing calibration checks must have recoveries in the range of 90-110%. Refer to the quality control section of this SOP for more detail on these quality

control samples.

11.2.8 After the run is completed, review all of the chromatograms and check for overlapping peaks, dilutions, etc.

11.2.9 If one or more calibration levels are responsible for the calibration curve *not* being linear, the offending level can be dropped if, and only if, the offender is the highest level or lowest level of calibration.

11.2.10 If linearity still cannot be achieved, new standards must be prepared and/or instrument operation must be examined.

11.2.11 Verify the working calibration curve on each working day by running a CCV standard before any samples. The calibration must also be verified whenever the eluent strength is changed.

11.2.12 If the retention time of any anion in the ICV or CCV check standards has shifted more than 10% from the original calibration curve retention time, then no results can be reported for that anion. The column should be reconditioned, if necessary, and the instrument recalibrated before any more samples are reported for that anion. Affected samples are reanalyzed after the problem has been corrected.

11.2.13 If a sample peak has shifted significantly from the original retention time (and the ICV and CCV check standards are within the 10% retention time window), then verify the reported result using a spike on that sample. Do not report results from peaks where the retention time has shifted more than 10 percent unless the peak can be verified using a known spike.

11.2.14 For large or overlapping peaks, make dilutions. If at all possible, make dilutions and reruns on the same run as the original sample.

11.2.15 Refer to section 14.7 for information on how to determine the appropriate retention time window.

11.3 Samples may be scheduled using the Determination Series found in the Workplace of the software. Special attention need be given to ensure proper sample table setup when using advanced techniques such as Metrohm in-Vial Dilution Technique (MiVDT). With advanced methods, the various information fields found in the Sample Table drive the logic of the method. It is very important to adhere to the guidance indicated in Attachment A: Sample Table Control Guideline to ensure proper scheduling.

11.4 Review all data and update the appropriate tests in the LIMS system. A write-up including a run log, a calibration summary, batch quality control summary, and copies of all chromatograms should be turned into the area supervisor for each batch.

11.4.1 If edits are needed in the calibration after the data has been calculated, the run can be reprocessed using the batch function in the software. Refer to the instrument manuals or on-screen help for addition information.

12.0 INSTRUMENT MAINTENANCE

12.1 If system pressure increases from nominal values, the suppressor may need to be cleaned. Refer to Metrohm document number 8.110.8010 for cleaning instructions.

12.2 The in-line sample filters on the 930 Compact IC Flex need to be changed on a regular basis (Quarterly) or as needed.

12.3 The ultrafiltration membrane should be replaced once a week, more often if running samples high in sediment.

12.4 Guard and analytical columns should be changed as dictated by instrument response and standard recoveries. An increase in nominal system pressure can be an indication of fouling from either the columns or the inline filters.

12.5 The instrument must be recalibrated whenever new guard or analytical columns are installed.

12.6 Samples high in metal concentration (especially aluminum and iron) can coat the MSM resin and affect both the baseline and the peak response.

12.7 A series of three 200 mM oxalic acid “samples”, followed by three blanks, may be ran at the end of a batch to cleanse the entire system of metal contamination. If problems persist with suppressor, refer to section 12.1.

12.8 Augmenting the suppressor regenerant solution (8.7) to a total concentration of 1000 mM H_2SO_4 and 1-200 mM oxalic acid will prevent MSM contamination when running samples high in metal concentration.

12.9 Only ethanol may be used to clean the ultrafiltration membrane housing.

12.10 30% hydrogen peroxide may be used to clean out the buffer coils if they show microbial growth. Make sure the buffer coils are disconnected from the instrument when flushing them as hydrogen peroxide can damage the guard and the column.

12.11 All maintenance performed on the instrument must be recorded in the maintenance logbook.

13.0 METHOD PERFORMANCE

Method performance (accuracy and precision) is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

Filtered method blanks and blank spikes to act as QC check of the filters. Unfiltered method blanks and blank spikes are used to monitor overall method performance.

14.0 QC REQUIREMENTS

14.1 A method detection limit study must be completed following the procedure outlined in 40 CFR, Part 136, Appendix B, Rev. 2, 2016. Refer to SOP QA020, current revision. If instrument conditions (columns, etc.) are modified, then a new initial MDL must be done.

14.2 A method blank and a spike blank are required to be run with every batch of 20 samples. Additionally, a matrix spike and a matrix duplicate are required for every 10 samples. In some cases, a matrix spike duplicate may be required in place of a duplicate.
The method blank must contain <½ RL (absolute value) of each anion that is reported, and this sample must be run with each set of samples in a batch. If the blank contains more than the absolute value of <1/2 RL, then all samples must be reanalyzed. If no sample volume remains to be reanalyzed, then the data must be flagged. Refer to SOP QA043, current revision. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

Note: West Virginia state specific requirement for method blank must contain analyte at <MDL

14.2.1 The recovery of the spike blank must be within the limits of 90-110% recovery for each anion that is reported, and this sample must be run with each set of samples in a batch. If the recoveries are outside of this range, then all associated samples must be reanalyzed. If no sample volume remains to be reanalyzed, then the data must be flagged. Refer to SOP QA043, current revision.

14.2.2 The matrix spike is spiked with all anions of interest. Method limits of 90 -110 % recovery must be applied. If the recoveries are outside of this range, and all other method quality control is within limits, then matrix interference should be suspected.

14.2.3 For matrix duplicates control limits of 15% RPD must be applied for all sample values within the calibration range (up to 10 times the reporting limit). If the RPD values are outside of this range, and all other method quality control is within limits, then sample non-homogeneity should be suspected.

14.3 An external source standard (ICV) must be analyzed after every new calibration and its recovery must be within 10% of the true value. If the ICV is not within ±10%, a second ICV should be prepared and analyzed. If the ICV is still outside of the limits, sample analysis must be discontinued and the cause determined (preparation of ICV from third source, instrument recalibration, etc.).

14.4 It is required that a new calibration be run a minimum of once per quarter. Calibrations standards may be varied from the one stated in this SOP depending on the levels of each anion that are to be reported. A minimum of 5 standards and a blank are required and a low standard must be at or below the reporting limit for each anion. A correlation coefficient of ≥ 0.995 is

required. The percent relative error for the mid-point (See Table 1) and lowest calibration (See 14.5 below) standards must be within acceptable criteria.

14.4.1 A new calibration is required when standard retention times shift by more than 10% from the original calibration.

14.5 A low check at the reporting limit (CRI) for each anion must be run after each calibration. Acceptance criteria is 60–140%.

14.6 Continuing Calibration Verification (CCV) Checks at or near the mid-level of the curve must be run at the beginning and the end of the run and after every 10 samples throughout the run. Every CCV must be followed by a continuing calibration blank (CCB). The CCV must have results within 90-110% of the true value. If the CCV results are outside of the acceptance criteria range, analyst must demonstrate acceptable performance with two CCVs analyzed immediately (started within 1 hour), with no samples between failing CCV and the two additional CCVs. The results for the CCB must be <1/2 RL for an analyte. If they are not, then all bracketed samples for that analyte must be reanalyzed.

14.7 Retention time window widths must be established whenever a new column/guard column is installed in an instrument or whenever a major change has been made to an instrument. .

Retention time windows are established by injecting standard mix three times over the course of 72 hours and calculating the standard deviation of the retention times of each analyte. Retention time windows are $\pm$3 times the standard deviation for each analyte or 0.03 minutes, whichever is greater.

Retention times for analytes are determined by using the midpoint of the ICAL. On days where the ICAL is not performed, the initial CCV for the sequence will be used.

Peak identification is based on the retention time of an analyte in the standard (initial or continuing) being used as the mid-point of the retention time window. The retention time windows should be used as a guide for identifying compounds; however, the experience of the analyst should weigh heavily in the interpretation of the chromatograms. The analyst should monitor the retention times of known standard peaks throughout an instrument run as an indication of instrument performance.

Because calculated retention time windows are generally very tight (less than $\pm$ 0.10 minutes), the retention time windows for the data processing method are generally set wider than the calculated window. This is done to ensure that the software does not miss any potential “hits”. The analyst will then review these “hits” and determine if the retention times are close enough to the retention time of the target analyte to positively identify the peak or to require confirmation.

14.8 The Linear Calibration Range (LCR) is the concentration range the instrument response is linear and must be initially determined and verified every 6 months or whenever a significant change in the instrument is observed or expected. Initially, enough standards must be used to ensure the curve is linear. The linearity verification must use at a minimum, a blank and 3 standards. The verification data must be within $\pm$10% of the assigned values. If the data falls outside of this range, then the linearity of the instrument must be reestablished. If any portion

of the curve is nonlinear, then sufficient standards must be used to clearly delineate the nonlinear portion of the curve.

NOTE: Samples with detections within 10% of highest calibration standard must be diluted.

14.9 ***Contingencies for handling out-of-control QC***. Upon certain circumstances data can be reported from batches with QC non-conformances. Such samples are to be qualified accordingly. Examples include:

- If the MB is contaminated but the samples are non-detect, then the source of contamination should be investigated and documented. The sample results reported with appropriate qualifiers and footnotes. If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination should be investigated and documented. The samples results may be reported with the appropriate qualifier. Refer to SOP QA043, current revision. *This must be approved by the department supervisor.* Samples with hits <10 times contamination are reprepped and reanalyzed. If there is insufficient sample to reanalyze, or if the sample is re-analyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. *This must be approved by the department supervisor.*
- Similarly, if the recovery of LCS or CCV is high and the associated sample is non-detect, the data may be reportable with appropriate qualifiers and footnotes. If the recovery of LCS or CCV is below lower acceptance limit, the department supervisor shall review the data and determine what further corrective action is best for each sample. That may include reanalyzing the samples, re-prepping and/or reanalyzing the samples, or qualifying the results as estimated. Refer to SOP QA043, current revision. *This must be approved by the department supervisor.* If there is insufficient sample to reanalyze, or if the sample is re-analyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. *This must be approved by the department supervisor.*
- If the matrix spike recoveries are not within the established control limits, compare the recoveries to those of the LCS to assess method performance in clean QC matrix. Matrix spike recovery failures are not grounds for reanalysis but are an indication of the sample matrix effects.

15.0 DOCUMENTATION REQUIREMENTS

15.1 All reagents must be recorded in a reagent logbook with manufacturers, lot numbers, and expiration dates. All reagent information must be cross referenced on the sample worksheet.

15.2 All instrument data must be exported to the LIMS system and a copy of the run log must be included in the logbook by the instrument.

15.3 A data package consisting of a manual run log, a LIMS run log, a calibration summary, batch quality control summary, and copies of all chromatograms must be turned into the area supervisor for each batch. The analyst should also complete the preliminary review in the LIMS system.

15.4 Refer to SOP QA029, current revision, for procedures and documentation that must be followed

when peaks are manually integrated.

16.0 POLLUTION PREVENTION & WASTE MANAGEMENT

16.1 Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 16.2.

16.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the waste management SOP, SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

17.0 ADDITIONAL REFERENCES

17.1 Metrohm Instrument and column manuals

17.2 TNI 2016 standards.

17.3 CFR 40 Part 136, Tables IB and II

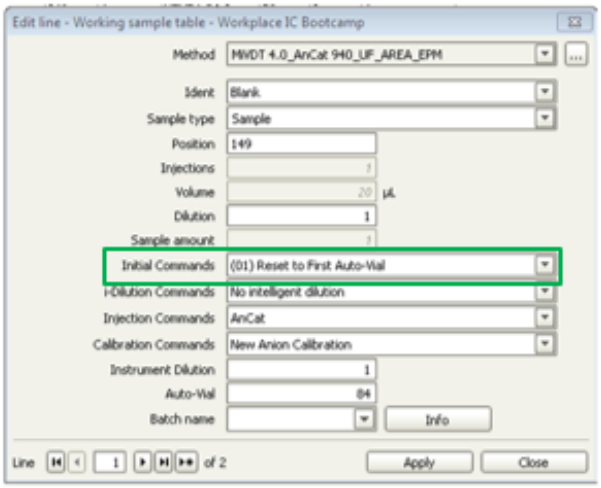
17.4 Metrohm AG document number 8.110.8010 "*IC Anion Suppressors*"

ATTACHMENT A: Sample Table Control Guideline

Sample Table Control: Initial Commands (Info 1)

Info 1 field used to specify initial (pre-analysis) commands

- **(01)Reset to First Auto-Vial**
  - Resets the auto-vial position to the Common Variable (01) First Auto-Vial
  - Used after placing new, empty dilution vials on the autosampler
  - Also restarts the Sample Counter
- **(02) Restart sample prep**
  - Used if an error occurs during the previous sample run
  - Causes the sample dilution to be prepared again in new auto-vial
  - **Best practice is to run a blank rather than utilize this command!**
- **(03) Initial rinse**
  - Rinse of sample flow path prior to analysis
  - Use when contamination from a high sample is suspected



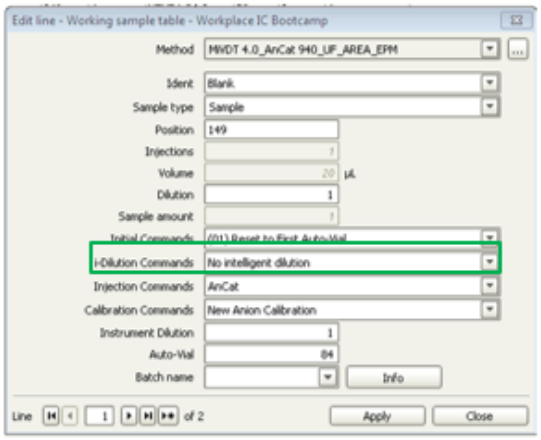
Troubleshooting Tip

- Be sure to avoid mistakenly using the "(01) Reset to First Auto-Vial" command.
- This could lead to dilutions being made in used auto-vials.

Sample Table Control: i-Dilution Commands (Info 2)

Info 2 field used to specify if a sample will be evaluated for an intelligent dilution

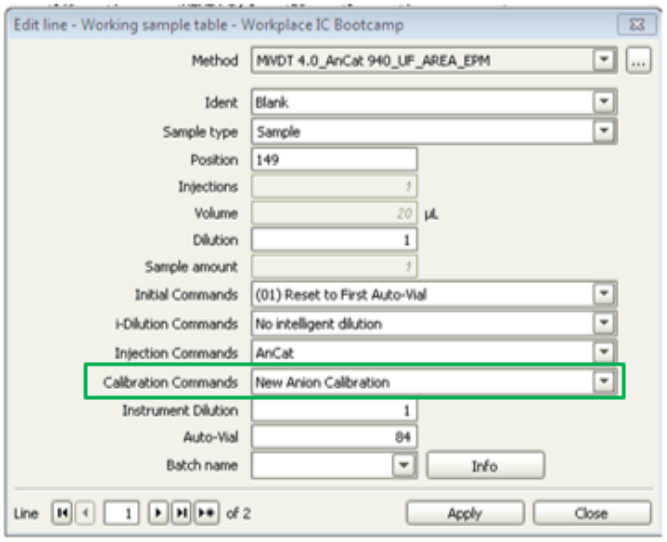
- **Blank (no entry)**
  - Sample will be evaluated for an intelligent dilution
- **"No intelligent dilution"**
  - Sample will NOT be evaluated for an intelligent dilution



Sample Table Controls: Calibration Reset (Info 4)

Info 4 field used to specify when a new calibration is being performed

- **New Anion Calibration**
  - Resets Common Variable areas to zero for high standards



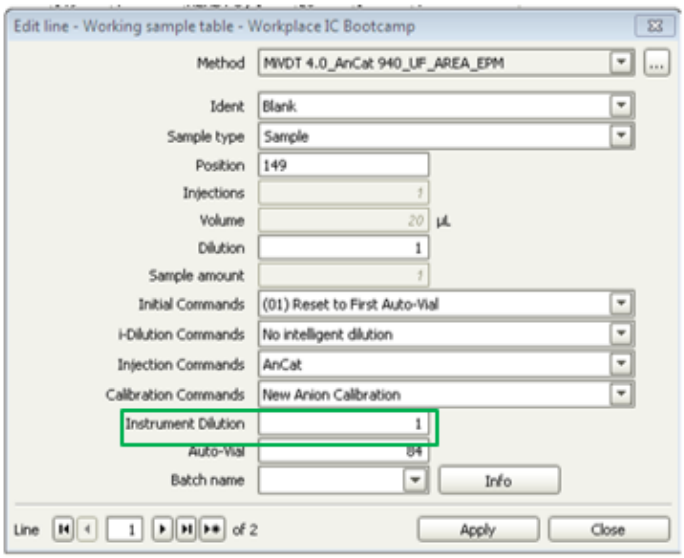
Troubleshooting Tip:

- Do not use calibration reset commands unless performing a new calibration.
  - Erroneous use will result in Common Variable areas being set to zero and will lead to incorrect intelligent dilutions.

Sample Table Controls: Instrument Dilution (Value 1)

Value 1 field used to specify the dilution the instrument is to perform

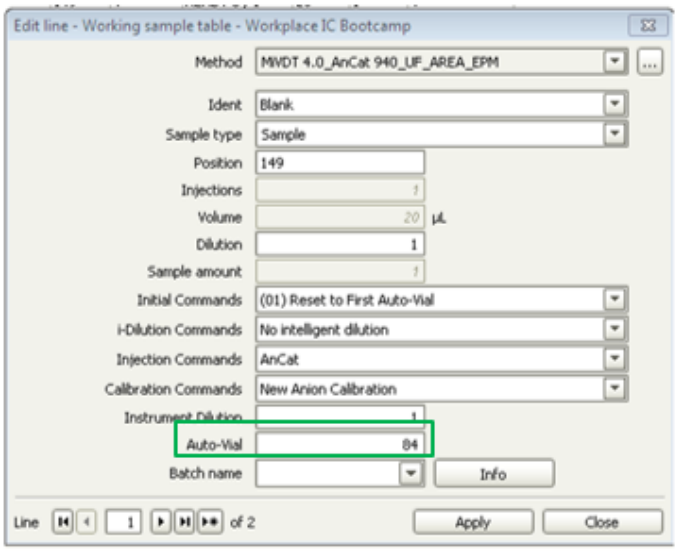
- **1:100 is the maximum dilution!**



Sample Table Controls: Auto-Vial Position (Value 2)

Value 2 field used to serve as a reminder for which auto-vial positions to fill with clean, capped empty vials

- **This is not the actual position where dilutions will occur.**
- **It is a reminder to the user to load a sufficient number of empty vials on the sample processor.**
- **Actual current vial position can be found in the Configuration view under (03) Current Auto-Vial**
- **Numerical value must be between 84 – 148.**



ATTACHMENT B: CONDUCTIVITY SCREENING FOR UNKNOWN SAMPLES

Conductivity Screen	Dilution Factor
< 700 µS	No dilution
700 – 1000 µS	1:5
1001 – 3000 µS	1:10
3001 – 5000 µS	1:25
5001 – 8000 µS	1:50
8 – 10 mS	1:100
10 – 15 mS	1:200
>15 mS	1:500

Table 1 QC Criteria

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration: r = coefficient of correlation	At least quarterly	≥0.995	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument, or document why the data are acceptable. See 14.4
Percent Relative Error (%RE)	Each initial calibration	60 – 140% of the lowest cal. standard's true value. 90 – 110% of the calibration standard at or near the mid-point's true value	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.
Initial Calibration Verification standard (ICV)	One per calibration	90-110% of the standard's true value	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable. See 14.3
Continuing Calibration Verification standard (CCV)	After initial calibration, every tenth sample, and at end of run	90-110% of the standard's true value	Rerun standard, and/or recalibrate instrument and reanalyze all samples run since the last acceptable CCV, or document why the data are acceptable. See 14.6
Low-level Standard (CRI)	One per calibration	60-140%% of the standard's true value	Rerun standards, and/or recalibrate instrument and reanalyze all samples associated with CCV2.
Continuing Calibration Blank (CCB)	After initial calibration, every tenth sample, and at the end of the run	< ½ RL DoD projects Abs value < ½ RL WV projects ICB/CCBs evaluated to <MDL	Stop the analysis, determine the source of contamination, rerun CCB and all samples following CCB outside acceptance criteria, or document why the data are acceptable.
Method blank (MB)	One per batch	< ½ RL DoD projects Abs value < ½ RL WV projects ICB/CCBs evaluated to <MDL	Stop the analysis, determine the source of contamination, reanalyze, or document why the data are acceptable.

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Blank Spike (BS or LCS)	One per batch	90-110% of the standard's true value	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable.
Blank Spike/Blank Spike Duplicate (BS/BSD or LCS/LCSD)	One per batch only when sufficient sample is not available for MS/MSD	EPA 9056A/300.0: 90-110%, DoD projects per QSM 6.0 %RPD<10%	Determine and correct the problem, reanalyze samples and BS/BSD, or document why data are acceptable.
MS/MSD	10% of matrix	90-110% of the standard's true value RPD $\leq$ 15%	Determine and correct the problem, reanalyze samples and MS/MSD, or document why data are acceptable
Linear Calibration Range (LCR)	Semi-annually	±10% of the standard's true value	Rerun and/or prepare new series of standard, and/or recalibrate instrument

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
09/04/2021	01	Entire Document	Added applicable SOP references
09/04/2021	01	Entire Document	Updated MDL determination procedure to 40 CFR, part 136, Appendix B, Revision 2
09/04/2021	01	Entire Document	Changed PO4 to OPO4 for Ortho Phosphate
09/04/2021	01	References	Added Revision for SW-846; Moved 40 CFR reference to Additional References section
09/04/2021	01	4.0	Updated MDL definition; Updated Reagent Water definition to match TNI 2016 Standards; Added Linear Calibration Range definition
09/04/2021	01	5.0	Added gloves for Health & Safety PPE
09/04/2021	01	6.0	Revised sample temperature preservation to “a temperature above the freezing point of water to 6^0C”; removed H2SO4 preservation references
09/04/2021	01	07	Added balance calibration verification procedure
09/04/2021	01	8.0	Added additional requirements for reagents and standards to meet current regulations; Updated preparation of Combined Anion Working Stock Calibration and individual Anions; and CCV concentrations; Updated preparation of Stock Eluent
09/04/2021	01	10.0	Added use of wrist action shaker for sample and QC preparation
09/04/2021	01	11.0	Added Percent Relative Error; Added evaluation of absolute value for MB acceptance criteria; Removed MB QC acceptance criteria for WV
09/04/2021	01	14.0	Expanded Method Blank QC requirements; Revised calibration frequency from once per month to at least quarterly; Added Percent Relative Error
09/04/2021	01	17.0	Added CFR 40 Part 136 Table IB and II; Updated SOP references
09/04/2021	01	Appendix A	Changed title to Attachment A
09/04/2021	01	Attachment B	Conductivity Screening Table for sample dilution added
09/04/2021	01	Table 1	Added % Relative Error; Expanded frequency of CCV to include after initial calibration and at the end of the run; Revised corrective action for MB; Separated MB and

			CCB; Revised corrective actions for Retention Time shifts
09/04/2021	01	Appendix of Significant Changes	Added
09/04/2021	01	SOP Acknowledge-ment Form	Added
01/05/2023	02	Table 1	Updated RPD limit for MS/MSD
04/21/2023	03	14.0	Updated RPD limit for MS/MSD
03/13/2024	04	Entire SOP	Removed ortho-phosphate from method
03/13/2024	04	8.4.1	Combined Anion mix added for ICV and Blank Spike
03/13/2024	04	10.1.2	DI volume revised to 48.75mL
12/02/2024	05	Entire SOP	Added Class A to volumetric glassware
12/02/2024	05	3.1	Changed RL of Fluoride to 0.1mg/L from 0.2mg/L
12/02/2024	05	5	Updated Health and Safety section. Added SGS Orlando SOP QA033 (Laboratory Safety Procedures) reference
12/02/2024	05	17.4	Changed DoD QSM 5.4 from QSM 5 series, current revision
09/2025	06	Entire Document	Changed DoD QSM 5.4 to DoD QSM 6.0.
09/2025	06	Entire Document	Updated %RE of low level standards.
9/2025	06	8.2	Added South Carolina to list of States that do not allow for quadratic fit of a calibration curve.
09/2025	06	14.7	Updated retention time and retention time window width establishments.

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: QA005, QA006, QA017, QA020, QA029, QA034, QA042, QA043, and SAM108, current revisions.

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

SAMPLE RECEIPT AND STORAGE

Prepared by: Elizabeth Kent Date: 09/19/2024

Approved by: Shayla Prince Date: 09/19/2024

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 09/19/2024

Issued to: Sample Management Date: * 09/19/2024

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: SAMPLE RECEIPT AND STORAGE

REFERENCES: TNI Standards 2016; State of Florida DEP SOPs; 40 CFR Part 136; DoD QSM 5.4; SOP QA021, Subcontracting, current revision.

1.0 SCOPE AND APPLICATION

To maintain documentation of custody of all bottle sets, samples (domestic and foreign), digestates, distillates, and extracts that fall under the responsibility of SGS North America, Inc. - Orlando.

2.0 EXTERNAL CHAIN-OF-CUSTODY PROCEDURE

2.1 Samples are received via commercial carrier, client delivery, or are picked up by SGS - Orlando employees. Upon receipt, sample management inspects the outside of the container for signs of tampering, such as a torn or missing custody seal. The staff reviews Chain Of Custody (CoC) document for the following information:

2.1.1 Client Information- Name / Address, Phone and Fax contact numbers.

2.1.2 Facility Information- Project name, Location, Project Number.

2.1.3 Field ID / Point of Collection- Date- Time- (HOLD TIMES) Samplers Initials- # of containers Shipped, Preservative types.

2.1.4 Matrix of samples: WW- water, GW-ground water, SW-surface water, DW-drinking water, SO-Soil, SOL-other solid, LIQ-other liquid, OI- Oil, AIR-air, WP- Wipe, FB-field blank, TB-trip blank.

2.1.5 Analytical Information - Samples withhold times of 72 hours or less remaining on analyses upon receipt are considered Short Hold Samples and are listed on Short Hold Notification form in order of hold times, from ASAP to 7 days with less than 3 days left. These samples are processed immediately. Job Numbers are assigned, and the samples are given directly to the appropriate lab. Copy of CoC and completed Short Hold Notification Forms are automatically emailed to the department supervisors and SGS - Orlando Project Manager (PM) team from the Receipt utility by the sample receiving technician. Laboratory personnel accept the samples, time of transfer is recorded (See Attachment I, Short Hold Notification Form, and Attachment IV, for container types and sizes, hold times and required preservatives.)

2.1.5.1 VOC soil sample vials must be frozen within 48 hours of collection. Receiving technicians review sample times and deliver samples with a SHNF if sufficient hold-time remains to process the samples. If samples are close to

expiring the samples are immediately placed in the freezer with a card notating the time they were placed in the freezer. (See Attachment II, listing of tests associated with the requirement)

2.1.6 TURN AROUND TIME- Samples with a 6 day or less TAT are processed as soon as possible, depending on samples with short hold status.

2.1.7 Sample custody documentation signatures – relinquished/received in Client – Carrier – Laboratory sequence. Per FL DEP SOPs signature shall consist of full signature – no initials allowed – and business affiliation.

2.1.8 Special Requirements and or comments - Compositing, filtering, or preservation of samples, Extended sample storage etc.

2.2 Samples are processed by a two-technician team, The sample custodian(s) accepts sample custody upon receipt of samples and verifies that the custody document is correct. Sample conditions, sample temperature, and other observations, including custody seal condition, are documented in detail on the electronic Sample Receipt Confirmation form (p-note).

2.2.1 Temperature is measured using IR thermometer against white label on temperature blank, or on the sample container, if temperature blank is absent. **NOTE: For jobs originated in West Virginia every sample container must be checked.** This thermometer is calibrated measuring the temperature off white sample label against NIST-traceable liquid-in-glass thermometer – see SOP QA002, current revision. When recording the cooler temperature with the use of an IR thermometer the following needs to be documented on Sample Receipt Confirmation Form:

2.2.1.1 IR thermometer used.
2.2.1.2 Correction factor.
2.2.1.3 Observed cooler temperature.
2.2.1.4 Corrected cooler temperature.

2.2.2 Verify IR thermometer correction factor. Correction factor recorded in Receipt utility to make sure it is correct in both locations. Notify QA/Department Manager if these values are not the same. Apply temperature correction factor for a face value – positive number to be added to direct reading temperature, negative correction factor to be subtracted. Receipt utility calculates corrected temperatures.

2.2.3 **Samples must remain in coolers full of ice until it is time to process the job for login. Coolers received out of temperature range have initial temperature recorded and are then placed into a Walk-In cooler until resolution from client is received.** 40 CFR part 136, TNI Standards 2016 revision and DoD QSM 5.4 series all designate acceptable temperature as ≤ 6°C without freezing. Temperature is measured and recorded to first decimal place due to state-specific and client-specific requirements.

2.2.4 Any discrepancies or non-compliant situations are documented on the Sample Receipt Confirmation Form (also referred to as p-note) which is automatically e-mailed to the entire SGS - Orlando Project Manager (PM) team. The Project M assigned to the client contacts the client for resolution. Major issues require the client to be contacted, are but not limited to missing COC's, insufficient sample volume, bottles received not on COC, samples being out of hold or out of temperature range.

2.2.4.1 Missing CoC requires the client to be contacted before the samples can be logged in. If resolution of the problem is not immediate, the samples remain in the original cooler until the problems are resolved.

2.2.4.2 Minor issues identify discrepancies that do not interfere with log-in and/or analysis of the samples, such as 1 of 2 PAH bottles received broken or supplied. The resolution is documented and communicated to sample management for execution.

2.2.5 Once the sample custodian(s) is (are) satisfied with the information on the chain of custody document, the job number is generated from Receipt access-based utility with the next available SGS - Orlando sequential job ID in FXXXXXX convention.

2.2.6 First technician arranges samples on the counter in the order of CoC. Every different point of collection must have a different fraction number, i.e. -1, -2, etc. The assigned fraction number must be written on the chain of custody, to the left of the line identifying the point of collection (Client ID) unless there is insufficient space. The custodian then assigns a unique sample identifier to each sample container, i.e. FAXXXXX-1.4, where 4 is a unique container designation.

2.2.7 The same technician enters samples in the sample location database and prints the labels for the samples. A second technician then attaches the labels to the samples and re-verifies sample client ID and Lab fraction number against CoC. After all the steps are completed, first technician closes the Sample Receipt Confirmation Form and second technician reviews it for completeness and accuracy of recorded information. The CoC then initialed with both technicians' IDs.

2.2.7.1 Wherever samples are designated to be put on hold by the client, labels on these samples are marked with bright pink sticker.

2.2.8 Identify samples with subcontracted parameters and process according to SOP QA021, current revision. Most common, but not limited to, subcontracted parameters are listed in Attachment III.

2.2.9 **Cooler Drop-Off Procedure**. Upon return to the laboratory, SGS - Orlando-employed couriers will visually inspect the coolers and take the original temperature. Sample Receiving technicians verify Short Holds, Rushes etc. Coolers will then be placed into Refrigerated storage until Sample Receiving Technicians can process the coolers.

2.2.9.1 SGS – Orlando has installed an outside locker equipped with digital lock for clients' after-hours deliveries. Project Management staff shares lock combination with the clients as necessary and Sample Management staff checks the locker every morning and assumes the custody of the coolers.

2.3 When generating a job number, the following information is entered in the Access Receipt utility:

2.3.1 SGS - Orlando Job # (generated sequentially)
2.3.2 Client Name
2.3.3 Project Name
2.3.4 Date and Time Samples Received.
2.3.5 # of coolers Received.
2.3.6 Courier Information and airbill # if available
2.3.7 Technician ID

2.4 The sample custodian then checks the samples' preservation, except for the **VOA** samples, which are checked by the analyst after the sample is analyzed and **AQ Oil and Grease** due to method-specific way preservation is checked. Should a sample be received preserved incorrectly the following actions are taken:

2.4.1 pH and residual chlorine: For samples requiring preservation (HNO3, H2SO4, NAOH and NAOH/Zn Acetate) each container is tested by applying the sample with disposable capillary to narrow-range pH paper. Residual chlorine presence/absence is measured using potassium iodide/starch paper in all samples with EPA 600-series methods indicated on CoC and samples originated in North Carolina (one bottle per well). 40-ml VOC vials are exempt from this procedure and are being tested in the lab after the requested tests are completed (purge-and-trap GC and GC/MS, TOC/TC and EPA 504/8011).

2.4.2 Pesticides/PCB's/Semivolatile Organic aqueous samples with residual chlorine present: Immediately request an appropriate amount of 8% sodium thiosulfate solution to be prepared by WetChem department. Segregate affected samples on a cart in a walk-in cooler until solution is received. Add 1 ml of 8% sodium thiosulfate solution per 1liter (0.008%) to all containers except VOA. Record event on Sample Receipt Confirmation Form and in preservative adjustment log.

2.4.3 Organochlorine pesticides and PCBs by EPA 608 - samples that are not extracted within 72 hours of collection need to have pH checked and adjusted, if necessary, to a pH within 5.0-9.0 using H2SO4 or NaOH. Coordinate with Extraction department.

2.4.4 Cyanide is preserved to pH $\geq$ 12 using 10N NaOH, prepared by WetChem personnel.

2.4.5 Sulfide is preserved to pH $\geq$ 9 using 10N NaOH and Zn acetate, prepared by WetChem personnel.

2.4.6 Aqueous samples for metals are preserved to pH ≤ 2 with nitric acid, prepared by WetChem Personnel. These samples are marked with colored label "**Metals Sample Received Unpreserved. Preserved Date_____Time_____ Analyze after 24 hours".** For correctly preserved aqueous metals sampling date and time from COC is recorded as date and time of preservation.

2.4.7 Aqueous samples for TRPH and some WetChem parameters are preserved to a pH of ≤2 with H2SO4, prepared by WetChem Personnel.

2.4.8 To avoid using expired preservatives Sample Receiving does not keep them in the department. Staff obtains necessary preservatives from Shipping department.

2.5 Upon confirmation to proceed from PM or client incorrectly preserved samples have the proper amount of preservative added. Volume added is recorded on the Sample Receipt Confirmation form. The same volume and type of preservative is then added to the Equipment Blank and/or Field Blank, regardless of pH reading. Volume added is also recorded on the Sample Receipt Confirmation form.

Full preservation adjustment record should contain Sample ID, Bottle Number, Parameter, Preservative Type, Preservative Lot, and Amount of Preservative Added, Date/Time Added and the technician's initials.

2.6 All bottles must be labeled. Each bottle will be labeled both on the cap and on the bottle. The labels are generated by the electronic sample receipt log. The following information is entered into the electronic log along with the information already captured in sec. 2.3:

2.6.1 Job # automatically assigned by Receipt utility
2.6.2 Client Name and Project
2.6.3 Date and time samples were received.
2.6.4 The number of coolers received
2.6.5 The temperature of each cooler
2.6.6 ID of custodian logging in the job
2.6.7 Number of samples
2.6.8 Number of bottles
2.6.9 Bottle type
2.6.10 Preservative by code. Choose from pull down menu in the Receipt utility app.
2.6.11 Bottle storage location – cooler and shelf
2.6.12 Department assigned to the analysis

The information is saved, and labels can be printed.

2.7 The following information is present on the bottle:

2.7.1 The sample number and bottle number
2.7.2 Storage location
2.7.3 The preservative used during sampling as indicated on the chain

2.8 The samples must be placed in their assigned locations and kept at above freezing and below 6.0°C until preparation and/or analysis. Water samples preserved with HNO_3 for metals analyses are stored at room temperature. Access to the area is limited.

2.9 The original chain of custody and any additional documented information relative to the job is then placed in a bin in receiving for the Login personnel to pick up for entry into LIMS.

2.10 **Foreign samples** are referred to samples originated outside of continental United States. These samples must be segregated from domestic samples in storage, processing and disposal. Objective of such segregation is to keep agricultural pests and pathogens from entering continental US territory and interfering with animal and plant health.

2.10.1 Foreign Samples shall be shipped in securely closed watertight containers and free of debris and macro organisms (insects, mollusks, worms, ticks and mites).

2.10.2 Foreign samples are stored in lockable cooler #14 to prevent accidental disposal. This cooler is clearly marked *for foreign samples only*. Sample labels are marked with green sticker to stand out in the lab departments.

2.10.3 Keep lids tightly closed while in storage.

2.10.4 All unconsumed samples and containers must be separately collected for disposal. SGS - Orlando employs outside contractor to sterilize and dispose of foreign samples – see SOPs SAM108 and SAM109, current revisions.

3.0 SAMPLE STORAGE TEMPERATURE AND CROSS-CONTAMINATION MONITORING

3.1 While in the laboratory, samples shall be stored in limited-access, temperature –controlled areas. Refrigerators shall be monitored for temperature daily. Acceptance criteria for the temperature of refrigerators is 0.5 to 6.0 °C and is listed in the refrigerator log. Thermometers that have been calibrated with a NIST traceable thermometer monitor all cold storage areas. As indicated calibration verification, a correction factor is applied to each thermometer for a face value. Records that include acceptance criteria are maintained.

*According to TNI 2016, V1M2, sec. 5.8.9.a.i) temperature should be above freezing point and below 6.0°C, when specified storage temperature is 4°C. Lowest temperature that can be practically read above freezing point is 0.5°C.

3.2 Samples for volatile organics determination shall be stored separately from other samples, standards, and sample extracts. Acceptance criteria for the temperature of a volatile refrigerator is 0.5 to 6.0 °C and is listed in the refrigerator's log. VOC Soil freezers are maintained between –10.0°C and -20.0°C per SW-846 5035A. For further details refer to SOP QA004, current revision.

3.3 Sample storage for unconsumed containers PFAS by EPA 1633 are stored at ≤ 6°C without freezing.

3.4 Sample storage area for volatile organics shall be monitored for cross contamination using refrigerator blanks. Refrigerator blanks shall be analyzed every other week.

3.4.1 If contamination of the refrigerator is confirmed, the samples must be removed from the refrigerator and placed in coolers with ice, or in alternate refrigerated storage.

3.4.2 All samples received after the date of the last clean refrigerator blank must be checked for the same contaminants. If present, they must be reported and flagged with a qualifier indicating possible lab contamination.

3.4.3 The source of the contamination must be located and removed.

3.4.4 A new refrigerator blank is then placed in the refrigerator and analyzed after 24 hours.

3.4.5 Samples may be returned to the refrigerator when all contaminants are removed as indicated by the analysis of a refrigerator blank without contamination.

4.0 SAFETY and POLLUTION PREVENTION

4.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedures), current revision. Safety glasses, a lab coat, and appropriate gloves should be worn when handling samples.

The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

Safety Data Sheets (SDS) are available for all standards and reagents used in the laboratory. Analysts should review the SDS prior to using any new standards or reagents.

4.2 Pollution Prevention

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

Samples are archived and stored for 30 days after analysis. After the storage time has elapsed, the remaining aqueous samples are transferred to the appropriate drums for disposal.

5.0 DOCUMENTATION

All samples received by SGS - Orlando must come with a chain-of-custody (COC). Special attention shall be paid to client-specific COCs.

SGS - Orlando personnel MUST record dates and time in **mm/dd/yy 24:00** format, and both observed and corrected temperatures.

Current revisions of forms and label templates used in sample receipt process are maintained as controlled documents in limited access directory on LAN.

Attachment I

SHORT HOLD NOTIFICATION FORM **JOB #**_____

HOLD TIME	ANALYTE	CHECK COC	COMMENTS
ASAP	RedOx		
	pH		
	Ferrous Iron		
	Total Coliform/Fecal Coliform (Subcontract)		
24 hrs	XCr / Hexachrome / Cr +6		
	Dissolved/Filtered Metals		
	Odor		
	Color		
48 hrs	BOD		
	CBOD		
	MBAS (Subcontract)		
	Turbidity		
	Nitrate (NO3)		
	Nitrite (NO2)		
	TN (NO2/NO3)		
	OPO4 / Orthophosphate		
	SS (Settleable Solids)		
	Chlorophyll A (Subcontract)		
72 hrs	Organochlorine Pesticides 608.3 (If no pH check and adjustment done)		
	Acrolein/Acrylonitrile (VOA from Alaska)		
	Formaldehyde (Subcontract)		
7 days Only for samples received after 5 days	Unpreserved VOA Vials		
	TDS/TSS/TS		
	Sulfide		
	8141 pesticides in soil		
	All the Water extractables		
Soils			
48 Hours	5035 Field Kit (DI vials)		
	Encore Sampler VOA/VPH/GRO		
	Soil Jar (Bulk Sample) VOA/VPH/GRO		
	NO2/NO3 from WV (IC analysis)		

Relinquished by:_____**Date/Time relinquished:**_____

Received by:_____**Date/Time received:**_____

Attachment II

SOIL SAMPLES

Samples associated with tests listed below need to be brought to Volatile Soil Prep or Frozen within 48 hours from Date/Time of Sampling.
This requirement applies to soil Jars, 5035 Field Kits, Encores and Terracores

8260

8021

Any GRO, including State-Specific TPH

VPH

OA1

VOA

VOC

VOH

PRE-BURN

8015

5035

5030

Attachment III

SUBCONTRACT ANALYSES

MOST COMMON – but not limited to - SUB CONTRACT PARAMETERS

TOX (Total Organic Halides)

Oil and Grease SOILS

GROSS ALPHA, GROSS BETA (GR-A, GR-B)

Radium 226/228 (R-226/R-228)

ASBESTOS

CO2 as Dissolved Gas (VIALS ONLY)

URANIUM (U)

B-BORON

LI-LITHIUM

Various Drinking Water tests

Microbiology

ORGANIC ANALYSIS

ANALYSIS	ANALYTICAL METHOD	MATRIX	MINIMUM VOLUME	CONTAINER TYPE	REQUIRED PRESERVATIVE	HOLDING TIME FROM DATE and TIME SAMPLED
SEMI-VOLATILE AND VOLATILE[1]						
Volatile Organic Compounds	624 8260 SM 6200	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
	8260	Soil	3 x 40 mL[2]	Field Kit[2]	Freeze at -10°C	Freeze 48 hours, Analysis 14 Days
	MAVPH	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
		Soil	2 x 40 mL[2]	Field Kit[2]	MeOH Cool to 4°C	28 Days
Methane, Ethane, Ethene	RSK147	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
Gasoline Range Organics (GRO)	8015	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
		Soil	2 x 40 mL	Vials	MeOH Cool to 4°C	14 Days
Diesel Range Organics (DRO)	8015	Water	2 x 250 mL[3]	Amber Glass	H_2SO_4 to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Acid Base Neutrals Extractable Organics (PAH and PAH SIM)	8270	Water	2 x 250 mL[3]	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Acid Base Neutrals Extractable Organics full list Organo Pesticides and PCBs by 608	608 625 8270	Water	2 X 1L	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Pesticides	8081	Water	2 x 250 mL[3]	Amber Glass	Cool, 4°C	14 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
	8141	Water	2 x 250 mL[3]	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	7 Days Analysis: 40 Days
PCBs	8082	Water	2 x 250 mL[3]	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Herbicides	8151	Water	2 x 250 mL[3]	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Explosives	8330A/B	Water	2 x 1L	Amber Glass	Cool, 4°C	7 Days
	8330A	Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
	8330B	Soil	Approximately 500 g	Clear Glass or Double Plastic Bags	Cool, 4°C	14 Days Analysis: 40 Days
EDB/DBCP	504.1 8011	Water	3 x 40 mL	Vials	Cool, 4°C 10 mg Na_2S2O_3 For Residual Cl_2	14 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Acrylamide	8316	Water	2 x 40 mL	Vials	Cool, 4°C	7 days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 days
Perchlorate	6850	Water	1x 125 mL	Plastic 2/3 Full	Cool, 4°C	28 days
		Soil	1x 4 oz	Plastic 2/3 Full	Cool, 4°C	28 days
Extractable Petroleum Hydrocarbons (EPH)	MAEPH	Water	2 x 1L	Amber Glass	H_2SO_4 to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	Extraction: 14 Days Analysis: 40 Days
Total Recoverable Petroleum Hydrocarbons (TRPH)	FLPRO	Water	2 x 250 mL[3]	Amber Glass	H_2SO_4 to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	Extraction: 14 Days
Perfluorinated Compounds	DoD 5-series Table B-15	Water	2 x 125 mL	HDPE, no Teflon liners	Cool 4°C	Extraction: 28 Days Analysis: 40 Days
		Soil	1x 4 oz			
	DoD 5-series Table B-24; EPA 1633 Draft	Water	2 x 500 mL + 1x 60 ml		Cool 4°C for up to 28 days, freeze <-20°C up to 90 days	Extraction: 28 Days Analysis: 28 Days
		Soil	1x 4 oz			
	EPA 537 MOD	Water	2 x 125 mL		Cool 4°C	Extraction: 14 Days
		Soil	1x 4 oz		Cool 4°C	Analysis: 28 Days
	EPA 533	DW	2 x 250 ml	HDPP / HDPE	Cool 4°C, Ammonium	Extraction: 28 Days; Analysis: 28 Days
	EPA 537.1	DW	2 x 250 ml	HDPP / HDPE	Cool 4°C, Tirzma	Extraction: 14 Days; Analysis: 28 Days
TCLP AND SPLP						
TCLP/SPLP Extractables	8270 8081 8151		2 x 1L	Amber Glass	Cool, 4°C	14 days for leaching, 7 days for extraction, 40 days for analysis
TCLP/SPLP Metals	6010		2 x 1L	Amber Glass	Cool, 4°C	Extract. & Analysis: 6 Months Aqueous and Solid; Hg Extract. & Analysis: 28 Days Aqueous and Solid
TCLP/SPLP Volatiles	8260		2 x 40 mL	Vials	Cool, 4°C	Extract. & Analysis: 14 Days to leaching, 14 days to analysis
Full Water TCLP/SPLP		Water	5 x 1L	Amber Glass	Cool, 4°C	See Above for Individual Analyses
			1x 1L	Plastic		
			2 x 40 mL	Glass Vials		
Full Soil TCLP/SPLP		Solid	2 x 8 oz + 1x 4	Glass Jars		
AIR						
Volatile Organics	TO3	Air	1x 1L	Tedlar Bag	None	72 Hours

Solids and soils may be analyzed for the above analytes with a general requirement of approximately 100 grams (60 ml) per analyte, or in combinations of analytes in 1-300 ml

[1] Multiple analyses can be performed from a single container. Please see SOP for more guidance.
[2] Pre-weighed methanol preserved and/or DI water vials are available upon request (Method 5035 preservation) for volatile analysis.
[3] For South Carlolina EPA 8000 Series, use 2 x 1L Amber Glass Bottles preserved as noted.

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INORGANIC ANALYSIS

ANALYSIS	ANALYTICAL METHOD	MINIMUM VOLUME	CONTAINER TYPE	REQUIRED PRESERVATIVE	HOLDING TIME FROM DATE and TIME SAMPLED
IMMEDIATE TO 48 HOURS					
pH	SM 4500-H; EPA 9040C	100 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Biochemical Oxygen Demand	SM 5210B	1L	Plastic, Glass	Cool, 4°C	48 Hours
Color	SM 2120B	100 mL	Plastic, Glass	Cool, 4°C	24 Hours
Ferrous Iron (Fe^{+2})	SM 3500-Fe B	100 mL	Plastic	Cool, 4°C	15 minutes, Field Parameter
Hexavalent Chromium	EPA 7196A/7199	500 mL	Plastic, Glass	Cool, 4°C	24 Hours
Nitrate Nitrogen; Nitrite Nitrogen	EPA 300/9056A	50 mL	Plastic, Glass	Cool, 4°C	48 Hours
Nitrate Nitrogen; Nitrite Nitrogen	EPA 9056A	4 oz	Glass	Cool, 4°C	48 Hours
Nitrite Nitrogen	EPA 353.2	50 mL	Plastic, Glass	Cool, 4°C	48 Hours
Orthophosphate	EPA 365.3	100 mL	Plastic, Glass	Cool, 4°C	Field Filtered 15 minutes, 48 Hours
Sulfite	SM 4500SO3	200 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Total Residual Chlorine	SM 4500CL-F	200 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Total Settleable Solids	SM 2540F	2 x 1L	Plastic, Glass	Cool, 4°C	48 Hours
Turbidity	EPA 180.1	100 mL	Plastic, Glass	Cool, 4°C	48 Hours
7 DAYS					
Sulfide	SM 4500S=F	3 x 250 mL	Plastic, Glass	NaOH to pH>=9 ZnAc/Cool, 4°C	7 Days
Total Dissolved Solids (TDS)	SM 2540C	250 ml	Plastic, Glass	Cool, 4°C	7 Days
Total Solids (TS)	SM 2540B	200 mL	Plastic, Glass	Cool, 4°C	7 Days
Total Suspended Solids (TSS)	SM 2540D	1L	Plastic, Glass	Cool, 4°C	7 Days
Total Volatile Solids (TVS)	SM 2540E/F	200 mL	Plastic, Glass	Cool, 4°C	7 Days
Total Volatile Suspended Solids (TVSS)	SM 2540E/F	1L	Plastic, Glass	Cool, 4°C	7 Days
GREATER THAN 7 DAYS					
Acidity/Alkalinity	SM 2310B	200 mL	Plastic, Glass	Cool, 4°C	14 Days
Amenable Cyanide	SW846 9012B	250 mL	Plastic, Glass	NaOH to pH>12/Cool, 4°C	14 Days
Ammonia Nitrogen	EPA 350.1	200 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Bulk Density	ASTM D2937-94	8 OZ	Glass	Cool, 4°C	Not Regulated
Carbonate, Bicarbonate, CO2 calculation	SM 2320B SM 4500-CO2	200 mL	Plastic, Glass	Cool, 4°C	14 Days
Chemical Oxygen Demand (COD)	SM 5220C	100 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Chloride, Sulfate, Bromide, Fluoride	EPA 300/9056A	100 mL	Plastic, Glass	Cool, 4°C	28 Days
Chloride, Sulfate, Bromide, Fluoride	EPA 9056A	4 oz	Glass	Cool, 4°C	28 Days
Cyanide AQ	EPA 335.4/9012B	100 mL	Plastic, Glass	NaOH to pH>12/Ascorbic Acid Cool, 4°C	14 Days
Cyanide SO	EPA 9012B	4 oz	Glass	Cool, 4°C	14 days
Hardness Calculation	SM 2340B	100 mL	Plastic, Glass	HNO_3 to pH<2/Cool, 4°C	6 Months
Hexavalent Chromium	EPA 3060A/7196A/7199	4 oz	Glass	Cool, 4°C	Digestion 30 days, Digestate 7 days
Hexavalent Chromium	EPA 218.6	100 mL	Plastic, Glass	Cool, 4°C, pH 9.3 - 9.7 with buffer	28 Days
Ignitability	SW846 1020B/C	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Mercury	EPA 245.1/7470A	500 mL	Plastic, Glass	HNO_3 to pH<2/Cool, 4°C	28 Days
Nitrate +Nitrite Nitrogen	EPA 353.2	100 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Nitrate Nitrogen	EPA 353.2	100 ml	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Oil & Grease	EPA 1664A/B/9070A	2 x 1L	Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Organic Nitrogen	TKN - AMN	500 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Oxidation Reduction Potential	ASTM D1498-76	200 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Paint Filter Test	EPA 9065	200 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Percent Ash	ASTM D482-91/D2974-00	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Phenols	EPA 420.4	250 mL	Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Reactive Cyanide	SW846 Chapter 7	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Reactive Sulfide	SW846 Chapter 7	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Specific Conductance	EPA 120.1	200 mL	Plastic, Glass	Cool, 4°C	28 Days
Total Kjeldahl Nitrogen (TKN)	EPA 351.2	100 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Total Metals	EPA 6010/6020/200.7/200.8	500 mL	Plastic, Glass	HNO_3 to pH<2/Cool, 4°C	6 Months
Total Nitrogen	TKN +NO2 +NO3	500 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Total Phosphorus	EPA 365.3	200 mL	Plastic, Glass	H_2SO_4 to pH<2/Cool, 4°C	28 Days
Total Organic Carbon SO	EPA 9060A	4 oz	Glass	Cool, 4°C	28 Days
Total, Dissolved Organic Carbon	SM 5310B/9060A	2 x 40 mL	Amber VOC Vials	HCl to pH<2/Cool, 4°C	28 Days

Solids and soils may be analyzed for the above analytes with a general requirement of approximately 100 grams (1-60 mL) per analyte, or in combinations of analytes in 1-300 mL bottle.

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
07/2023	22	References	Updated to current references; removed TNI 2009 throughout the document
07/2023	22	2.1.5	Short Hold form process updated
07/2023	22	2.2 and subsections	Editorial updates
07/2023	22	2.2.10	Added outside locker for clients' after hours deliveries
07/2023	22	2.3	Editorial updates
07/2023	22	2.4	Added Oil and Grease preservation check discussion
07/2023	22	2.4.8	Updated location of preservatives
07/2023	22	2.5	Editorial updates
07/2023	22	2.6	Editorial updates
07/2023	22	3.3	PFAS freezer added
07/2023	22	4.0	Safety and Pollution prevention section added, documentation moved to 5.0
07/2023	22	Attachments I through IV	revised
07/2023	22	Appendix of Significant Changes	Added
07/2023	22	SOP Acknowledgement Form	Added
09/2024	23	Entire Document	Updated QSM 5-series to QSM 5.4
09/2024	23	Entire Document	Updated EPA Draft 1633 to EPA 1633
09/2024	23	2.2.3	Removed allowance for PFAS sample temperature upper tolerance up to 10°C
09/2024	23	3.3	PFAS sample storage updated to ≤ 6°C without freezing
09/2024	23	Attachment III	Removed TOC-Soils, Boron and Lithium from sub-contract analysis list

SAMPLE RECEIPT AND STORAGE

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: QA002, QA004, QA021, QA033, and SAM108, current revisions.

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

SAMPLE AND LABORATORY WASTE DISPOSAL

Prepared by: Svetlana Izosimova Date: 11/15/2025

Approved by: Shayla Prince Date: 11/18/2025

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 11/18/2025

Issued to: Sample Management (Shipping) - digital Date: * 11/18/2025

Issued to: General Chemistry – digital Date: 11/18/2025

Issued to: Metals Department – digital Date: 11/18/2025

Issued to: Organic Prep – digital Date: 11/18/2025

Issued to: Semivolatile Department – digital Date: 11/18/2025

Issues to: VOC – Department Date: 11/18/2025

Effective 7 days after "*" date

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TITLE: SAMPLE AND LABORATORY WASTE DISPOSAL

REFERENCES: Florida DEP Hazardous Waste; 40 CFR, Parts 261, 273 and 761; DoD/DoE QSM rev. 6.0

1.0 SCOPE AND APPLICATION

The disposal of samples and laboratory waste adhering to the State of Florida and Federal Regulations, including Toxic Substances Control Act (TSCA)

2.0 SUMMARY

This SOP describes the procedures used by SGS - Orlando to properly and safely dispose of samples and laboratory wastes; hazardous and non-hazardous; domestic and foreign.

The SOP also describes selection and evaluation of a treatment, storage, and disposal facility (TSDF) to ensure proper disposition of waste.

3.0 DEFINITIONS

3.1 Foreign sample: Samples from sites that are outside the continental United States.

3.2 Hazardous Sample or Waste: A material is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity.

3.3 TSCA – Toxic Substances Control Act

3.4 TSDF – Transportation, Storage and Disposal Facility

4.0 PROCEDURE

Waste brokering and Treatment, Storage, and Disposal Facility (TSDF) evaluation: Hazardous Waste Disposal companies (waste brokers) are contracted locally, Corporate SGS evaluates liability coverage, financial stability of the Haz Waste company and sets up the account of an approved vendor in the procurement system.

The laboratory management contacts the TSDF Company and requests audit reports, Notices of Violation information, etc. Laboratory management examines any records collected from EPA-run public domain sites, such as ENVIROFACTS and ECHO (Enforcement and History On-line). Safety records are to be scrutinized as well, such as Lost Time Rate or Insurance Modification Rate (i.e. a number below 1 means safety record is above industry average).

Repeat the process every three years and maintain the records of evaluation.

Sample Disposal: Samples are kept in appropriate storage for a minimum of 30 days after the report is sent to the client unless otherwise specified by client. The samples are divided into four categories: Aqueous, Soil, Foreign Soil, and Non-aqueous liquid.

4.1 Aqueous Samples

4.1.1 A disposal list is generated based on date range (see Attachment 1). This spreadsheet allows sorting per Sample Delivery Group (SDG), Program requirements, hazard status etc. The disposal sheet allows tracking of individual containers and whether the container was consumed during analysis.

4.1.2 Samples are then removed from the refrigerators and/or cabinets, and are separated as non-hazardous (”nonhazardous” or “normal”) and hazardous samples.

4.1.3 Non-hazardous samples are emptied into a neutralization unit, then into city/county sewer and ultimately to a wastewater treatment plant. Neutralization unit is capable of automatically adjusting pH of waste to 6.5 – 9.0 interval, performance is tested, monitored, and recorded weekly.

4.1.3.1 Neutralization unit effluent is collected and tested on monthly basis and the results are compared to the FDEP discharge requirements.

4.1.4 VOA vials are disposed of in their own designated waste stream. All vials are directed intact through a single waste stream regardless of matrix. Vials are collected in 55gal drums and shipped off site for disposal.

4.1.5 Hazardous waste is segregated into multiple waste streams to be handled in the appropriate manner by the Disposal Company contracted by SGS-Orlando (currently Veolia).

4.2 Soil Samples (including Foreign Soils)

4.2.1 Disposal process begins with the review of the dump sheet. Domestic Soil Samples (DSS) are placed in drums after the storage period, either in a hazardous or non-hazardous drum per the samples’ status as defined above.

4.2.2 When the drums are full, they are labeled accordingly, and the vendor contacted for removal.

4.2.3 Some samples, on a case-by-case basis, will be returned to the client for disposal, or may need specialized disposal such as LabPak. This would include samples of a proprietary nature, or those that contain excessive amounts of regulated or unregulated materials. (i.e.: Very high PFAS content, PCBs in excess of 50ppm, elemental samples, etc.)

4.2.4 Foreign soil samples (FSS) come in vials (volatile organic analysis) or jars. These soils are segregated in lockable refrigerator to prevent accidental release into the environment (see also SAM101 and SAM109, current revisions).

4.2.5 After minimum 60-day hold period, but not to exceed 6 months, these FSS are disposed of following the procedures in SOP SAM 109, current revision.

4.3 Non-aqueous liquid samples

4.3.1 Non-aqueous liquid samples are placed in drums after the hold period.

4.3.2 When the drums are full, they are labeled accordingly, and the vendor contacted for removal. Drums have a 6 month expiration time. If the drum is not full by then it is picked up by our contract disposal company.

4.3.3 Samples may, on a case-by-case basis, will be returned to the client for disposal.

4.4 Sample Containers

4.4.1 Containers from samples deemed Non-Hazardous are disposed of into a waste container provided by Waste Management services.

4.4.2 Containers from samples deemed hazardous are disposed of into the Hazardous waste solids drum or other appropriate waste stream.

4.4.3 The contracted vendor picks the container up on a weekly basis and brings to the local sort facility where contents are destroyed - recycled.

4.4.4 Sample container labels may be obscured using privacy labels per client/program requirements (mandatory for DoE samples). These samples are to be disposed of in dedicated drums and tracked to these drums using dump sheet. The drums are later tracked through pick-up manifests and final disposition records.

4.5 Laboratory Waste Disposal:

4.5.1 All materials determined to be hazardous are containerized in appropriate vessels (i.e. drums). A waste is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity. Our contract disposal company disposes of the drums. Materials subject to 40 CFR part 273, Standards for Universal Waste Management (batteries, lamps, mercury devices, electronics, pesticides and aerosols cans) are containerized separately.

4.5.2 PCB TSCA waste is containerized separately from other waste.

4.5.3 WASTE DRUMS are separated by type. As of the date of this SOP, SGS-Orlando is separating wastes into several different waste streams. General descriptions of the primary stream types are below. A more descriptive list along with the corresponding profile numbers and primary generators within the laboratory can be found at the end of this document. If/when new profiles are needed, the contract vendor must be contacted and the appropriate information supplied.

Chlorinated Waste- Spent Methylene Chloride

Non-Chlorinated Waste - Hexane, Methanol, and mixed solvents

Sodium Sulfate/Used Charcoal- Charcoal and paper filters used in the filtering of samples.

Non-Hazardous Aqueous Vials - Primarily Acid Vials.

Hazardous Flammable Vials - Methylene Chloride, Hexane.

MeOH VOA vials

HCL VOA vials

Hazardous Aqueous waste - High Odor Samples, SEAL Waste.

Non-Hazardous Soil – Soils

Universal Waste

PCB TSCA Waste

Waste resulted from the receipt, analysis, and shipping of DOE samples

Hazardous Solid Waste

Non-Aqueous/Oil Samples

The laboratory will collect soil cores for hazardous waste characterization determination of waste resulted from the receipt, analysis, and shipping of DoE samples over the life of the drum twice per drum.

4.5.4 Disposal is done as conscientiously as possible following guidelines set forth by EPA, the State of Florida, DoE, and our contract disposal company. Management and proper handling of laboratory wastes is necessary to avoid any violation. The guidelines change depending on how much waste is generated on a monthly basis:

4.5.4.1 Less than 220 pounds (100 kilograms or about half a drum) is a “Conditionally Exempt Small Quantity Generator”.

4.5.4.2 A “Small Quantity Generator” generates 220-2,200 pounds (100-1,000 kilograms or about half a drum to 5 drums)

4.5.4.3 More than 2,200 pounds (100-1,000 kilograms or more than about 5 drums) is a “Large quantity Generator”.

4.5.4.4 Currently SGS - Orlando is considered a “Large Quantity Generator”.

4.6 Waste Containers and Storage

4.6.1 Containers must be maintained in good condition at all times. Care must be taken to prevent leaks, ruptures, and the accumulation of rainwater on tops of the drums.

4.6.2 Waste containers must be kept closed at all times, except when waste is being transferred to drum.

4.6.3 The containers must be compatible with the waste being stored (i.e. acids should not be stored in metal drums). Never store incompatible wastes in the same container (i.e. acids and bases). Containers must be stored in such a way to accommodate inspection for leaks and damage from all sides

4.6.4 Each waste container must be labeled with the following information.

4.6.4.1 Type and nature of waste (soil, oil, hazardous, non-hazardous)

4.6.4.2 Waste generator’s name and address

4.6.4.3 Manifest document number

4.6.4.4 Proper DOT shipping name and identification number

4.6.4.5 Accumulation start date (change to storage date when container is full)

4.6.4.6 In addition, a hazardous waste must have the words “HAZARDOUS WASTE. FEDERAL LAW PROHIBITS IMPROPER DISPOSAL. IF FOUND, PLEASE CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY” prominently displayed on the container.

4.6.5 Inspection and Records

4.6.5.1 Containers must be inspected weekly. All records must be kept on file for three years. The records, which must be kept on file, include:

- A written log of the inspections
- Manifests and shipping receipts
- Land Disposal Restriction form

4.7 Samples in “HOLD” status

4.7.1 Wherever samples are designated to be put on hold by the client, labels on these samples are highlighted in bright pink and additional bright pink **“HOLD – Do Not Dispose”** label is attached to the individual containers.

4.7.2 Additionally, all Foreign Soils are kept in lockable container regardless of status.

4.7.3 When “hold” samples are removed from the temperature-controlled storage and boxed for extended storage these boxes also receive same bright pink label as individual containers.

4.7.4 “Hold” samples are segregated into a designated quarantine area with clear signs to the nature of the stored samples.

4.7.5 Prior to removal and disposal of “hold” samples from this area, personnel must first confirm with management (Sample Management Supervisor, Laboratory Manager or Operations Manager) that samples can indeed be disposed of.

4.7.5.1 Due to 6-months storage restriction on Foreign Soils samples, Project Manager’s input must be requested by Sample Management department in a timely manner.

4.8 TSCA-regulated PCB waste and derived waste

4.8.1 Do not mix TSCA PCB wastes with non-PCB hazardous waste or universal waste.

4.8.2 Samples containing PCBs > 50 ppm, “suspect” pending results and their derived waste (including but not limited to vials, pipettes, wipes, debris, absorbents and impacted PPE) are immediately physically separated into appropriately designated TSCA PCB waste stream Temporary Storage Area. Do not store for more than 30 days.

4.8.3 If later confirmed that PCB content is $\leq$50 ppm, relabel and reassign to a non-TCSA waste stream.

4.8.4 Confirmed TSCA PCB waste is drummed using compatible material, such as closed HDPE liners used with HDPE drums with absorbent

4.8.5 Label container and storage area with TSCA PCB placard (ML) and Accumulation Start Date (date first placed in storage).

4.8.5.1 Minimum required label text:

- TSCA PCB WASTE >50ppm
- [Affix TSCA ML mark]
- Accumulation Start Date: __/__/__
- Contents/notes, i.e. “lab pack inners; do not mix”, etc.

4.8.6 Storage location and time limits

4.8.6.1 Temporary Storage Area: ≤ 30 days from generation. If not shipped by day 30, then move to TSCA 1-year storage before 30 days expire.

4.8.6.2 One-Year Storage: <1 year total from the original start date (date does not reset when containers move). Should feature impermeable floor, no floor drains, secondary containment (≥ 25% of liquids or largest container), weather/flood protection, security/aisles, spill kit.

4.8.7 Inspections

4.8.7.1 Weekly checks for TSCA PCB storage areas: containers closed, ML mark present, start date present, no leaks/deterioration, aisle space, secondary containment, dates within ≤ 30 d (TSA) / <1 yr (storage). Correct deficiencies immediately and document correction.

4.8.8 Tracking

4.8.8.1 Using LIMS internal CoC track TSCA PCB wastes at physical sample container level from receipt to storage to shipment.

4.8.8.2 Assign due-by notifications to prevent 30-day and 1-year exceedances.

4.8.9 Packaging and Shipment

4.8.9.1 Lab-packs: Intact, closed inners; absorbent; TSCA ML mark on the outer; inventory list attached. No bulking of liquids.

4.8.9.2 Drummed waste: Lid secured; ML + Accumulation Start Date on each drum.

4.8.9.3 Ship on TSCA PCB profiles per TSDF/hauler; apply proper DOT marking/labeling; retain shipping docs

NOTE: The laboratory scans all DoE samples during intake, therefore preventing potentially radioactive materials from entering the premises. Nevertheless, physically separate and appropriately marked “Radioactive-TSCA” shelf space is designated to contain such samples in the unlikely event of remaining on premises

5.0 HEALTH AND SAFETY

5.1 All employees who handle waste materials should wear full protective clothing including safety glasses &/or face shield, gloves, boots, lab coat. Direct skin contact with waste materials should be avoided. The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedure), current revision.

5.2 If an employee has accidentally been exposed to a hazardous waste, the individual should rinse the affected areas thoroughly under a safety shower for at least 15 minutes. If the individual begins to exhibit any adverse effects from the exposure, he should be immediately transported to the nearest hospital emergency room. Employees are referred to the Safety Data Sheets (SDS) for specific instructions on exposure to hazardous substances.

Attachment 1

Disposal sheet example (Account and Project are redacted for confidentiality considerations)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Job	Samplenum	Bottle#	Matx	Location	Received	Closed	Account	Project	Status	DispDate	Depleted	Program
2	FC27881	FC27881-1	1	SOL	3D-1C	18-Sep-25	2-Oct-25	XXX	XXX	HAZARD	4-Nov-25		MARINE
3	FC27888	FC27888-1	1	SOL	3D-1C	18-Sep-25	2-Oct-25	XXX	XXX	HAZARD	4-Nov-25		MARINE
4	FC27888	FC27888-1	2	SOL	3D-1C	18-Sep-25	2-Oct-25	XXX	XXX	HAZARD	4-Nov-25		MARINE
5	FC27901	FC27901-1	3	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
6	FC27901	FC27901-2	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
7	FC27901	FC27901-3	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
8	FC27901	FC27901-4	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
9	FC27901	FC27901-5	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
10	FC27901	FC27901-6	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
11	FC27901	FC27901-6	2	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
12	FC27901	FC27901-7	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
13	FC27901	FC27901-7	2	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
14	FC27901	FC27901-8	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	NONHAZARD	4-Nov-25		
15	FC27901	FC27901-9	1	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	HAZARD	4-Nov-25		
16	FC27901	FC27901-9	2	SO	WI2-11	19-Sep-25	1-Oct-25	XXX	XXX	HAZARD	4-Nov-25		
17	FC27922	FC27922-1	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
18	FC27922	FC27922-2	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
19	FC27922	FC27922-3	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
20	FC27922	FC27922-4	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
21	FC27922	FC27922-5	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
22	FC27922	FC27922-6	1	LIQ	WI1-38	19-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
23	FC27951	FC27951-1	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
24	FC27951	FC27951-2	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
25	FC27951	FC27951-3	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
26	FC27951	FC27951-4	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
27	FC27951	FC27951-5	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
28	FC27951	FC27951-6	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
29	FC27951	FC27951-7	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
30	FC27951	FC27951-8	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
31	FC27951	FC27951-9	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
32	FC27951	FC27951-10	1	SO	WI2-12	22-Sep-25	26-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		
33	FC28000	FC28000-1	1	SO	R-33	24-Sep-25	30-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		DODQSM54
34	FC28000	FC28000-1	2	SO	R-33	24-Sep-25	30-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		DODQSM54
35	FC28000	FC28000-1	3	SO	R-33	24-Sep-25	30-Sep-25	XXX	XXX	NONHAZARD	4-Nov-25		DODQSM54

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
11/2023	12	References	Updated references to include DoD /DoE manual
11/2023	12	2	Added TSDF evaluation to Scope
11/2023	12	3	Updated Definition to include TSDF
11/2023	12	4.0	Added process of waste brokering and TSDF evaluation
11/2023	12	4.1.1	Revised according to dumpsheet use
11/2023	12	4.1.3	revised to reflect neutralization unit
11/2023	12	4.2	Minor editorials in soil disposal
11/2023	12	4.4.4	Sample label obliteration section added
11/2023	12	4.5.2	Additional Waste streams discussed
11/2023	12	5.1	Removed respirator requirement
11/2023	12	Attachment 1	Added dump sheet example
11/2023	12	Appendix of Significant Changes	Added
11/2023	12	SOP Acknowledge-ment Form	Added
01/2025	13	Document Control	Added General Chemistry, Metals Department, Organic Prep, Semivolatile Department, and VOC department to distribution list
01/2025	13	4.4.1	Waste Management dumpster for non-hazardous waste containers - lock and key requirement removed
01/2025	13	5.0	Updated Health and Safety Section to include reference to SOP QA033 (laboratory safety procedure)
11/2025	14	References	Added 40 CFR, Parts 273 and 761 Updated DoD/DoE QSM rev. 5.4 to 6.0

Revision Date	Revision Number	Affected Section(s)	Revision Description
11/2025	14	1.0	Added Toxic Substance Control Act (TSCA)
11/2025	14	4.1.3	Increased neutralization unit pH performance to weekly
11/2025	14	4.1.3.1	Added collection of neutralization unit effluent for FDEP discharge requirement testing
11/2025	14	4.2	Added reference to SOP SAM 109 for disposal of Foreign Soil procedure
11/2025	14	4.4.4	Added mandatory obscuring of container labels for DoE samples
11/2025	14	4.5	Added 40 CFR part 273, Standards for Universal Waste Management and PCB TSCA waste Added discussion of Universal waste, DoD-related waste, and PCB TSCA waste
11/2025	14	4.5.3	Updated waste drum types to include universal waste, PCB TSCA waste, and waste resulted from the receipt, analysis, and shipping of DOE samples Added collection of DOE soil drum waste samples for determination of hazardous waste characteristics

SAMPLE AND LABORATORY WASTE DISPOSAL

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: QA033 and SAM 109, current revisions.

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

APPENDIX B
FIELD DOCUMENTATION FORMS

Former Ft. Ord, CA
3/1/2020
1Q 2020 Groundwater Monitoring
Project #
Weather: (am) Clear, cool 48°
(pm) Overcast, 63°
Team #2
Ahtna Rep. - Shaelyn Hession
Blaine Tech Rep. - Ross Mikovich

0800 - Arrived at MW-002-18-A
W.L. = 78.40 T.D. = 110.6
0810 - Sample collected from station #2
#201ØY0U2100F
0815 - Duplicate sample #201ØY0U2101D
0820 - Labled Trip Blank #201ØY0U2102A
Lid requires new paint & I.D.

0835 - Arrived at MW-BW-75-A
W.L. = 84.32 T.D. = 126.3
Required new lock - replaced.

0845 - Arrived at MW-BW-14-A
W.L. = 63.11 T.D. = 97.5

3/1/2020
1Q2020 FO GWM
Team #2
S. Hession
R. Mikovich

0900 - Arrived at MW-BW-07-180
W.L. = 121.63 T.D. = 194.6
0910 - Sample collected from station #1
201ØY0BW103F
0915 - Station #2 sample # 201ØY0BW104F
0920 - Station #3 sample # 201ØY0BW105F
0925 - Station #4 sample # 201ØY0BW106F
0930 - Station #5 sample # 201ØY0BW107F
No PDB's installed.

1000 - Return to staging area.
Unload equipment
QC all samples, placed in refrigerator.
1030 - Team #2 offsite

Steve Morlay

Water Level Measurements

Job #: Event: Site:

Well ID	Date	Time	Depth to Water	Total Depth (measured)	Total Depth (Historical)	Ref Point (TOC/TOB)

Passive Diffusion Bag (PDB) Groundwater Sampling Form
Former Fort Ord Groundwater Sampling Program

Ahtna

Project Number: _____ **Task #:** _____
Task Manager: _____ **Lab:** SGS
Team Number: _____ **Analysis:** 8260 SIM **Preservative:** HCl
Recorded by: _____ **Sampled By:** _____
Reviewed by: _____ **Water Level Indicator Serial #:** _____ **Correction:** _____

Well	# Stations	Sample Number	Date	DTW/TD Time	DTW	TD	Dup	Bag Sampled	# of Bottles	Sample Time	Bag Drop	Cooler Temp.

Quality Control Samples:		
Type	Date	Sample Number

General Comments: _____

Groundwater Sampling
and Pressure Levels Form
for Westbay Wells

Ahtna

Project Number: _____ **Well Name:** MP - BW - _____ **Client:** USACE

Task Manager: _____ **Sample Date:** / / **Location:** Former Fort Ord

Technicians: _____ **Barometric Pressure:** _____ **Probe Type:** West Bay

Recorded By: _____ / **Sample Time:** **Start:** _____ **DTW:** _____
(Signature) (Initials) **Finish:** _____

Reviewed By: _____ / **Probe Serial No.:** _____
(Signature) (Initials) **Sample # First Port:** _____

Port Identification			**Surface Functioning Tests (Probe in Flushing Collar)**						**Position Sampler**	**Pressure Test and Sample Collection Check at Port (Pressure Test)**				**(Sample Collection)**				
Port No.	Port Name	Port Depth (Cable)	Arm Out Land Probe Shoe Out	Close Valve	Check Vacuum	Open Valve	Evacuate Container	Close Valve Shoe In	1. Locate Port 2. Arm Out 3. Land Probe	Pressure in MP (Internal)	Shoe Out	Zone Pressure (External)	Open Valve	Zone Pressure (External)	Close Valve	Shoe In	Pressure in MP (Internal)	Last 4 Digits of Sample #
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		

General Comments: **Cooler Temp:** °C

QC Sample # Associated Sample:

Fort Ord Groundwater Monitoring Program

Water Level Indicator Calibration by Steel Tape

Event:	
Well #:	
Steel Tape DTW:	
Date:	

Serial #	Measured DTW	Calibration Correction

Reviewed By:	
Date:	

Site Safety Tailgate Meeting

Installation/Site Name		Project Number	
Event Name		Safety Representative	
Date		Field Team Leader	
Weather Forecast:			

Participants (attach loose-leaf sheet if additional space is needed)

Printed Name and Initials	Affiliation	Role	Signature

Scope of Today's Work

Health and Safety Topics Discussed (✓ applicable topics)

☐ Weather Factors	☐ Chem. of Concern	☐ Lifting Safety	☐ Sanitation
☐ AHA Review	☐ PPE Requirements	☐ Recent near miss/injuries/lessons	☐ _____
☐ Site emergency SOP, rally point, etc.	☐ Slip/Trip/Fall Hazards	☐ BBS Hazard Triggers[1]	☐ _____
☐ Changed Conditions	☐ Site Controls	☐ BBS Trigger Controls[2]	☐ _____
☐ Equipment Hazards	☐ Biological Hazards	☐ Traffic Control	☐ _____
	☐ COVID 19 SOPs		

[1] Behavior-based Safety Hazard Triggers: Distractions, rushing, short-cuts, frustration, exhaustion, complacency, anger, multi-tasking, not focusing on task

[2] Behavior-based Safety Trigger Controls: Communicating, accountability, patience, relaxation techniques, healthy lifestyle, and adequate sleep

Comments:

The individual in the Safety Representative role acknowledges that the checked (✓) topics were discussed.

Name (Print) _____ Signature _____ Date _____

FORT ORD MUNITIONS AND EXPLOSIVES OF CONCERN (MEC)
INCIDENT REPORTING FORM

If you recognize any object that resembles munitions or explosives on current or former Fort Ord property, retreat to a safe location, and report the finding to the **appropriate agencies immediately** (see below)

A. PROVIDE THE FOLLOWING INFORMATION:

Name of Person Reporting:	Telephone:
Agency:	Fax:
Date & Time of Incident/Discovery:	
Description of Item Found (refer to the "Safety Alert" pamphlet if possible):	
Location (direction from nearest road/building, attach map if possible):	
GPS Coordinate Location: (Type of Instrument, NAD83 California State Plan Coordinates Zone IV, feet)	
Describe how the item was found:	

CONTACT THE APPROPRIATE AGENCIES IMMEDIATELY:

Initial when completed	Mon– Thu (6 a.m. – 5 p.m.) Contact and FAX Form to:	Contact Number	Date & Time Called
	USACE Ordnance Safety Specialist or MMRP Site Safety Manager	Ph: (831) 884-9925 ext.226 Cell: (831) 760-2571 Fax:(831) 884-9030 Ph: (831) 242-7919 Fax:(831) 242-7019 Cell: (831) 760-2575	
	Fri – Sun (24 Hours) 60th Civ Engr Sqdn EOD	Phone: (707) 424-5517	
	Note: If 60th Civ Engr Sqdn EOD is contacted, notify the MMRP Site Safety Manager: (831) 242-7919, Cell (831) 760-2575.		

B. To be completed by USACE Ordnance Safety Specialist when applicable (Mon – Thu)

Form Received By:		Date & Time:
Identification of Item Found:		
Extent of Area Surveyed:		Name of digital file for picture (date):
Disposition of Item:		
Fax completed form to MMRP Site Safety Mgr Bldg 4463 Gigling Rd, POM (Fort Ord) when response complete	Fax: (831) 242-7091 Phone: (831) 242-7919	Date & Time:

C. To be completed by MMRP Site Safety Manager:

Acknowledge Completed Form Received:	Date & Time:
Regulatory Agencies Notified (Date):	

Ahtna
9699 Blue Larkspur Lane, Suite 203
Monterey, CA 93940
(831) 287-5240

CHAIN OF CUSTODY

WATER / SOIL

Chain of Custody #: _____

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord , CA **Sampler/s:** _____

Project Name: Basewide Groundwater Monitoring Program **Report To:** Derek Lieberman

Project Number: 05IC6.21065.000.00.01 **E-Mail:** dlieberman@ahtna.net

Sampling Event/Site: _____ **Laboratory:** SGS

Analysis Requested

Lab Sample Receipt

Laboratory Sample Delivery

Group #: _____

Custody Seal: _____

Temp (°C): _____

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Water	Matrix: Soil	Matrix: Other	Total # of Bottles	Number of Preserved Bottles: HCl	HNO_3	H_2SO_4	NaOH	MeOH	$NaHSO^4$	None	Other	VOCs 8260 - SIM	Metals 6010D	Chloride 9056A						Notes

Turnaround Time: ____: Standard _____: 3-5 Day Rush _____: 48 Hour Rush _____: 24 Hour Rush

Shipment: **Method:** _____ **Tracking ID:** _____

Comments:

Chain of Custody Tracking:

Relinquished By Sampler:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By Laboratory:	Date/Time:

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0034

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord , CA
Sampler/s: A. Haskin, A. Manvalco
Project Name: Site 12 SGMP
Report To: Derek Lieberman
Project Number: 21065.000.01.0000 (21187.004.01.0000)
E-Mail: dlieberman@ahtna.net
Sampling Event: 2Q2026
Laboratory: ~~SGS~~ Eurofins

Lab Sample Receipt

Laboratory Sample Delivery Group #:
Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	Analysis Requested: TO-15 LL	Analysis Requested: ASTM D1946 ARC	Notes
	2619A212084F	5-7-26	0939	X			1C5471 Am	29967	-5.24	X	X	SG-12-23-10
	2619A212085F	5-7-26	1006	X			1C5418	29931	-7.40	X	X	SG-12-23-20
	2619A212086F	5-7-26	1035	X			1C2853	25321	-5.06	X	X	SG-12-23-50
	2619A212087F	5-7-26	1159	X			1C4042	29979	-6.31	X	X	SG-12-23-70
	2619A212088F	5-7-26	1228	X			3400549	29908	-6.41	X	X	SG-12-23-30
	2619A212089F	5-8-26	0846	X			1C2066	29849	-6.94	X	X	SG-12-24-40
	2619A212090F	5-8-26	0946	X			1C5911	30107	-4.89	X	X	SG-12-24-10
	2619A212091F	5-8-26	1026	X			1C1644	29995	-5.28	X	X	SG-12-24-70
	2619A212092F	5-8-26	1166	X			1C2896	28800	-6.46	X	X	SG-12-24-20
	2619A212093F	5-8-26	1130	X			1C1864	28140	-7.01	X	X	SG-12-24-50
	2619A212094F	5-8-26	1228	X			1C3479	29978	-5.81	X	X	SG-12-24-30
	2619A212095F	5-8-26	1252	X			1C4964	27826	-5.11	X	X	SG-12-24-60

Turnaround Time: ____: Standard ____: 3-5 Day Rush ____: 48 Hour Rush ____: 24 Hour Rush

Shipment: **Method:** **Tracking ID:**

Comments:

Chain of Custody Tracking:

Relinquished By Sampler: Carson Haskin / Ahtna	**Date/Time:** 5/8/26 1330	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By Laboratory:**	**Date/Time:**

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0113

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord , CA

Sampler/s: BEST ENVIRONMENTAL ERIC SCHMIDT

Project Name: FORT ORD TTU 21187.001.01.000

Report To: ~~Derek Lieberman~~ eschmidt@ahtna.net

Project Number: ~~21065.000.01.0000~~

E-Mail: ~~dlieberman@ahtna.net~~

Sampling Event: SOURCE TEST

Laboratory: ~~SGS~~ AAC LABS

Analysis Requested

TO-15 ASTM D5505

Lab Sample Receipt

Laboratory Sample Delivery

Group #:

Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	TO-15	Notes
	TTU-FM-1505	4/29/25	1340	X			TEDLAR BAGS			X	
	TTU-FM-1515	4/29/25	1343	X						X	

Turnaround Time: X : Standard ____ : 3-5 Day Rush ____ : 48 Hour Rush ____ : 24 Hour Rush

Shipment:

Method:

Tracking ID:

Comments: SEE QAPP FOR SULFUR COMPOUND LIST

Chain of Custody Tracking:

Relinquished By Sampler:	Date/Time:	Received By:	Date/Time:
	4/29/25 @ 1400	MARK FISHER	4/30/25 1420
Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**
	4/30/25 @ 1500		
Relinquished By:	**Date/Time:**	**Received By Laboratory:**	**Date/Time:**

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0085

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord , CA **Sampler/s:** MARK FISHER

Project Name: OU2 LANDFILL **Report To:** Derek Lieberman

21187.001.01.0000 eschmidt@ahtna.net

Project Number: 21065.000.01.0000 TASK 04 **E-Mail:** dlieberman@ahtna.net

Sampling Event: ANNUAL VOCS **Laboratory:** SGS EMPIRICAL/AIR TOXIC

Analysis Requested

Lab Sample Receipt

Laboratory Sample Delivery

Group #:

Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	TO-15								Notes
	OU2GM7002	4/29/25	0926	X			[illegible]	60404	-3.0	X		SGP-3B-12						CANISTER ID 6L3703
	OU2GM7003		0941	X			6L2914	60169	-6.5	X		SGP-4B-12						
	OU2GM7004		0954	X			6L1725	60012	-6.0	X		SGP-2C-12						
	OU2GM7005		1003	X			6L1534	60413	-5.0	X		SGP-7E-12						
	OU2GM7006		1022	X			6L2961	60089	-4.8	X		SGP-8E-12						
	OU2GM7007		1054	X			6L3720	60134	-5.5	X		SGP-7F-12						
	OU2GM7008		1106	X			6L0353	60089	-6.0	X		SGP-12F-32						
	OU2GM7009		1127	X			6L0259	60268	-6.0	X		SGP-9F-12						
	OU2GM7010		1146	X			6L0648	60201	-5.5	X		SGP-8F-12						DUP
	OU2GM7011		1136	X			6L0913	60133	-5.0	X		SGP-8F-22						
	OU2GM7012		1144	X			6L1606	60154	-5.0	X		SGP-8F-22						DUP
	OU2GM7013		1159	X			6L2720	60055	-5.5	X		SGP-13F-12						
	OU2GM7014		1207	X			6L0103	60256	-4.5	X		SGP-13F-12						DUP
	OU2GM7015	4/30/25	0833	X			6L1865	60238	-5.5	X		SGP-13F-32						
	OU2GM7016		0846	X			6L0554	60477	-5.5	X		SGP-13F-12						

Turnaround Time: (X): Standard ( ): 3-5 Day Rush ( ): 48 Hour Rush ( ): 24 Hour Rush **Shipment:** **Method:** **Tracking ID:**

Comments: FULL LIST OF VOCs

Chain of Custody Tracking:

Relinquished By Sampler:	**Date/Time:** 4/30/25 1430	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By Laboratory:**	**Date/Time:**

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0086

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord, CA

Sampler/s: MARK FISLER

Project Name: COU2 LANDFILLS

Report To: Derek Lieberman

Project Number: ~~21065.000.01.0000~~ 21187.001.01.0000 TASK 6.4

E-Mail: dlieberman@ahtna.net

Sampling Event: ANNUAL VOCS

Laboratory: ~~SGS~~ EUROFINS/AIR TOXICS

Lab Sample Receipt

Laboratory Sample Delivery Group #:

Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	Analysis Requested: TO-15	Notes
	OU2GM7017	4.30.25	0857	X			6L0719	60359	-6.0	X	SGP-15F-32
	OU2GM7018		0912	X			6L1763	60137	-5.5	X	SGP-17F-12
	OU2GM7019		0920	X			6L0881	60251	-5.0	X	SGP-17F-32
	OU2GM7020		0939	X			6L0361	60214	-4.5	X	SGP-6D-12
	OU2GM7021		0949	X			6L1355	60255	-4.0	X	SGP-6D-22
	OU2GM7022		1010	X			6L2308	60362	-5.0	X	SGP-4D-12
	OU2GM7023		1026	X			6L1546	60317	-4.0	X	SGP-4D-22
	OU2GM7024		~~1049~~ 1048	X			6L0970	60289	-5.5	X	SGP-3C-12
	OU2GM7025		1133	X			6L4029	60187	-5.0	X	SGP-9E-12

Turnaround Time: X : Standard ____ : 3-5 Day Rush ____ : 48 Hour Rush ____ : 24 Hour Rush

Shipment: Method: ____ Tracking ID: ____

Comments: FULL LIST OF VOCS

Chain of Custody Tracking:

Relinquished By Sampler:	Date/Time: 4/30/25 1400	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By Laboratory:	Date/Time:

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0112

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord, CA
Sampler/s: ERIC Schmidt
Project Name: FORT ORD TTU
Report To: ERIC Schmidt / Derek Lieberman
Project Number: 21187.001.01.000 / 21065.000.01.0000
E-Mail: eschmidt@ahtna.net / dlieberman@ahtna.net
Sampling Event: 2025 Q2 ANNUAL
Laboratory: ~~SGS~~ EUROFINS

Analysis Requested: TO-15; ASTM D1945-96

Lab Sample Receipt

Laboratory Sample Delivery
Group #:
Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	TO-15	ASTM D1945-96	Notes
	TTU-FM-150	4/29/25	1350	X			6L2303	G0020	-2.0	X	X	
	TTU-FM-151	4/29/25	1335	X			6L2627	80484	-2.0	X	X	
	TTU-FO-152	4/29/25	1410	X			6L0952	G0510	-3.0	X		

Turnaround Time: X : Standard ____ : 3-5 Day Rush ____ : 48 Hour Rush ____ : 24 Hour Rush

Shipment: **Method:** **Tracking ID:**

Comments: Operational LFG TO-15 (compounds from QAPP (Section 3.6.3)

Chain of Custody Tracking:

Relinquished By Sampler:	**Date/Time:** 1410	**Received By:**	**Date/Time:** 4/29/25 1500
Relinquished By:	**Date/Time:** 4/30/25 1400	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By Laboratory:**	**Date/Time:**

Ahtna

CHAIN OF CUSTODY

SOIL GAS / AIR

Chain of Custody #: 0111

Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: Former Fort Ord, CA

Sampler/s: ~~Best~~ MARK FISLER

Project Name: LFG SAMPLING 21187.001.01.000

Report To: ~~Derek Lieberman~~ ERIC SCHMIDT

Project Number: 21065.000.01.0000

E-Mail: ~~dlieberman@ahtna.net~~ eschmidt@ahtna.net

Sampling Event: ANNUAL SAMPLING

Laboratory: ~~SGS~~ Eurofins

Analysis Requested

Lab Sample Receipt

Laboratory Sample Delivery

Group #:

Custody Seal:

Lab Number	Sample Number/Description	Sample Collection: Date	Sample Collection: Time	Matrix: Soil Gas	Matrix: Ambient Air	Matrix: Other	SUMMA Canister Collection: Canister ID	SUMMA Canister Collection: Regulator ID	SUMMA Canister Collection: Final Vacuum ("Hg)	TO-15	Notes
	TTU-D-146	4/30/25	1200	X			N3491	G0159	-3.0	X	
	TTU-E-147	4/30/25	1215	X			6L1006	G0489	-5.0	X	
	TTU-VF-148	4/30/25	1220	X			6L2307	G0365	-6.0	X	
	TTU-EF-149	4/30/25	1245	X			6L1048	G0183	-5.0	X	

Turnaround Time: X : Standard ____ : 3-5 Day Rush ____ : 48 Hour Rush ____ : 24 Hour Rush

Shipment: **Method:** **Tracking ID:**

Comments: Operational LFG TO-15 Compounds from QAPP (Section 3.6.3)

Chain of Custody Tracking:

Relinquished By Sampler:	Date/Time: 4/30/25 1400	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By Laboratory:	Date/Time:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: _________
Sample #:

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Date: Time: _________
Sample #:

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Ft Ord GW Monitoring-
Samplers:
Date: Time: _________
Sample #:

Ahtna

POST-TREATMENT PARAMETER MONITORING FORM

Project Information:

Project and Task No.: _____

Project Name: _____

Date: _____

Field Personnel Name/s: _____

Well Information:

Well ID: _____

Total Depth: _____ **Well Diameter:** _____

Three Casing Volumes: _____

Parameter Collection Information:

Method of Monitoring: ☐ **Purging** ☐ **Downhole Meter**

Downhole Meter Type and ID: _____

Pump Type and ID: _____

Multi-Meter Type and ID: _____

Meter Calibration Completed (except Temperature)[1]: ☐

Water Level Information:

Initial Depth to Water: _____

Depth to Water after Monitoring: _____

Time	Pump Intake Depth	Rate (mL/min)	Cum. Vol. (L)	Temp. (°C)	pH (units)	Specific Electrical Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	Turbidity (NTU)	Remarks (color, odor, suspended materials, etc.)

NOTES:

[1] If the Horiba U-50 Series multi-meter is used, calibration should occur daily. If the YSI 6-Series Multi-Parameter Water Quality Sonde with downhole probe is used, calibration is performed by the vendor and field calibration is not required for field events lasting less than 1 month, unless field conditions present erroneous data or the Sonde experiences mechanical issues.

Soil Vapor Well/Probe Sampling-Project Specific

Installation/Site		Project Number	
Event Name		Field Team Leader	
Date		Location ID	

Field Team (list name/affiliation)

Weather Conditions

Rain Event (Verify: ☐ <½ in. ☐ ≥½ in.)

A significant rain event is ≥½ inch of rain in a 24-hr period before sampling. If ≥½ inch, obtain field variance.

Sampling Container

Container Type	☐ 1-L Summa	☐ 6-L Summa	☐Tedlar Bag (list size) _____
Certification Level	☐ Batch	☐ Individual	☐ Not Certified

Shut-In Test

Sample Type[1]	Canister ID	Manifold ID	Initial		After 15 minutes		Pass/ Fail[3]
			Time	Vacuum[2]	Time	Vacuum[2]	
N							
FD							

[1] (N) normal (FD) field duplicate (AA) ambient air; extra lines provided for additional shut-in testing
[2] Vacuum measured in inches of mercury (in. Hg)
[3] The shut-in test passes if the drop in vacuum is no greater than 1 in. Hg after 15 minutes of observation

Leak Test

Initial and Final Flow Rate (mL/min.) [4] _____ / _____

Start Time	Helium Concentration (%) [5]								End Time	Pass/ Fail
	t=0 minutes		t=5 minutes		t=10 minutes		t=15 minutes			
	Inline	Enclosed	Inline	Enclosed	Inline	Enclosed	Inline	Enclosed		

[4] Record both the initial and final rates. Target 200 mL/minute for wells up to 20 feet, or 400 mL/minute for wells > 20 feet.
[5] If the inline % He is ≥ 5% of the enclosed space, corrective action is necessary to remedy the leak (e.g., enclosed He=30%, 30% × .05 = 1.5% inline)

Pore Space Purge (Based on Screen Depth)

Start Time		Flow Rate (mL/min.)	
End Time		Total Purge Time (Including Leak Test)	

Soil Vapor Well/Probe Sampling-Project Specific

Sample Collection

Sample Type	Field Sample ID	Start Sampling		End Sampling	
		Time	Vacuum (in Hg)[6]	Time	Vacuum (in Hg) [7]
N					
FD					
AA					

[6] Do not use if the vacuum is less than 25 in. Hg
[7] The final volume should be between 4–8 in. Hg. Field variance from FTL is needed if outside the range

Addition of Helium During Sample Collection

	Helium Concentration (%)[8]								
Sample Type	t= 0 min	t=2 mins	t=4 mins	t=6 mins	t=8 mins	T=10 mins	T=12 mins	T=14 mins	Final
N									
FD									
AA									

[8] The concentration in the shroud must remain above 20% for the duration of the sample collection.

Sample Analysis

Laboratory Name _____

Description	Method	Analyte(s)

Comments (additional observations, probe conditions, other)

Initial _____ Signature _____ Date _____

INSTRUMENT CALIBRATION RECORD

Daily Log				
	Date:			
	No.			
	Sheet	1 Of		1

PROJECT NAME: FORT ORD, CA	Project Number: 21187.
FIELD ACTIVITY SUBJECT: Calibration of Landtec GEM 5000	

DESCRIPTION OF DAILY ACTIVITIES AND EVENTS

Landtec Calibration Gas (high-level) Lot# _____, Expiration Date:_____

Compound	Initial Reading	Calibrated to	Comments
CH4		50% 15%	
CO2		35% 15%	

Landtec Calibration Gas (Oxygen) Lot# _____, Expiration Date:_____

Compound	Initial Reading	Calibrated to	Comments
O2		4%	

VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:

PERSONNEL ON SITE:

SIGNATURE: DATE:

APPENDIX C
ANALYTICAL LABORATORY CERTIFICATIONS

CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

SGS North America Inc. - Orlando
4405 Vineland Road, Suite C-15
Orlando, FL 32811

Fulfills the requirements of

ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V6.0)

In the field of

TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

Jason Stine, Vice President

Expiry Date: 15 December 2026

Certificate Number: L2229

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD/DOE QSM V6.0)

SGS North America Inc. - Orlando

4405 Vineland Road, Suite C-15
Orlando, FL 32811
Svetlana Izosimova, Ph. D., QA Officer
407-425-6700

TESTING

ISO/IEC 17025 Accreditation Granted: **15 December 2024**

Certificate Number: **L2229** Certificate Expiry Date: **15 December 2026**

Environmental

Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA 537.1	Perfluorohexanoic Acid
LC/MS/MS	EPA 537.1	Perfluoroheptanoic Acid
LC/MS/MS	EPA 537.1	Perfluorooctanoic Acid
LC/MS/MS	EPA 537.1	Perfluorononanoic Acid
LC/MS/MS	EPA 537.1	Perfluorodecanoic Acid
LC/MS/MS	EPA 537.1	Perfluoroundecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorododecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorotridecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorotetradecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorobutanesulfonic Acid
LC/MS/MS	EPA 537.1	Perfluorohexanesulfonic Acid
LC/MS/MS	EPA 537.1	Perfluorooctanesulfonic Acid

Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA 537.1	N-Methyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537.1	N-Ethyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537.1	ADONA
LC/MS/MS	EPA 537.1	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	EPA 537.1	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	EPA 537.1	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	EPA 533	Perfluorobutanoic acid
LC/MS/MS	EPA 533	Perfluoropentanoic acid
LC/MS/MS	EPA 533	Perfluorohexanoic acid
LC/MS/MS	EPA 533	Perfluoroheptanoic acid
LC/MS/MS	EPA 533	Perfluorooctanoic acid
LC/MS/MS	EPA 533	Perfluorononanoic acid
LC/MS/MS	EPA 533	Perfluorodecanoic acid
LC/MS/MS	EPA 533	Perfluoroundecanoic acid
LC/MS/MS	EPA 533	Perfluorododecanoic acid
LC/MS/MS	EPA 533	Perfluorobutanesulfonic acid
LC/MS/MS	EPA 533	Perfluoropentanesulfonic acid
LC/MS/MS	EPA 533	Perfluorohexanesulfonic acid
LC/MS/MS	EPA 533	Perfluoroheptanesulfonic acid
LC/MS/MS	EPA 533	Perfluorooctanesulfonic acid
LC/MS/MS	EPA 533	4:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	6:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	8:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	Perfluoro-3-methoxypropanoic acid

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Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA 533	Perfluoro-4-methoxybutanoic acid
LC/MS/MS	EPA 533	Nonafluoro-3,6-dioxaheptanoic acid
LC/MS/MS	EPA 533	Perfluoro(2-ethoxyethane)sulfonic acid
LC/MS/MS	EPA 533	Hexafluoropropylene oxide dimer acid
LC/MS/MS	EPA 533	4,8-Dioxa-3H-perfluorononanoic acid
LC/MS/MS	EPA 533	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid
LC/MS/MS	EPA 533	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-Chloropropane (DBCP)
GC/ECD	EPA 504.1	1,2-Dibromoethane (EDB)
GC/ECD	EPA 504.1	1,2-Dibromo-3-Chloropropane (DBCP)
GC/ECD	EPA 504.1	1,2,3-Trichloropropane (1,2,3-TCP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Oil Range Organics (ORO)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDD
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDE
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDT
GC/ECD	EPA 608.3; EPA 8081B	Aldrin
GC/ECD	EPA 608.3; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	delta-BHC
GC/ECD	EPA 608.3; EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608.3; EPA 8081B	alpha-Chlordane
GC/ECD	EPA 608.3; EPA 8081B	gamma-Chlordane
GC/ECD	EPA 608.3; EPA 8081B	Dieldrin

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan I
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan II
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 608.3; EPA 8081B	Endrin
GC/ECD	EPA 608.3; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 608.3; EPA 8081B	Endrin ketone
GC/ECD	EPA 608.3; EPA 8081B	Heptachlor
GC/ECD	EPA 608.3; EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 608.3; EPA 8081B	Methoxychlor
GC/ECD	EPA 608.3; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	Total PCB
GC/FPD	EPA 8141B	Azinphos-methyl (Guthion)
GC/FPD	EPA 8141B	Bolstar (Sulprofos)
GC/FPD	EPA 8141B	Carbophenothion
GC/FPD	EPA 8141B	Chlorpyrifos
GC/FPD	EPA 8141B	Coumaphos
GC/FPD	EPA 8141B	Demeton-o
GC/FPD	EPA 8141B	Demeton-s
GC/FPD	EPA 8141B	Demeton
GC/FPD	EPA 8141B	Diazinon
GC/FPD	EPA 8141B	Dichlorovos (DDVP Dichlorvos)
GC/FPD	EPA 8141B	Dimethoate
GC/FPD	EPA 8141B	Disulfoton
GC/FPD	EPA 8141B	EPN
GC/FPD	EPA 8141B	Ethion
GC/FPD	EPA 8141B	Ethoprop

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/FPD	EPA 8141B	Famphur
GC/FPD	EPA 8141B	Fensulfothion
GC/FPD	EPA 8141B	Fenthion
GC/FPD	EPA 8141B	Malathion
GC/FPD	EPA 8141B	Merphos
GC/FPD	EPA 8141B	Methyl parathion (Parathion methyl)
GC/FPD	EPA 8141B	Mevinphos
GC/FPD	EPA 8141B	Monocrotophos
GC/FPD	EPA 8141B	Naled
GC/FPD	EPA 8141B	Parathion ethyl
GC/FPD	EPA 8141B	Phorate
GC/FPD	EPA 8141B	Ronnel
GC/FPD	EPA 8141B	Stirofos
GC/FPD	EPA 8141B	Sulfotepp
GC/FPD	EPA 8141B	Tetraethyl pyrophosphate (TEPP)
GC/FPD	EPA 8141B	Thionazin (Zinophos)
GC/FPD	EPA 8141B	Tokuthion (Prothiophos)
GC/FPD	EPA 8141B	Trichloronate
GC/FPD	EPA 8141B	O,O,O-Triethyl phosphorothioate
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop (Dichlorprop)
GC/ECD	EPA 8151A	Dinoseb (2-sec-butyl-4,6-dinitrophenol DNBP)
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2,4,5-TP)
GC/FID	RSK-175	Acetylene
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/FID	RSK-175	Propane
GC/FID	FL-PRO	Total Petroleum Hydrocarbons (TPH)
GC/FID	MA-VPH	Volatile petroleum range organics (VPH)
GC/FID	MA-EPH	Extractable petroleum range organics (EPH)
GC/FID	AK-101	Gasoline range organics (GRO)
GC/FID	AK-102	Diesel range organics (DRO)
GC/FID	KS LRH	Low-Range Hydrocarbons (LRH)
GC/FID	KS MRH	Mid-Range Hydrocarbons (MRH)
GC/FID	KS HRH	High-Range Hydrocarbons (HRH)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 624.1; EPA 8260D	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2,3-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	EPA 624.1; SM 6200B-11;	1,2-Dichlorobenzene (o-Dichlorobenzene)

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Non-Potable Water		
Technology	**Method**	**Analyte**
	EPA 8260D	
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2-Dichloroethene (total)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,2-Dichloropropane
GC/MS	EPA 8260D	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260	1-Chlorohexane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 624.1; EPA 8260D	2-Chloroethyl vinyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	2-Chlorotoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	2-Hexanone
GC/MS	EPA 8260	2-Nitropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	4-Chlorotoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	4-Methyl-2-pentanone (MIBK)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 624.1; EPA 8260D	Acrolein (Propenal)

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride (3-Chloropropene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl Chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Bromobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Bromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Bromodichloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Bromoform
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	n-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	sec-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	tert-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Carbon disulfide
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Carbon tetrachloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Chlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Chloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 624.1; EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	cis-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	trans-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	cis-1,3-Dichloropropene

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	trans-1,3-Dichloropropylene
GC/MS	EPA 8260D	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Di-isopropylether (DIPE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Dibromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Dibromomethane (Methylene Bromide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diethyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D; EPA 8260D SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260D	Ethyl acetate
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Ethyl tert-butyl ether (ETBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Ethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Hexane
GC/MS	EPA 8260D	Iodomethane (Methyl iodide)
GC/MS	EPA 8260D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	p-Isopropyltoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 624.1; EPA 8260D	Methyl Acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Methyl bromide (Bromomethane)

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Methyl chloride (Chloromethane)
GC/MS	EPA 624.1; EPA 8260D	Methylcyclohexane
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Methylene chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Naphthalene
GC/MS	EPA 8260D	Pentachloroethane
GC/MS	EPA 8260D	Propionitrile (Ethyl cyanide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	n-Propylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Styrene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	tert-Amyl alcohol (TAA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	tert-Amyl methyl ether (TAME)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	tert-Butyl alcohol (TBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	tert-Butyl formate (TBF)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Toluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Vinyl acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	Vinyl chloride
GC/MS	EPA 624.1; SM 6200B-11;	Xylene (total)

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Non-Potable Water		
Technology	**Method**	**Analyte**
	EPA 8260D	
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	m,p-Xylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260D	o-Xylene
GC/MS	EPA 625.1; EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 625.1; EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 625.1; EPA 8270E	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 625.1; EPA 8270E	1,2-Diphenylhydrazine
GC/MS	EPA 8270E	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 625.1; EPA 8270E	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270E	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 625.1; EPA 8270E	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270E	1,4-Naphthoquinone
GC/MS	EPA 8270E	1,4-Phenylenediamine
GC/MS	EPA 8270E	1-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	1-Methylnaphthalene
GC/MS	EPA 8270E	1-Naphthylamine
GC/MS	EPA 625.1; EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 625.1; EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 625.1; EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 625.1; EPA 8270E	2,4-Dinitrotoluene (2,4-DNT)
GC/MS	EPA 8270E	2,6-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270E	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270E	2-Acetylaminofluorene
GC/MS	EPA 625.1; EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270E	2-Chlorophenol
GC/MS	EPA 625.1; EPA 8270E	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	2-Methylnaphthalene
GC/MS	EPA 625.1; EPA 8270E	2-Methylphenol (o-Cresol)

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 625.1; EPA 8270E	2-Nitroaniline
GC/MS	EPA 625.1; EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	2-Picoline (2-Methylpyridine)
GC/MS	EPA 625.1; EPA 8270E	3,3`-Dichlorobenzidine
GC/MS	EPA 8270E	3,3`-Dimethylbenzidine
GC/MS	EPA 8270E	3-Methylcholanthrene
GC/MS	EPA 625.1; EPA 8270E	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 625.1; EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 625.1; EPA 8270E	4-Bromophenyl phenyl ether
GC/MS	EPA 625.1; EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 625.1; EPA 8270E	4-Chloroaniline
GC/MS	EPA 625.1; EPA 8270E	4-Chlorophenyl phenylether
GC/MS	EPA 8270E	4-Dimethyl aminoazobenzene
GC/MS	EPA 625.1; EPA 8270E	4-Nitroaniline
GC/MS	EPA 625.1; EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	5-Nitro-o-toluidine
GC/MS	EPA 8270E	7,12-Dimethylbenz(a) anthracene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Acenaphthene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 625.1; EPA 8270E	Acetophenone
GC/MS	EPA 625.1; EPA 8270E	Aniline
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Anthracene
GC/MS	EPA 8270E	Aramite
GC/MS	EPA 625.1; EPA 8270E	Atrazine
GC/MS	EPA 625.1; EPA 8270E	Benzaldehyde
GC/MS	EPA 625.1; EPA 8270E	Benzidine
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 625.1; EPA 8270E;	Benzo(b)fluoranthene

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Non-Potable Water		
Technology	**Method**	**Analyte**
	EPA 8270E SIM	
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 625.1; EPA 8270E	Benzoic acid
GC/MS	EPA 625.1; EPA 8270E	Benzyl alcohol
GC/MS	EPA 625.1; EPA 8270E	Biphenyl(1,1'-Biphenyl)
GC/MS	EPA 625.1; EPA 8270E	bis(2-Chloroethoxy)methane
GC/MS	EPA 625.1; EPA 8270E	bis(2-Chloroethyl) ether
GC/MS	EPA 625.1; EPA 8270E	bis(2-Chloroisopropyl) ether (2,2`-Oxybis(1-chloropropane))
GC/MS	EPA 625.1; EPA 8270E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625.1; EPA 8270E	Butyl benzyl phthalate
GC/MS	EPA 625.1; EPA 8270E	Carbazole
GC/MS	EPA 625.1; EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Chlorobenzilate
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E	Diallate
GC/MS	EPA 625.1; EPA 8270E	Di-n-butyl phthalate
GC/MS	EPA 625.1; EPA 8270E	Di-n-octyl phthalate
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E	Dibenz(a,j)acridine
GC/MS	EPA 625.1; EPA 8270E	Dibenzofuran
GC/MS	EPA 625.1; EPA 8270E	Diethyl phthalate
GC/MS	EPA 625.1; EPA 8270E	Dimethyl phthalate
GC/MS	EPA 8270E	a,a-Dimethylphenethylamine
GC/MS	EPA 827/E	Diphenyl Ether
GC/MS	EPA 8270E EPA 8270E SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270E	Ethyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Fluoranthene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Fluorene

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1; EPA 8270E	Hexachlorobenzene
GC/MS	EPA 625.1; EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 625.1; EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 625.1; EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Hexachlorophene
GC/MS	EPA 8270E	Hexachloropropene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270	Isodrin
GC/MS	EPA 625.1; EPA 8270E	Isophorone
GC/MS	EPA 8270E	Isosafrole
GC/MS	EPA 8270E	Kepone
GC/MS	EPA 8270E	Methapyrilene
GC/MS	EPA 8270E	Methyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Naphthalene
GC/MS	EPA 625.1; EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	Nitroquinoline-1-oxide
GC/MS	EPA 8270E	n-Nitroso-di-n-butylamine
GC/MS	EPA 625.1; EPA 8270E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiethylamine
GC/MS	EPA 625.1; EPA 8270E	n-Nitrosodimethylamine
GC/MS	EPA 625.1; EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270E	n-Nitrosomethylethylamine
GC/MS	EPA 8270E	n-Nitrosomorpholine
GC/MS	EPA 8270E	n-Nitrosopiperidine
GC/MS	EPA 8270E	n-Nitrosopyrrolidine
GC/MS	EPA 8270E	Pentachlorobenzene
GC/MS	EPA 8270E	Pentachloroethane
GC/MS	EPA 8270E	Pentachloronitrobenzene
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 625.1; EPA 8270E;	Phenanthrene

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Non-Potable Water		
Technology	**Method**	**Analyte**
	EPA 8270E SIM	
GC/MS	EPA 625.1; EPA 8270E	Phenol
GC/MS	EPA 8270E	Pronamide (Kerb)
GC/MS	EPA 625.1; EPA 8270E; EPA 8270E SIM	Pyrene
GC/MS	EPA 625.1; EPA 8270E	Pyridine
GC/MS	EPA 8270E	Safrole
GC/MS	EPA 8270E	Simazine
GC/MS	EPA 8270E	Thionazin (Zinophos)
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	Dimethoate
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Famphur
GC/MS	EPA 8270E	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270E	Parathion ethyl
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	O,O,O-Triethyl phosphorothioate
HPLC	EPA 8330A/B	1,3,5-Trinitrobenzene (1,3,5-TNB)
HPLC	EPA 8330A/B	1,3-Dinitrobenzene (1,3-DNB)
HPLC	EPA 8330A/B	2,4,6-Trinitrotoluene (2,4,6-TNT)
HPLC	EPA 8330A/B	2,4-Dinitrotoluene (2,4-DNT)
HPLC	EPA 8330A/B	2,6-Dinitrotoluene (2,6-DNT)
HPLC	EPA 8330A/B	2-Amino-4,6-dinitrotoluene (2-am-dnt)
HPLC	EPA 8330A/B	2-Nitrotoluene
HPLC	EPA 8330A/B	3,5-Dinitroaniline
HPLC	EPA 8330A/B	3-Nitrotoluene
HPLC	EPA 8330A/B	4-Amino-2,6-dinitrotoluene (4-am-dnt)
HPLC	EPA 8330A/B	4-Nitrotoluene
HPLC	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC	EPA 8330A/B	Nitrobenzene
HPLC	EPA 8330A/B	Nitroglycerin
HPLC	EPA 8330A/B	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
HPLC	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)

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Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC	EPA 8330A/B	Pentaerythritoltetranitrate (PETN)
HPLC	EPA 8330A/B	2,4-diamino-6-Nitrotoluene
HPLC	EPA 8330A/B	2,6-diamino-4-Nitrotoluene
HPLC	EPA 8330A/B	DNX
HPLC	EPA 8330A/B	MNX
HPLC	EPA 8330A/B	TNX
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanoic Acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonic Acid (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanesulfonic Acid (PFDS)

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Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanesulfonic Acid (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctane sulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	6:2 Fluorotelomer Sulfonate (FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	ADONA
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	3:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	5:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	7:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	10:2 Fluorotelomer sulfonate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-3-methoxypropanoic acid (PFMPA)

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Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4-PFecHS (Perfluoro-4-ethylcyclohexanesulfonate)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA Method 1633A	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	EPA Method 1633A	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	EPA Method 1633A	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	EPA Method 1633A	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	EPA Method 1633A	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	EPA Method 1633A	Perfluorononanoic Acid (PFNA)
LC/MS/MS	EPA Method 1633A	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	EPA Method 1633A	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	EPA Method 1633A	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	EPA Method 1633A	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	EPA Method 1633A	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	EPA Method 1633A	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	EPA Method 1633A	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	EPA Method 1633A	Perfluorooctanesulfonic Acid (PFOS)
LC/MS/MS	EPA Method 1633A	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	EPA Method 1633A	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	EPA Method 1633A	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Method 1633A	Perfluoropentanesulfonic Acid (PFPeS)

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Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633A	Perfluorododecanesulfonic Acid (PFDoS)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (FTS 4:2)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (FTS 6:2)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (FTS 8:2)
LC/MS/MS	EPA Method 1633A	3-Perfluoropropyl propanoic acid (3:3 FTCA)
LC/MS/MS	EPA Method 1633A	2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)
LC/MS/MS	EPA Method 1633A	3-Perfluoroheptyl propanoic acid (7:3 FTCA)
LC/MS/MS	EPA Method 1633A	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctane sulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Method 1633A	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Method 1633A	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Method 1633A	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Method 1633A	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Method 1633A	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Method 1633A	Perfluoro-4-methoxybutanoic acid (PFMBA)

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Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633A	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Method 1633A	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	EPA Method 1633A	Perfluoropropanoic acid (PFPrA)
LC/MS/MS	EPA Method 1633A	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	EPA Method 1633A	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	EPA Method 1633A	Perfluoropropanesulfonic acid (PFPrS)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorododecane sulfonic acid (FTS 10:2)
LC/MS/MS	EPA Method 1633A	Perfluorobutanesulfonamide (PFBSA)
LC/MS/MS	EPA Method 1633A	Perfluorohexanesulfonamide (PFHxSA)
LC/MS/MS	EPA Method 1633A	Perfluoro (4-ethylcyclohexane) sulfonic acid (4-PFecHS)
LC/MS/MS	EPA Method 1633A	Bis (trifluoromethane) sulfonimide (TFSI HQ-115)
GC/MS/MS	EPA 8270E	1,4-Dioxane
GC/MS/MS	EPA 8270E	1-Methylnaphthalene
GC/MS/MS	EPA 8270E	2-Methylnaphthalene
GC/MS/MS	EPA 8270E	Acenaphthene
GC/MS/MS	EPA 8270E	Acenaphthylene
GC/MS/MS	EPA 8270E	Anthracene
GC/MS/MS	EPA 8270E	Benzo(a)anthracene
GC/MS/MS	EPA 8270E	Benzo(a)pyrene
GC/MS/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS/MS	EPA 8270E	Carbazole
GC/MS/MS	EPA 8270E	Chrysene
GC/MS/MS	EPA 8270E	Dibenz(a,h)anthracene
GC/MS/MS	EPA 8270E	Dibenzofuran
GC/MS/MS	EPA 8270E	Fluoranthene
GC/MS/MS	EPA 8270E	Fluorene
GC/MS/MS	EPA 8270E	Indeno(1,2,3-cd)pyrene
GC/MS/MS	EPA 8270E	Naphthalene
GC/MS/MS	EPA 8270E	Pentachlorophenol

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS/MS	EPA 8270E	Phenanthrene
GC/MS/MS	EPA 8270E	Pyrene
GC/MS/MS	EPA 8270E	4,4'-DDD
GC/MS/MS	EPA 8270E	4,4'-DDE
GC/MS/MS	EPA 8270E	4,4'-DDT
GC/MS/MS	EPA 8270E	Aldrin
GC/MS/MS	EPA 8270E	alpha-BHC
GC/MS/MS	EPA 8270E	alpha-Chlordane
GC/MS/MS	EPA 8270E	beta-BHC
GC/MS/MS	EPA 8270E	delta-BHC
GC/MS/MS	EPA 8270E	Dieldrin
GC/MS/MS	EPA 8270E	Endosulfan I
GC/MS/MS	EPA 8270E	Endosulfan II
GC/MS/MS	EPA 8270E	Endosulfan sulfate
GC/MS/MS	EPA 8270E	Endrin aldehyde
GC/MS/MS	EPA 8270E	gamma-BHC (Lindane)
GC/MS/MS	EPA 8270E	gamma-Chlordane
GC/MS/MS	EPA 8270E	Heptachlor
GC/MS/MS	EPA 8270E	Heptachlor epoxide
GC/MS/MS	EPA 8270E	Methoxychlor
GC/MS/MS	EPA 8270E	Chlordane
GC/MS/MS	EPA 8270E	Toxaphene
GC/MS/MS	EPA 8270E	Bolstar
GC/MS/MS	EPA 8270E	Carbophenothion
GC/MS/MS	EPA 8270E	Chlorpyrifos
GC/MS/MS	EPA 8270E	Coumaphos
GC/MS/MS	EPA 8270E	Demeton-O
GC/MS/MS	EPA 8270E	Demeton-S
GC/MS/MS	EPA 8270E	Diazinon
GC/MS/MS	EPA 8270E	Dichlorvos
GC/MS/MS	EPA 8270E	Dimethoate
GC/MS/MS	EPA 8270E	Disulfoton
GC/MS/MS	EPA 8270E	EPN
GC/MS/MS	EPA 8270E	Ethion
GC/MS/MS	EPA 8270E	Ethoprop

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS/MS	EPA 8270E	Ethyl Parathion
GC/MS/MS	EPA 8270E	Famphur
GC/MS/MS	EPA 8270E	Fensulfothion
GC/MS/MS	EPA 8270E	Fenthion
GC/MS/MS	EPA 8270E	Malathion
GC/MS/MS	EPA 8270E	Merphos
GC/MS/MS	EPA 8270E	Merphos Oxone
GC/MS/MS	EPA 8270E	Methyl Azinphos
GC/MS/MS	EPA 8270E	Methyl Parathion
GC/MS/MS	EPA 8270E	Mevinphos
GC/MS/MS	EPA 8270E	Monocrotophos
GC/MS/MS	EPA 8270E	Naled
GC/MS/MS	EPA 8270E	o,o,o-Triethyl Phosphorothioate
GC/MS/MS	EPA 8270E	Phorate
GC/MS/MS	EPA 8270E	Ronnel
GC/MS/MS	EPA 8270E	Stirophos
GC/MS/MS	EPA 8270E	Sulfotepp
GC/MS/MS	EPA 8270E	TEPP
GC/MS/MS	EPA 8270E	Thionazin
GC/MS/MS	EPA 8270E	Tokuthion
GC/MS/MS	EPA 8270E	Tributyl phosphate
GC/MS/MS	EPA 8270E	Trichloronate
ICP	EPA 200.7; EPA 6010D	Aluminum
ICP	EPA 200.7; EPA 6010D	Antimony
ICP	EPA 200.7; EPA 6010D	Arsenic
ICP	EPA 200.7; EPA 6010D	Barium
ICP	EPA 200.7; EPA 6010D	Beryllium
ICP	EPA 200.7; EPA 6010D	Boron
ICP	EPA 200.7; EPA 6010D	Cadmium
ICP	EPA 200.7; EPA 6010D	Calcium
ICP	EPA 200.7; EPA 6010D	Chromium
ICP	EPA 200.7; EPA 6010D	Cobalt
ICP	EPA 200.7; EPA 6010D	Copper
ICP	EPA 200.7; EPA 6010D	Iron
ICP	EPA 200.7; EPA 6010D	Lead

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 200.7; EPA 6010D	Lithium
ICP	EPA 200.7; EPA 6010D	Magnesium
ICP	EPA 200.7; EPA 6010D	Manganese
ICP	EPA 200.7; EPA 6010D	Molybdenum
ICP	EPA 200.7; EPA 6010D	Nickel
ICP	EPA 200.7; EPA 6010D	Potassium
ICP	EPA 200.7; EPA 6010D	Selenium
ICP	EPA 200.7; EPA 6010D	Silver
ICP	EPA 200.7; EPA 6010D	Sodium
ICP	EPA 200.7; EPA 6010D	Strontium
ICP	EPA 200.7; EPA 6010D	Thallium
ICP	EPA 200.7; EPA 6010D	Tin
ICP	EPA 200.7; EPA 6010D	Titanium
ICP	EPA 200.7; EPA 6010D	Vanadium
ICP	EPA 200.7; EPA 6010D	Zinc
ICP/MS	EPA 200.8; EPA 6020B	Aluminum
ICP/MS	EPA 200.8; EPA 6020B	Antimony
ICP/MS	EPA 200.8; EPA 6020B	Arsenic
ICP/MS	EPA 200.8; EPA 6020B	Barium
ICP/MS	EPA 200.8; EPA 6020B	Beryllium
ICP/MS	EPA 200.8; EPA 6020B	Cadmium
ICP/MS	EPA 200.8; EPA 6020B	Calcium
ICP/MS	EPA 200.8; EPA 6020B	Chromium
ICP/MS	EPA 200.8; EPA 6020B	Cobalt
ICP/MS	EPA 200.8; EPA 6020B	Copper
ICP/MS	EPA 200.8; EPA 6020B	Iron
ICP/MS	EPA 200.8; EPA 6020B	Lead
ICP/MS	EPA 200.8; EPA 6020B	Magnesium
ICP/MS	EPA 200.8; EPA 6020B	Manganese
ICP/MS	EPA 200.8; EPA 6020B	Molybdenum
ICP/MS	EPA 200.8; EPA 6020B	Nickel
ICP/MS	EPA 200.8; EPA 6020B	Potassium
ICP/MS	EPA 200.8; EPA 6020B	Selenium
ICP/MS	EPA 200.8; EPA 6020B	Silver
ICP/MS	EPA 200.8; EPA 6020B	Sodium

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 200.8; EPA 6020B	Strontium
ICP/MS	EPA 200.8; EPA 6020B	Thallium
ICP/MS	EPA 200.8; EPA 6020B	Tin
ICP/MS	EPA 200.8; EPA 6020B	Titanium
ICP/MS	EPA 200.8; EPA 6020B	Vanadium
ICP/MS	EPA 200.8; EPA 6020B	Zinc
CVAA	EPA 7470A	Mercury
CVAA	EPA 245.1	Mercury
UV/VIS	EPA 7196A	Hexavalent Chromium (Cr6+)
UV/VIS	EPA 9012B	Cyanide (Total)
IC	EPA 300; EPA 9056A	Bromide
IC	EPA 300; EPA 9056A	Chloride
IC	EPA 300; EPA 9056A	Fluoride
IC	EPA 300; EPA 9056A	Nitrate
IC	EPA 300; EPA 9056A	Nitrite
IC	EPA 300; EPA 9056A	Sulfate
IC	EPA 300; EPA 9056A	Total nitrate-nitrite
IC	EPA 7199	Hexavalent Chromium
Automated Colorimetry	EPA 350.1	Ammonia
Automated Colorimetry	EPA 350.1	Ammonia, Gas Diffusion Option
Automated Colorimetry	EPA 351.2	Total Kjeldahl Nitrogen
Automated Colorimetry	EPA 353.2	Nitrate
Automated Colorimetry	EPA 353.2	Nitrite
Automated Colorimetry	EPA 353.2	Nitrate + Nitrite
Manual Colorimetry	EPA 365.3	Orthophosphate
Manual Colorimetry	EPA 365.3	Total Phosphorus
Automated Colorimetry	EPA 420.4	Total Phenolics
Titrimetric	SM 2320B-11	Alkalinity, Total
Titrimetric	SM 4500-S2 F-11	Sulfide, Iodometric
Gravimetric Methods	EPA 1664A; EPA 1664B; EPA 9070A	Oil and Grease
Gravimetric Methods	SM 2540B-15	Total Residue (Total Solids)
Gravimetric Methods	SM 2540C-15	Filterable Residue (Total Dissolved Solids)
Gravimetric Methods	SM 2540D-15	Non-Filterable Residue

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Non-Potable Water		
Technology	**Method**	**Analyte**
		(Total Suspended Solids)
Electrometric Methods	SM 4500H+B-11; EPA 9040C	Hydrogen Ion (Ph)
Electrometric Methods	EPA 120.1	Specific conductivity
Combustion	EPA 9060A	Total Organic Carbon
Combustion	SM 5310B-14	Total Organic Carbon
Ignitability	EPA 1020B/C/ASTM D3278-78	Flash Point
Waste Characterization	EPA 9095B	Paint Filter Liquid Test
Preparation	**Method**	**Type**
Organic Preparation	EPA 3510C	Separatory Funnel Liquid-Liquid Extraction
Organic Preparation	EPA 3511	Micro-extraction
Organic Preparation	EPA 3535A; EPA 3535A MOD	Solid Phase Extraction
Organic Preparation	EPA 8151A	Chlorinated Herbicides, Liquid-Liquid Extraction
Organic Preparation	EPA 608; EPA 625	Separatory Funnel Liquid-Liquid Extraction
Volatile Organic Preparation	SW836 5030B	Closed System Purge and Trap
Volatile Organic Preparation	EPA 624	Closed System Purge and Trap
Volatile Organic Preparation	SM 6200B-11	Closed System Purge and Trap
Lachat MicroDistillation	EPA 9012B	Cyanide MicroDistillation; proprietary method
Inorganic Preparation	EPA 3010A	Metals Acid Digestion by Hotblock
Inorganic Preparation	EPA 7470A	CVAA Digestion by Hotblock
Organics Cleanup	EPA 3660B	Sulfur Cleanup
Organics Cleanup	EPA 3665A	Sulfuric Acid Cleanup
Organics Cleanup	EPA 3630C	Silica Gel Cleanup

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-Chloropropane (DBCP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Oil Range Organics (ORO)

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/ECD	EPA 8081B	4,4`-DDD
GC/ECD	EPA 8081B	4,4`-DDE
GC/ECD	EPA 8081B	4,4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	alpha-Chlordane
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin ketone
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	Total PCB

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/FPD	EPA 8141B	Azinphos-methyl (Guthion)
GC/FPD	EPA 8141B	Bolstar (Sulprofos)
GC/FPD	EPA 8141B	Carbophenothion
GC/FPD	EPA 8141B	Chlorpyrifos
GC/FPD	EPA 8141B	Coumaphos
GC/FPD	EPA 8141B	Demeton-o
GC/FPD	EPA 8141B	Demeton-s
GC/FPD	EPA 8141B	Demeton
GC/FPD	EPA 8141B	Diazinon
GC/FPD	EPA 8141B	Dichlorovos (DDVP Dichlorvos)
GC/FPD	EPA 8141B	Dimethoate
GC/FPD	EPA 8141B	Disulfoton
GC/FPD	EPA 8141B	EPN
GC/FPD	EPA 8141B	Ethion
GC/FPD	EPA 8141B	Ethoprop
GC/FPD	EPA 8141B	Famphur
GC/FPD	EPA 8141B	Fensulfothion
GC/FPD	EPA 8141B	Fenthion
GC/FPD	EPA 8141B	Malathion
GC/FPD	EPA 8141B	Merphos
GC/FPD	EPA 8141B	Methyl parathion (Parathion methyl)
GC/FPD	EPA 8141B	Mevinphos
GC/FPD	EPA 8141B	Monocrotophos
GC/FPD	EPA 8141B	Naled
GC/FPD	EPA 8141B	Parathion ethyl
GC/FPD	EPA 8141B	Phorate
GC/FPD	EPA 8141B	Ronnel
GC/FPD	EPA 8141B	Stirofos
GC/FPD	EPA 8141B	Sulfotepp
GC/FPD	EPA 8141B	Tetraethyl pyrophosphate (TEPP)
GC/FPD	EPA 8141B	Thionazin (Zinophos)
GC/FPD	EPA 8141B	Tokuthion (Prothiophos)
GC/FPD	EPA 8141B	Trichloronate
GC/FPD	EPA 8141B	O,O,O-Triethyl phosphorothioate
GC/ECD	EPA 8151A	2,4,5-T

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop (Dichlorprop)
GC/ECD	EPA 8151A	Dinoseb (2-sec-butyl-4,6-dinitrophenol DNBP)
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2,4,5-TP)
GC/FID	FL-PRO	Total Petroleum Hydrocarbons (TPH)
GC/FID	MA-VPH	Volatile petroleum range organics (VPH)
GC/FID	MA-EPH	Extractable petroleum range organics (EPH)
GC/FID	AK-101	Gasoline range organics (GRO)
GC/FID	AK-102	Diesel range organics (DRO)
GC/FID	AK-103	Residual range organics (RRO)
GC/FID	KS LRH	Low-range Hydrocarbons (LRH)
GC/FID	KS MRH	Mid-Range Hydrocarbons (MRH)
GC/FID	KS HRH	High-Range Hydrocarbons (HRH)
GC/MS	EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 8260D	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethylene
GC/MS	EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 8260D	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA 8260D	1,2,3-Trichlorobenzene
GC/MS	EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260D	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260D	1,2-Dibromoethane

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
		(EDB Ethylene dibromide)
GC/MS	EPA 8260D	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 8260D	1,2-Dichloroethene (total)
GC/MS	EPA 8260D	1,2-Dichloropropane
GC/MS	EPA 8260D	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 8260D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260D	1-Chlorohexane
GC/MS	EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 8260D	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 8260D	2-Chloroethyl vinyl ether
GC/MS	EPA 8260D	2-Chlorotoluene
GC/MS	EPA 8260D	2-Hexanone
GC/MS	EPA 8260D	2-Nitropropane
GC/MS	EPA 8260D	4-Chlorotoluene
GC/MS	EPA 8260D	4-Methyl-2-pentanone (MBK)
GC/MS	EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 8260D	Acrolein (Propenal)
GC/MS	EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride (3-Chloropropene)
GC/MS	EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl Chloride
GC/MS	EPA 8260D	Bromobenzene
GC/MS	EPA 8260D	Bromochloromethane
GC/MS	EPA 8260D	Bromodichloromethane
GC/MS	EPA 8260D	Bromoform
GC/MS	EPA 8260D	n-Butylbenzene
GC/MS	EPA 8260D	sec-Butylbenzene
GC/MS	EPA 8260D	tert-Butylbenzene
GC/MS	EPA 8260D	Carbon disulfide
GC/MS	EPA 8260D	Carbon tetrachloride

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Chlorobenzene
GC/MS	EPA 8260D	Chloroethane
GC/MS	EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 8260D	cis-1,2-Dichloroethylene
GC/MS	EPA 8260D	trans-1,2-Dichloroethylene
GC/MS	EPA 8260D	cis-1,3-Dichloropropene
GC/MS	EPA 8260D	trans-1,3-Dichloropropylene
GC/MS	EPA 8260D	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	Di-isopropylether (DIPE)
GC/MS	EPA 8260D	Dibromochloromethane
GC/MS	EPA 8260D	Dibromomethane (Methylene Bromide)
GC/MS	EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diethyl ether
GC/MS	EPA 8260D; EPA 8260D SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8260D	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260D	Ethyl acetate
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260D	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 8260D	Ethyl tert-butyl ether (ETBE)
GC/MS	EPA 8260D	Ethylbenzene
GC/MS	EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Hexane
GC/MS	EPA 8260D	Iodomethane (Methyl iodide)
GC/MS	EPA 8260D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 8260D	p-Isopropyltoluene
GC/MS	EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 8260D	Methyl Acetate
GC/MS	EPA 8260D	Methyl bromide (Bromomethane)
GC/MS	EPA 8260D	Methyl chloride (Chloromethane)
GC/MS	EPA 8260D	Methylcyclohexane

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 8260D	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 8260D	Methylene chloride
GC/MS	EPA 8260D	Naphthalene
GC/MS	EPA 8260D	Pentachloroethane
GC/MS	EPA 8260D	Propionitrile (Ethyl cyanide)
GC/MS	EPA 8260D	n-Propylbenzene
GC/MS	EPA 8260D	Styrene
GC/MS	EPA 8260D	tert-Amyl alcohol (TAA)
GC/MS	EPA 8260D	tert-Amyl methyl ether (TAME)
GC/MS	EPA 8260D	tert-Butyl alcohol (TBA)
GC/MS	EPA 8260D	tert-Butyl formate (TBF)
GC/MS	EPA 8260D	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 8260D	Toluene
GC/MS	EPA 8260D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 8260D	Vinyl acetate
GC/MS	EPA 8260D	Vinyl chloride
GC/MS	EPA 8260D	Xylene (total)
GC/MS	EPA 8260D	m,p-Xylene
GC/MS	EPA 8260D	o-Xylene
GC/MS	EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270E	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8270E	1,2-Diphenylhydrazine
GC/MS	EPA 8270E	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 8270E	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270E	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 8270E	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270E	1,4-Naphthoquinone
GC/MS	EPA 8270E	1,4-Phenylenediamine
GC/MS	EPA 8270E	1-Chloronaphthalene
GC/MS	EPA 8270E; EPA 8270E SIM	1-Methylnaphthalene
GC/MS	EPA 8270E	1-Naphthylamine

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 8270E	2,4-Dinitrotoluene (2,4-DNT)
GC/MS	EPA 8270E	2,6-Dichlorophenol
GC/MS	EPA 8270E	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270E	2-Acetylaminofluorene
GC/MS	EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 8270E	2-Chlorophenol
GC/MS	EPA 8270E	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 8270E; EPA 8270E SIM	2-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 8270E	2-Nitroaniline
GC/MS	EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	2-Picoline (2-Methylpyridine)
GC/MS	EPA 8270E	3,3`-Dichlorobenzidine
GC/MS	EPA 8270E	3,3`-Dimethylbenzidine
GC/MS	EPA 8270E	3-Methylcholanthrene
GC/MS	EPA 8270E	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 8270E	4-Bromophenyl phenyl ether
GC/MS	EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 8270E	4-Chloroaniline
GC/MS	EPA 8270E	4-Chlorophenyl phenylether
GC/MS	EPA 8270E	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270E	4-Nitroaniline
GC/MS	EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	5-Nitro-o-toluidine
GC/MS	EPA 8270E	7,12-Dimethylbenz(a) anthracene

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E; EPA 8270E SIM	Acenaphthene
GC/MS	EPA 8270E; EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 8270E	Acetophenone
GC/MS	EPA 8270E	Aniline
GC/MS	EPA 8270; EPA 8270 SIM	Anthracene
GC/MS	EPA 8270E	Aramite
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Benzaldehyde
GC/MS	EPA 8270E	Benzidine
GC/MS	EPA 8270E; EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 8270E; EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 8270E; EPA 8270E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270E; EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270E; EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Benzoic acid
GC/MS	EPA 8270E	Benzyl alcohol
GC/MS	EPA 8270E	Biphenyl (1,1'-Biphenyl)
GC/MS	EPA 8270E	bis(2-Chloroethoxy) methane
GC/MS	EPA 8270E	bis(2-Chloroethyl) ether
GC/MS	EPA 8270E	bis(2-Chloroisopropyl) ether (2,2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270E	Butyl benzyl phthalate
GC/MS	EPA 8270E	Carbazole
GC/MS	EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Chlorobenzilate
GC/MS	EPA 8270E; EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E	Diallate
GC/MS	EPA 8270E	Di-n-butyl phthalate
GC/MS	EPA 8270E	Di-n-octyl phthalate
GC/MS	EPA 8270E; EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E	Dibenz(a,j)acridine
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Diethyl phthalate
GC/MS	EPA 8270E	Dimethyl phthalate

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	a,a-Dimethylphenethylamine
GC/MS	EPA 8270E	Diphenyl Ether
GC/MS	EPA 8270E EPA 8270E SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270E	Ethyl methanesulfonate
GC/MS	EPA 8270E; EPA 8270E SIM	Fluoranthene
GC/MS	EPA 8270E; EPA 8270E SIM	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Hexachlorophene
GC/MS	EPA 8270E	Hexachloropropene
GC/MS	EPA 8270E; EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270E	Isodrin
GC/MS	EPA 8270E	Isophorone
GC/MS	EPA 8270E	Isosafrole
GC/MS	EPA 8270E	Kepone
GC/MS	EPA 8270E	Methapyrilene
GC/MS	EPA 8270E	Methyl methanesulfonate
GC/MS	EPA 8270E; EPA 8270E SIM	Naphthalene
GC/MS	EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	Nitroquinoline-1-oxide
GC/MS	EPA 8270E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiethylamine
GC/MS	EPA 8270E	n-Nitrosodimethylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270E	n-Nitrosomethylethylamine
GC/MS	EPA 8270E	n-Nitrosomorpholine
GC/MS	EPA 8270E	n-Nitrosopiperidine
GC/MS	EPA 8270E	n-Nitrosopyrrolidine
GC/MS	EPA 8270E	Pentachlorobenzene

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Pentachloroethane
GC/MS	EPA 8270E	Pentachloronitrobenzene
GC/MS	EPA 8270E; EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 8270E; EPA 8270E SIM	Phenanthrene
GC/MS	EPA 8270E	Phenol
GC/MS	EPA 8270E	Pronamide (Kerb)
GC/MS	EPA 8270E; EPA 8270E SIM	Pyrene
GC/MS	EPA 8270E	Pyridine
GC/MS	EPA 8270E	Safrole
GC/MS	EPA 8270E	Simazine
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	Dimethoate
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Famphur
GC/MS	EPA 8270E	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270E	Parathion ethyl
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	Sulfotepp
GC/MS	EPA 8270E	Thionazin (Zinophos)
GC/MS	EPA 8270E	O,O,O-Triethyl phosphorothioate
HPLC	EPA 8330A/B	1,3,5-Trinitrobenzene (1,3,5-TNB)
HPLC	EPA 8330A/B	1,3-Dinitrobenzene (1,3-DNB)
HPLC	EPA 8330A/B	2,4,6-Trinitrotoluene (2,4,6-TNT)
HPLC	EPA 8330A/B	2,4-Dinitrotoluene (2,4-DNT)
HPLC	EPA 8330A/B	2,6-Dinitrotoluene (2,6-DNT)
HPLC	EPA 8330A/B	2-Amino-4,6-dinitrotoluene (2-am-dnt)
HPLC	EPA 8330A/B	2-Nitrotoluene
HPLC	EPA 8330A/B	3,5-Dinitroaniline
HPLC	EPA 8330A/B	3-Nitrotoluene
HPLC	EPA 8330A/B	4-Amino-2,6-dinitrotoluene (4-am-dnt)
HPLC	EPA 8330A/B	4-Nitrotoluene
HPLC	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC	EPA 8330A/B	Nitrobenzene

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC	EPA 8330A/B	Nitroglycerin
HPLC	EPA 8330A/B	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
HPLC	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC	EPA 8330A/B	Pentaerythritoltetranitrate (PETN)
HPLC	EPA 8330A/B	DNX
HPLC	EPA 8330A/B	MNX
HPLC	EPA 8330A/B	TNX
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanoic Acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonic Acid (PFOS)

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanesulfonic Acid (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctane sulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	6:2 Fluorotelomer Sulfonate (FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	ADONA
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	3:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	5:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	7:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	10:2 Fluorotelomer sulfonate

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4-PFecHS (Perfluoro-4-ethylcyclohexanesulfonate)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA Method 1633A	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	EPA Method 1633A	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	EPA Method 1633A	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	EPA Method 1633A	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	EPA Method 1633A	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	EPA Method 1633A	Perfluorononanoic Acid (PFNA)
LC/MS/MS	EPA Method 1633A	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	EPA Method 1633A	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	EPA Method 1633A	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	EPA Method 1633A	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	EPA Method 1633A	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	EPA Method 1633A	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	EPA Method 1633A	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	EPA Method 1633A	Perfluorooctanesulfonic Acid (PFOS)

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633A	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	EPA Method 1633A	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	EPA Method 1633A	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Method 1633A	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	EPA Method 1633A	Perfluorododecanesulfonic Acid (PFDoS)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (FTS 4:2)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (FTS 6:2)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (FTS 8:2)
LC/MS/MS	EPA Method 1633A	3-Perfluoropropyl propanoic acid (3:3 FTCA)
LC/MS/MS	EPA Method 1633A	2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)
LC/MS/MS	EPA Method 1633A	3-Perfluoroheptyl propanoic acid (7:3 FTCA)
LC/MS/MS	EPA Method 1633A	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	EPA Method 1633A	N-Methyl perfluorooctane sulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Method 1633A	N-Ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Method 1633A	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Method 1633A	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Method 1633A	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Method 1633A	Hexafluoropropylene oxide dimer acid (HFPO-DA)

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633A	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Method 1633A	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Method 1633A	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Method 1633A	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	EPA Method 1633A	Perfluoropropanoic acid (PFPrA)
LC/MS/MS	EPA Method 1633A	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	EPA Method 1633A	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	EPA Method 1633A	Perfluoropropanesulfonic acid (PFPrS)
LC/MS/MS	EPA Method 1633A	1H,1H, 2H, 2H-Perfluorododecane sulfonic acid (FTS 10:2)
LC/MS/MS	EPA Method 1633A	Perfluorobutanesulfonamide (PFBSA)
LC/MS/MS	EPA Method 1633A	Perfluorohexanesulfonamide (PFHxSA)
LC/MS/MS	EPA Method 1633A	Perfluoro (4-ethylcyclohexane) sulfonic acid (4-PFecHS)
LC/MS/MS	EPA Method 1633A	Bis (trifluoromethane) sulfonimide (TFSI HQ-115)
GC/MS/MS	EPA 8270E	1,4-Dioxane
GC/MS/MS	EPA 8270E	1-Methylnaphthalene
GC/MS/MS	EPA 8270E	2-Methylnaphthalene
GC/MS/MS	EPA 8270E	Acenaphthene
GC/MS/MS	EPA 8270E	Acenaphthylene
GC/MS/MS	EPA 8270E	Anthracene
GC/MS/MS	EPA 8270E	Benzo(a)anthracene
GC/MS/MS	EPA 8270E	Benzo(a)pyrene
GC/MS/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS/MS	EPA 8270E	Carbazole
GC/MS/MS	EPA 8270E	Chrysene
GC/MS/MS	EPA 8270E	Dibenz(a,h)anthracene
GC/MS/MS	EPA 8270E	Dibenzofuran
GC/MS/MS	EPA 8270E	Fluoranthene
GC/MS/MS	EPA 8270E	Fluorene

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS/MS	EPA 8270E	Indeno(1,2,3-cd)pyrene
GC/MS/MS	EPA 8270E	Naphthalene
GC/MS/MS	EPA 8270E	Pentachlorophenol
GC/MS/MS	EPA 8270E	Phenanthrene
GC/MS/MS	EPA 8270E	Pyrene
GC/MS/MS	EPA 8270E	4,4'-DDD
GC/MS/MS	EPA 8270E	4,4'-DDE
GC/MS/MS	EPA 8270E	4,4'-DDT
GC/MS/MS	EPA 8270E	Aldrin
GC/MS/MS	EPA 8270E	alpha-BHC
GC/MS/MS	EPA 8270E	alpha-Chlordane
GC/MS/MS	EPA 8270E	beta-BHC
GC/MS/MS	EPA 8270E	delta-BHC
GC/MS/MS	EPA 8270E	Dieldrin
GC/MS/MS	EPA 8270E	Endosulfan I
GC/MS/MS	EPA 8270E	Endosulfan II
GC/MS/MS	EPA 8270E	Endosulfan sulfate
GC/MS/MS	EPA 8270E	Endrin aldehyde
GC/MS/MS	EPA 8270E	gamma-BHC (Lindane)
GC/MS/MS	EPA 8270E	gamma-Chlordane
GC/MS/MS	EPA 8270E	Heptachlor
GC/MS/MS	EPA 8270E	Heptachlor epoxide
GC/MS/MS	EPA 8270E	Methoxychlor
GC/MS/MS	EPA 8270E	Chlordane
GC/MS/MS	EPA 8270E	Toxaphene
GC/MS/MS	EPA 8270E	Bolstar
GC/MS/MS	EPA 8270E	Carbophenothion
GC/MS/MS	EPA 8270E	Chlorpyrifos
GC/MS/MS	EPA 8270E	Coumaphos
GC/MS/MS	EPA 8270E	Demeton-O
GC/MS/MS	EPA 8270E	Demeton-S
GC/MS/MS	EPA 8270E	Diazinon
GC/MS/MS	EPA 8270E	Dichlorvos
GC/MS/MS	EPA 8270E	Dimethoate
GC/MS/MS	EPA 8270E	Disulfoton

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS/MS	EPA 8270E	EPN
GC/MS/MS	EPA 8270E	Ethion
GC/MS/MS	EPA 8270E	Ethoprop
GC/MS/MS	EPA 8270E	Ethyl Parathion
GC/MS/MS	EPA 8270E	Famphur
GC/MS/MS	EPA 8270E	Fensulfothion
GC/MS/MS	EPA 8270E	Fenthion
GC/MS/MS	EPA 8270E	Malathion
GC/MS/MS	EPA 8270E	Merphos
GC/MS/MS	EPA 8270E	Merphos Oxone
GC/MS/MS	EPA 8270E	Methyl Azinphos
GC/MS/MS	EPA 8270E	Methyl Parathion
GC/MS/MS	EPA 8270E	Mevinphos
GC/MS/MS	EPA 8270E	Monocrotophos
GC/MS/MS	EPA 8270E	Naled
GC/MS/MS	EPA 8270E	o,o,o-Triethyl Phosphorothioate
GC/MS/MS	EPA 8270E	Phorate
GC/MS/MS	EPA 8270E	Ronnel
GC/MS/MS	EPA 8270E	Stirophos
GC/MS/MS	EPA 8270E	Sulfotepp
GC/MS/MS	EPA 8270E	TEPP
GC/MS/MS	EPA 8270E	Thionazin
GC/MS/MS	EPA 8270E	Tokuthion
GC/MS/MS	EPA 8270E	Tributyl phosphate
GC/MS/MS	EPA 8270E	Trichloronate
ICP	EPA 6010D	Aluminum
ICP	EPA 6010D	Antimony
ICP	EPA 6010D	Arsenic
ICP	EPA 6010D	Barium
ICP	EPA 6010D	Beryllium
ICP	EPA 6010D	Boron
ICP	EPA 6010D	Cadmium
ICP	EPA 6010D	Calcium
ICP	EPA 6010D	Chromium
ICP	EPA 6010D	Cobalt

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010D	Copper
ICP	EPA 6010D	Iron
ICP	EPA 6010D	Lead
ICP	EPA 6010D	Lithium
ICP	EPA 6010D	Magnesium
ICP	EPA 6010D	Manganese
ICP	EPA 6010D	Molybdenum
ICP	EPA 6010D	Nickel
ICP	EPA 6010D	Potassium
ICP	EPA 6010D	Selenium
ICP	EPA 6010D	Silver
ICP	EPA 6010D	Sodium
ICP	EPA 6010D	Strontium
ICP	EPA 6010D	Thallium
ICP	EPA 6010D	Tin
ICP	EPA 6010D	Titanium
ICP	EPA 6010D	Vanadium
ICP	EPA 6010D	Zinc
ICP/MS	EPA 6020B	Aluminum
ICP/MS	EPA 6020B	Antimony
ICP/MS	EPA 6020B	Arsenic
ICP/MS	EPA 6020B	Barium
ICP/MS	EPA 6020B	Beryllium
ICP/MS	EPA 6020B	Cadmium
ICP/MS	EPA 6020B	Calcium
ICP/MS	EPA 6020B	Chromium
ICP/MS	EPA 6020B	Cobalt
ICP/MS	EPA 6020B	Copper
ICP/MS	EPA 6020B	Iron
ICP/MS	EPA 6020B	Lead
ICP/MS	EPA 6020B	Magnesium
ICP/MS	EPA 6020B	Manganese
ICP/MS	EPA 6020B	Molybdenum
ICP/MS	EPA 6020B	Nickel

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020B	Potassium
ICP/MS	EPA 6020B	Selenium
ICP/MS	EPA 6020B	Silver
ICP/MS	EPA 6020B	Sodium
ICP/MS	EPA 6020B	Strontium
ICP/MS	EPA 6020B	Thallium
ICP/MS	EPA 6020B	Tin
ICP/MS	EPA 6020B	Titanium
ICP/MS	EPA 6020B	Vanadium
ICP/MS	EPA 6020B	Zinc
CVAA	EPA 7471B	Mercury
UV/VIS	EPA 7196A	Hexavalent Chromium (Cr6+)
UV/VIS	EPA 9012B	Cyanide (Total)
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Total nitrate-nitrite
IC	EPA 7199	Hexavalent Chromium
Gravimetric Methods	SM 2540G	% solids
Electrometric Methods	EPA 9045D	Hydrogen Ion (pH)
Combustion	EPA 9060A	Total Organic Carbon
Ignitability	EPA 1020B/C MOD	Flash Point
Waste Characterization	EPA 9095B	Paint Filter Liquid Test
Preparation	**Method**	**Type**
Organics Preparation	EPA 3510C	Separatory Funnel Liquid-Liquid Extraction; Leachates
TCLP Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
SPLP Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Organics Preparation	EPA 8011	Microextraction
Organics Preparation	EPA 3546	Microwave Extraction
Organics Preparation	EPA 3550C	Ultrasonic Extraction

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Organics Preparation	EPA 3580A	Waste Dilution for Extractable Organics
Organics Preparation	EPA 8330A; EPA 8332	Ultrasonic Extraction
Organics Preparation	EPA 8330B	Shaker Table Extraction
Volatile Organics Preparation	EPA 3585	Waste Dilution for Volatile Organics
Volatile Organics Preparation	EPA 5030A	Closed System Purge and Trap; Bulk Soils
Volatile Organics Preparation	EPA 5030B	Closed System Purge and Trap; Leachates and Methanol Extracts
Volatile Organics Preparation	EPA 5035; EPA 5035A	Closed System Purge and Trap
Organics Cleanup	EPA 3660B	Sulfur Cleanup
Organics Cleanup	EPA 3665A	Sulfuric Acid Cleanup
Lachat MicroDistillation	EPA 9012B	Cyanide MicroDistillation; proprietary method
Inorganic Preparation	EPA 3010A	Metals Acid Digestion by Hotblock; Leachates
Inorganic Preparation	EPA 3050B	Metals Acid Digestion by Hotblock
Inorganic Preparation	EPA 3060A	Alkaline Digestion, Cr6+
Inorganic Preparation	EPA 7470A	CVAA Digestion by Hotblock; Leachates
Inorganic Preparation	EPA 7471B	CVAA Digestion by Hotblock

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Oregon

Environmental Laboratory Accreditation Program

NELAP Recognized

Eurofins Environment Testing Northern California, LLC

CA300005

180 Blue Ravine Road, Ste. B

Folsom, CA 95630

IS GRANTED APPROVAL BY ORELAP UNDER THE 2016 TNI STANDARDS, TO PERFORM ANALYSES ON ENVIRONMENTAL SAMPLES IN MATRICES AS LISTED BELOW :

Air	Drinking Water	Non-Potable Water	Solids & Chem. Waste	Tissue
Chemistry				

AND AS RECORDED IN THE LIST OF APPROVED ANALYTES, METHODS, ANALYTICAL TECHNIQUES, AND FIELDS OF TESTING ISSUED CONCURRENTLY WITH THIS CERTIFICATE AND REVISED AS NECESSARY.

ACCREDITED STATUS DEPENDS ON SUCCESSFUL ONGOING PARTICIPATION IN THE PROGRAM AND CONTINUED COMPLIANCE WITH THE STANDARDS.

CUSTOMERS ARE URGED TO VERIFY THE LABORATORY'S CURRENT ACCREDITATION STATUS IN OREGON.

Oregon State Public Health Laboratory
ORELAP Program Manager
7202 NE Evergreen Parkway, Suite 100
Hillsboro, OR 97124

EFFECTIVE DATE : **10/18/2026**

EXPIRATION DATE : **10/17/2027**

Certificate No : **CA300005 - 025**

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Environmental Laboratory Accreditation Program

ORELAP Fields of Accreditation

Eurofins Environment Testing Northern California, LLC
180 Blue Ravine Road, Ste. B
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ORELAP ID: CA300005
EPA CODE: CA00933
Certificate: CA300005 - 025

Issue Date: 10/18/2026 Expiration Date: 10/17/2027

As of 10/18/2026 this list supersedes all previous lists for this certificate number.

MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air							
	40 CFR Part 50 Appendix J				FR	10000507	Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere
		3950	Particulates <10 um				
	ASTM D1945			03	2010	30024443	Natural Gas by Gas Chromatography
		4938	2-Methylbutane (Isopentane)				
		4942	2-methylpropane (Isobutane)				
		4323	Acetylene				
		3755	Carbon dioxide				
		3780	Carbon monoxide				
		4747	Ethane				
		4752	Ethene				
		1767	Helium				
		1772	Hydrogen				
		4926	Methane				
		5007	n-Butane				
		5028	n-Pentane				
		5029	n-Propane				
		9511	Neopentane				
		1843	Nitrogen				
		3895	Oxygen				
	ASTM D1946-90				2006	30024465	Reformed Gas by Gas Chromatography
		3755	Carbon dioxide				
		3780	Carbon monoxide				
		4747	Ethane				
		4752	Ethene				
		1767	Helium				
		1772	Hydrogen				
		4926	Methane				
		1843	Nitrogen				
		3895	Oxygen				
	EPA 325B			2013		10277437	Sorbent Tubes Coupled with Thermal Desorption and GC/MS
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		9318	1,3-Butadiene				
		4375	Benzene				
		4765	Ethylbenzene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA 325B			2013		10277437	Sorbent Tubes Coupled with Thermal Desorption and GC/MS
		5240	m+p-xylene				
		4855	n-Hexane				
		5005	Naphthalene				
		5250	o-Xylene				
		5100	Styrene				
		5140	Toluene				
	EPA 327				7/8/2024	10237908	Fugitive and Area Source Measurement of Selected Volatile Organic Hazardous Air Pollutants Using Specially Prepared Canisters
		4795	Ethylene oxide				
		5235	Vinyl chloride				
	EPA TO-12				1988	10248201	Non-Methane Organic Compounds by GC/FID
		3860	Non-methane organics				
	EPA TO-13A				1999	10248405	Polycyclic Aromatic Hydrocarbons in Ambient Air by GC/MS
		5795	2-Chloronaphthalene				
		6385	2-Methylnaphthalene				
		5500	Acenaphthene				
		5505	Acenaphthylene				
		5555	Anthracene				
		5575	Benzo(a)anthracene				
		5580	Benzo(a)pyrene				
		5590	Benzo(g,h,i)perylene				
		5600	Benzo(k)fluoranthene				
		5585	Benzo[b]fluoranthene				
		5855	Chrysene				
		5895	Dibenz(a,h) anthracene				
		6265	Fluoranthene				
		6270	Fluorene				
		6315	Indeno(1,2,3-cd) pyrene				
		5005	Naphthalene				
		6615	Phenanthrene				
		6665	Pyrene				
	EPA TO-14A				1999	10248609	Volatile Organic Compounds with SUMMA canister and GC/MS
		5160	1,1,1-Trichloroethane				
		5110	1,1,2,2-Tetrachloroethane				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-14A				1999	10248609	Volatile Organic Compounds with SUMMA canister and GC/MS
		5185	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)				
		5165	1,1,2-Trichloroethane				
		4630	1,1-Dichloroethane				
		4640	1,1-Dichloroethylene				
		5155	1,2,4-Trichlorobenzene				
		5210	1,2,4-Trimethylbenzene				
		4585	1,2-Dibromoethane (EDB, Ethylene dibromide)				
		4695	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)				
		4610	1,2-Dichlorobenzene				
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		4655	1,2-Dichloropropane				
		5215	1,3,5-Trimethylbenzene				
		9318	1,3-Butadiene				
		4615	1,3-Dichlorobenzene				
		4620	1,4-Dichlorobenzene				
		4735	1,4-Dioxane (1,4-Diethyleneoxide)				
		4836	1-Propene (Propylene)				
		4410	2-Butanone (Methyl ethyl ketone, MEK)				
		4860	2-Hexanone (MBK)				
		4542	4-Ethyltoluene				
		4995	4-Methyl-2-pentanone (MIBK)				
		4315	Acetone				
		4375	Benzene				
		5635	Benzyl chloride				
		4395	Bromodichloromethane				
		4400	Bromoform				
		4450	Carbon disulfide				
		4455	Carbon tetrachloride				
		4475	Chlorobenzene				
		4575	Chlorodibromomethane				
		4485	Chloroethane (Ethyl chloride)				
		4505	Chloroform				
		4705	cis & trans-1,2-Dichloroethene				
		4645	cis-1,2-Dichloroethylene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-14A				1999	10248609	Volatile Organic Compounds with SUMMA canister and GC/MS
		4680	cis-1,3-Dichloropropene				
		4555	Cyclohexane				
		4625	Dichlorodifluoromethane (Freon-12)				
		4750	Ethanol				
		4765	Ethylbenzene				
		4835	Hexachlorobutadiene				
		4895	Isopropyl alcohol (2-Propanol, Isopropanol)				
		4900	Isopropylbenzene (Cumene)				
		5240	m+p-xylene				
		4950	Methyl bromide (Bromomethane)				
		4960	Methyl chloride (Chloromethane)				
		5000	Methyl tert-butyl ether (MTBE)				
		4975	Methylene chloride (Dichloromethane)				
		4825	n-Heptane				
		4855	n-Hexane				
		5090	n-Propylbenzene				
		5005	Naphthalene				
		5250	o-Xylene				
		5100	Styrene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5120	Tetrahydrofuran (THF)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		4685	trans-1,3-Dichloropropylene				
		5170	Trichloroethene (Trichloroethylene)				
		5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)				
		5235	Vinyl chloride				
		5260	Xylene (total)				
	EPA TO-15				1999	10248803	VOCs collected in Canisters by GC/MS
		5105	1,1,1,2-Tetrachloroethane				
		5160	1,1,1-Trichloroethane				
		5110	1,1,2,2-Tetrachloroethane				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-15				1999	10248803	VOCs collected in Canisters by GC/MS
		5185	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)				
		5165	1,1,2-Trichloroethane				
		4630	1,1-Dichloroethane				
		4640	1,1-Dichloroethylene				
		5180	1,2,3-Trichloropropane				
		5155	1,2,4-Trichlorobenzene				
		5210	1,2,4-Trimethylbenzene				
		4570	1,2-Dibromo-3-chloropropane (DBCP)				
		4585	1,2-Dibromoethane (EDB, Ethylene dibromide)				
		4695	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)				
		4610	1,2-Dichlorobenzene				
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		4655	1,2-Dichloropropane				
		5215	1,3,5-Trimethylbenzene				
		9318	1,3-Butadiene				
		4615	1,3-Dichlorobenzene				
		4660	1,3-Dichloropropane				
		4620	1,4-Dichlorobenzene				
		4735	1,4-Dioxane (1,4-Diethyleneoxide)				
		4836	1-Propene (Propylene)				
		5220	2,2,4-Trimethylpentane				
		4410	2-Butanone (Methyl ethyl ketone, MEK)				
		4535	2-Chlorotoluene				
		4860	2-Hexanone (MBK)				
		4938	2-Methylbutane (Isopentane)				
		4942	2-methylpropane (Isobutane)				
		4542	4-Ethyltoluene				
		4910	4-Isopropyltoluene (p-Cymene)				
		4995	4-Methyl-2-pentanone (MIBK)				
		4315	Acetone				
		4340	Acrylonitrile				
		4355	Allyl chloride (3-Chloropropene)				
		4357	alpha-Methylstyrene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-15				1999	10248803	VOCs collected in Canisters by GC/MS
		4375	Benzene				
		5635	Benzyl chloride				
		4385	Bromobenzene				
		4395	Bromodichloromethane				
		4400	Bromoform				
		4450	Carbon disulfide				
		4455	Carbon tetrachloride				
		4475	Chlorobenzene				
		4575	Chlorodibromomethane				
		4577	Chlorodifluoromethane (Freon-22)				
		4485	Chloroethane (Ethyl chloride)				
		4505	Chloroform				
		4705	cis & trans-1,2-Dichloroethene				
		4645	cis-1,2-Dichloroethylene				
		4680	cis-1,3-Dichloropropene				
		4555	Cyclohexane				
		4595	Dibromomethane (Methylene bromide)				
		4625	Dichlorodifluoromethane (Freon-12)				
		4627	Dichlorofluoromethane (Freon 21)				
		4750	Ethanol				
		4755	Ethyl acetate				
		4765	Ethylbenzene				
		4835	Hexachlorobutadiene				
		4895	Isopropyl alcohol (2-Propanol, Isopropanol)				
		4900	Isopropylbenzene (Cumene)				
		5240	m+p-xylene				
		4950	Methyl bromide (Bromomethane)				
		4960	Methyl chloride (Chloromethane)				
		4990	Methyl methacrylate				
		5000	Methyl tert-butyl ether (MTBE)				
		4965	Methylcyclohexane				
		4975	Methylene chloride (Dichloromethane)				
		5007	n-Butane				
		4435	n-Butylbenzene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-15				1999	10248803	VOCs collected in Canisters by GC/MS
		4825	n-Heptane				
		4855	n-Hexane				
		5026	n-Nonane				
		5027	n-Octane				
		5028	n-Pentane				
		5090	n-Propylbenzene				
		5005	Naphthalene				
		5250	o-Xylene				
		4440	sec-Butylbenzene				
		5100	Styrene				
		4420	tert-Butyl alcohol				
		4445	tert-Butylbenzene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5120	Tetrahydrofuran (THF)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		4685	trans-1,3-Dichloropropylene				
		5170	Trichloroethene (Trichloroethylene)				
		5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)				
		5225	Vinyl acetate				
		5230	Vinyl bromide (Bromoethane)				
		5235	Vinyl chloride				
		5260	Xylene (total)				
	EPA TO-15 GC/MS SIM				1999	10248858	VOCs collected in Canisters by GC/MS SIM
		5160	1,1,1-Trichloroethane				
		5110	1,1,2,2-Tetrachloroethane				
		5185	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)				
		5165	1,1,2-Trichloroethane				
		4630	1,1-Dichloroethane				
		4640	1,1-Dichloroethylene				
		4570	1,2-Dibromo-3-chloropropane (DBCP)				
		4585	1,2-Dibromoethane (EDB, Ethylene dibromide)				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-15 GC/MS SIM				1999	10248858	VOCs collected in Canisters by GC/MS SIM
		4695	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)				
		4610	1,2-Dichlorobenzene				
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		4615	1,3-Dichlorobenzene				
		4620	1,4-Dichlorobenzene				
		4375	Benzene				
		4455	Carbon tetrachloride				
		4475	Chlorobenzene				
		4485	Chloroethane (Ethyl chloride)				
		4505	Chloroform				
		4645	cis-1,2-Dichloroethylene				
		4625	Dichlorodifluoromethane (Freon-12)				
		4765	Ethylbenzene				
		4795	Ethylene oxide				
		5240	m+p-xylene				
		4960	Methyl chloride (Chloromethane)				
		5000	Methyl tert-butyl ether (MTBE)				
		5005	Naphthalene				
		5250	o-Xylene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		5170	Trichloroethene (Trichloroethylene)				
		5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)				
		5235	Vinyl chloride				
	EPA TO-17				1999	10312206	Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes
		6703	1,1'-Biphenyl (BZ-0)				
		4640	1,1-Dichloroethylene				
		4735	1,4-Dioxane (1,4-Diethyleneoxide)				
		6380	1-Methylnaphthalene				
		6385	2-Methylnaphthalene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-17				1999	10312206	Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes
		5500	Acenaphthene				
		5505	Acenaphthylene				
		5555	Anthracene				
		4375	Benzene				
		4505	Chloroform				
		4645	cis-1,2-Dichloroethylene				
		9369	Diesel range organics (DRO)				
		4765	Ethylbenzene				
		6265	Fluoranthene				
		6270	Fluorene				
		5240	m+p-xylene				
		5005	Naphthalene				
		5250	o-Xylene				
		6615	Phenanthrene				
		6665	Pyrene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		5170	Trichloroethene (Trichloroethylene)				
		5235	Vinyl chloride				
		5260	Xylene (total)				
	EPA TO-17 Modified			2	1999	10312217	Hydrocarbons in Ambient Air Using WMS Passive Sampling Tubes
		5160	1,1,1-Trichloroethane				
		5110	1,1,2,2-Tetrachloroethane				
		5165	1,1,2-Trichloroethane				
		4630	1,1-Dichloroethane				
		4640	1,1-Dichloroethylene				
		5210	1,2,4-Trimethylbenzene				
		4610	1,2-Dichlorobenzene				
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		5215	1,3,5-Trimethylbenzene				
		4615	1,3-Dichlorobenzene				
		4620	1,4-Dichlorobenzene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	EPA TO-17 Modified			2	1999	10312217	Hydrocarbons in Ambient Air Using WMS Passive Sampling Tubes
		4410	2-Butanone (Methyl ethyl ketone, MEK)				
		4995	4-Methyl-2-pentanone (MIBK)				
		4375	Benzene				
		4455	Carbon tetrachloride				
		4475	Chlorobenzene				
		4505	Chloroform				
		4645	cis-1,2-Dichloroethylene				
		4555	Cyclohexane				
		4765	Ethylbenzene				
		5240	m+p-xylene				
		4960	Methyl chloride (Chloromethane)				
		5000	Methyl tert-butyl ether (MTBE)				
		4825	n-Heptane				
		4855	n-Hexane				
		5090	n-Propylbenzene				
		5005	Naphthalene				
		5250	o-Xylene				
		5100	Styrene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		5170	Trichloroethene (Trichloroethylene)				
		5235	Vinyl chloride				
	EPA TO-3				1984	10312400	Method for the Determination of Volatile Organic Compounds in Ambient Air Using Cryogenic Preconcentration Techniques and Gas Chromatography With Flame Ionization and Electron Capture Detection
		9408	Gasoline range organics (GRO)				
	Modified EPA TO-17 Passive RAD130 Tube			2	1999	60032351	The Determination of Hydrocarbons in Air Via RAD130 RADIELLO Passive Sample Tubes
		5160	1,1,1-Trichloroethane				
		5110	1,1,2,2-Tetrachloroethane				
		5165	1,1,2-Trichloroethane				
		4630	1,1-Dichloroethane				
		4640	1,1-Dichloroethylene				

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MATRIX	Reference	Analyte Code	Analyte	Revision	Rev. Date	Method Code	Description
Air	Modified EPA TO-17 Passive RAD130 Tube			2	1999	60032351	The Determination of Hydrocarbons in Air Via RAD130 RADIELLO Passive Sample Tubes
		5210	1,2,4-Trimethylbenzene				
		4610	1,2-Dichlorobenzene				
		4635	1,2-Dichloroethane (Ethylene dichloride)				
		5215	1,3,5-Trimethylbenzene				
		4615	1,3-Dichlorobenzene				
		4620	1,4-Dichlorobenzene				
		4410	2-Butanone (Methyl ethyl ketone, MEK)				
		4995	4-Methyl-2-pentanone (MIBK)				
		4375	Benzene				
		4455	Carbon tetrachloride				
		4475	Chlorobenzene				
		4505	Chloroform				
		4645	cis-1,2-Dichloroethylene				
		4555	Cyclohexane				
		4755	Ethyl acetate				
		4765	Ethylbenzene				
		5240	m+p-xylene				
		5000	Methyl tert-butyl ether (MTBE)				
		4825	n-Heptane				
		4855	n-Hexane				
		5090	n-Propylbenzene				
		5005	Naphthalene				
		5250	o-Xylene				
		5100	Styrene				
		5115	Tetrachloroethylene (Perchloroethylene)				
		5140	Toluene				
		4700	trans-1,2-Dichloroethylene				
		5170	Trichloroethene (Trichloroethylene)				

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 • www.aqmd.gov

November 7, 2024

Dr. Sucha S. Parmar
Atmospheric Analysis & Consulting
2225 Sperry Ave.
Ventura, CA 93003

Subject: LAP Approval Notice
Reference # 03LA0606

Dear Dr. Parmar:

We completed our review of the renewal application you submitted for approval under the South Coast Air Quality Management District's Laboratory Approval Program (LAP). We are pleased to inform you that your firm is approved for the period beginning November 30, 2024, and ending November 30, 2025 for the following methods, subject to the requirements in the LAP Conditions For Approval Agreement:

South Coast AQMD Method 307-91
South Coast AQMD Method 25.1 (Analysis)
South Coast AQMD Method 25.3 (Analysis)

Thank you for participating in the LAP. Your cooperation helps us to achieve the goal of the LAP: to maintain high standards of quality in the sampling and analysis of source emissions. You may direct any questions or information to LAP Coordinator, Colin Eckerle. He may be reached by telephone at (909) 396-2476, or via e-mail at ceckerle@aqmd.gov.

Sincerely,

D. Sarkar

Dipankar Sarkar
Program Supervisor
Source Test Engineering

DS:CE

241107 LapRenewal.doc

CALIFORNIA
AIR RESOURCES BOARD

Gavin Newsom, Governor
Yana Garcia, CalEPA Secretary
Liane M. Randolph, Chair

June 6, 2025

Bobby Ashfour
Best Environmental
339 Stealth Court
Livermore, California 94551
bobby@best-enviro.com

Dear Bobby Ashfour:

I am pleased to inform you that the California Air Resources Board (CARB) has extended your approval, by means of enclosed Executive Order I-25-009, to perform CARB Test Methods 1, 2, 3, 4, 5, 8, 11, 17, 100 (CO, CO_2, NO_x, O_2, SO_2, THC), Visible Emissions Evaluation (VEE), and U.S. Environmental Protection Agency (U.S. EPA) Test Methods 15A, 18, 201A, 202, and 320. These approvals are valid through June 30, 2028.

If you have questions or need further assistance, please contact the *Independent Contractor Program*[1].

Sincerely,

Walter Ham (Jun 6, 2025 13:01 PDT)
Walter Ham, Ph.D., Chief, Monitoring and Laboratory Division

Enclosure

[1] *icp@arb.ca.gov*

APPENDIX D
THREE PHASE QUALITY CONTROL PROCESS AND DOCUMENTATION

Preparatory Inspections

Project Number		Field Team Leader	
Installation/Site		QC Lead	
Event Name		Project Lead	
Date		Safety Representative	

Meeting Attendees *(list additional attendees on second page)*

Name and Initials	Event Role/Position	Organization

Preparatory Steps

Planning Documents/Submittals Completed with Approvals	
Item	Comments
Planning Documents/Submittals Reviewed by Field Team (Ahtna and Subcontractors)	
Item	Comments
Preliminary Work Completed in Accordance with Plans	
Item	Comments

Ahtna

Preparatory Inspections

DFOW/Tasks Discussed, and Field Team to Implement Work According to Plans	
Item	Comments
Equipment/Supplies/Materials Procured, Available, in Working Order, and Conforming to Standards (list)	
Item	Comments

Action Items

Additional Meeting Attendees

Name and Initials	Event Role/Position	Organization

Approved By

Initial _____ Signature _____ Date _____

Initial/Follow-Up QC Inspections

Project Number		Field Team Leader	
Installation/Site		QC Lead	
Event Name		Project Lead	

List of Applicable Inspection Items

Item	Inspection	Spec. Document and/or Section	QC Category & Frequency[1]
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

[1] (W) Workmanship; (S) Safety; (M/E) Materials and Equipment; (P) Plan Compliance. Depending on the item, list one or more categories (W, S, M/E, or P) and specify the frequency of follow-up inspections.

Project Lead Approval

Initial _____ Signature _____ Date _____

Ahtna

Initial/Follow-Up QC Inspections

Project Number			
Installation/Site		QC Representative	
Event Name		Date of Inspection(s)	

Item Number and Inspection	Phase (I/F)[1]	Inspect. Type[2] W	S	M/E	P	Basis[3] E/N/P/O	Variance (Y/N)[4]	Deficient (Y/N)[5]	Inspector Initial/Time
Details:									
Details:									
Details:									
Details:									
Details:									
Details:									

Notes:

[1] **Phase:** Initial (I); Follow-up (F)

[2] **Inspection Type:** (W) Workmanship; (S) Safety; (M/E) Materials/Equipment; (P) Plan Compliance

[3] **Basis:** (E) Existing DFOW or task; (N) New DFOW or task; (P) New personnel; (O) Other (specify) _____

[4] **Variance:** Contact FTL/PL for variance approval, document resolution. Complete field form SWE-FFRM-004, "Work Variance" as directed by FTL..

[5] **Deficiency:** Contact FTL/PL before proceeding with work, note resolution. Complete field form SWE-FFRM-102, "Corrective Action" as directed.

Approved By

Initial _____ Signature _____ Date _____

APPENDIX E
ELECTRONIC DATA DELIVERABLE FILE SPECIFICATIONS

ADR Electronic Data Deliverable (EDD) File Specifications

The ADR EDD consists of three separate, comma-delimited ASCII text files or Excel CSV files (two, if instrument calibration information is not required by the project). Each file corresponds to a table in the ADR application. These tables are identified as the Analytical Results Table (A1), Laboratory Instrument Table (A2), and Sample Analysis Table (A3). Each file follows the naming convention of using the Laboratory Reporting Batch ID (SDG Number or some other identifier for the EDD) followed by the table identifier (A1, A2, or A3), and then a ".txt" or ".csv" extension. For example, the EDD file names for a laboratory reporting batch identified as SDG001 that includes instrument calibration data would be as follows.

SDG001A1.txt or SDG001A1.csv
SDG001A2.txt or SDG001A2.csv (A2 file is optional)
SDG001A3.txt or SDG001A3.csv

Analytical Results Table (A1 File)

The Analytical Results table contains analytical results and related information on an analyte level for field samples and associated laboratory quality control samples (excluding calibrations and tunes). Field QC blanks and laboratory method blanks must report a result record for each analyte reported within a method. The method target analyte list is matrix dependent and specified in the project library. Laboratory control samples (LCS and LCSD) and matrix spike samples (MS and MSD) must report a result record for every analyte specified as a spiked analyte in the project library. The project library is a reference table ADR uses for both EDD error checking and automated data review. The project library is populated with information from the project QAPP. Refer to the User Manual for detailed information on project libraries. Table 1 in this document lists all field names and their descriptions for the Analytical Results Table (A1).

Laboratory Instrument Table (A2 File)

The Laboratory Instrument table contains results and related information on an analyte level for instrument initial calibration standards, initial calibration verification standards, continuing calibration standards, and GC/MS tunes. A record must exist for each target analyte reported in a method (specified in the project library), for every calibration type (the field named QCType) associated to samples reported in the EDD. Initial calibrations, initial calibration verifications, and associated samples are linked to each other using a unique Run Batch ID for every distinct initial calibration within a method. Continuing calibrations and associated samples are linked to each other using a unique Analysis Batch ID for every distinct continuing calibration within a method. GC/MS tunes are linked to initial and continuing calibrations (and hence samples) using the Run Batch and Analysis Batch IDs respectively. The Laboratory Instrument Table (A2) is optional. Depending on the level of validation required by the data user, the Laboratory Instrument table may not be requested in the deliverable. Table 2 in this document lists field names and descriptions for the Laboratory Instrument Table (A2).

Sample Analysis Table (A3 File)

The Sample Analysis table contains information on a sample level for field samples and laboratory quality control analyses (excluding calibrations and tunes). A sample record exists for each sample/method/matrix/analysis type combination. Table 3 in this document lists field names and descriptions for the Sample Analysis Table (A3).

EDD Field Properties

Tables 1, 2, and 3 in this document specify the EDD field properties for each file. These include the field name and sequence, field name description, data type and length for each field, and whether or not a particular field requires a standard field. Field elements in the EDD must be sequenced according to the order they appear in Tables 1, 2, and 3. For example, in the Analytical Result table (the A1 file), the field "ClientSampleID" will always be the first piece of information to start a new line of data (or database record), followed by the fields "LabAnalysisRefMethodID", "AnalysisType", and so on.

Table 4 in this document lists standard values for those fields that hold standard values. Required field constraints depend on the combination of sample, matrix, method, analyte type, and calibration or QC type information reported in a record. Tables 5 through 9 in this document indicate required fields for each EDD file (table) according to the method category, matrix, analyte type, sample, and QC or calibration type reported in a record.

When creating an EDD as a text file, use the ASCII character set in a file of lines terminated by a carriage return and line feed. No characters are allowed after the carriage return and line feed. Enclose each data set in double quotes (") and separate each field by a comma (comma delimited). Data fields with no information (null) may be represented by two consecutive commas. For example, in the Sample Analysis table, since the "Collected", "ShippingBatchID", and "Temperature" fields do not apply to laboratory generated QA/QC samples, the record for a Laboratory Control Sample by Method 8270C would be entered as follows. Note that the first two fields ("ProjectNumber" and "ProjectName") are omitted in this example.

…"LCSW100598",,"AQ","LCSW100598","LCS",,"8270C",… (and so on)

Do not pad fields with leading or trailing spaces if a field is populated with less than the maximum allowed number of characters. In the above example, although the "MatrixID" field can accommodate up to 10 characters, only 2 characters were entered in this field.

The EDD can be constructed within Excel and saved as .csv file for import into the application. Be sure to format all cells as text beforehand, otherwise Excel will reformat entered values in some cases.

Table 1
Field Descriptions for the Analytical Results Table (A1 file)

Contains laboratory test results and related information for field and QC samples (excluding instrument calibrations) on an analyte level for environmental chemistry including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
ClientSampleID	Client or contractor's identifier for a field sample as reported on the chain-of-custody If a sample is analyzed as a laboratory duplicate, matrix spike, or matrix spike duplicate, append suffixes DUP, MS and MSD respectively to the Client Sample ID with no intervening spaces or hyphens (i.e. MW01DUP, MW01MS, and MW01MSD). For Method Blanks, LCS, and LCSD enter the unique LaboratorySampleID into this field Do not append suffixes to the ClientSampleID for dilutions, reanalyses, or re-extracts (the AnalysisType field is used for this distinction). For example, MW01DL and MW01RE are not allowed Parent sample records must exist for each MS and MSD. If an MS/MSD is shared between two EDDs, records for the MS/MSD and its parent sample must exist in the Analytical Results table for both EDDs.	Text	25	NO
LabAnalysisRefMethodID	Laboratory reference method ID. The method ID may be an EPA Method number or a Lab Identifier for a method such as a SOP Number, however; method ID is specified by the project. The method ID must be entered into the standard list.	Text	25	YES (specified in project plan)
AnalysisType	Defines the analysis type (i.e., Dilution, Reanalysis, etc.). This field provides distinction for sample result records when multiple analyses are submitted for the same sample, method, and matrix; for example dilutions, re-analyses, and re-extracts.	Text	10	YES (See Table 4)
LabSampleID	Laboratory tracking number for field samples and lab generated QC samples such as method blank, LCS, and LCSD. There are no restrictions for the LabSampleID except for field length and that the LabSampleID must be distinct for a given field sample or lab QC sample and method. Suffixes may be applied to the LabSampleID to designate dilutions, reanalysis, etc.	Text	25	NO
LabID	Identification of the laboratory performing the analyses.	Text	7	NO
ClientAnalyteID	CAS Number or unique client identifier for an analyte or isotope. If a CAS Number is not available, use a unique identifier provided by the client or contractor. The ClientAnalyteID for a particular target analyte or isotope should be specified by the project and must exist in the standard value tables for Analytes. For the LCS, LCSD, MS, and MSD, it is only necessary to report the compounds designated as spikes in the library (and surrogates for organic methods.) For TICs from GC/MS analyses, enter the retention time in decimal minutes as the Client Analyte ID.	Text	12	YES (specified by project)

Table 1
Field Descriptions for the Analytical Results Table (A1 file)

Contains laboratory test results and related information for field and QC samples (excluding instrument calibrations) on an analyte level for environmental chemistry including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
AnalyteName	Chemical name for the analyte or isotope. The project specifies how an analyte or isotope is named. The analyte name must be associated to a ClientAnalyteID in the standard values table for Analytes (excluding compounds designated as TIC's).	Numeric	60	YES (specified by project)
Result	Result value for the analyte or isotope. Entries must be numeric. For non-detects of target analytes or isotopes and spikes, do not enter "ND" or leave this field blank. If an analyte or spike was not detected, enter the reporting limit value corrected for dilution and percent moisture as applicable. Do not enter "0"	Text	10	NO
ResultUnits	The units defining how the values in the Result, DetectionLimit, and ReportingLimit fields are expressed. For radiochemistry this also includes how the value in the Error field is expressed.	Text	10	YES (specified by project in the library)
LabQualifiers	A string of single letter result qualifiers assigned by the lab based on client-defined rules and values. The "U" Lab Qualifier must be entered for all non-detects. Other pertinent lab qualifiers may be entered with the "U" qualifier. Order is insignificant. Lab qualifiers other than those listed in the standard values table may be used. If so, these must be added to the standard value table in the application.	Text	7	YES (See Table 4)
DetectionLimit	For radiochemistry methods, the minimum detectable activity for the isotope being measured. For all other methods: The minimum detection limit value for the analyte being measured. **For DoD QSM enter the Limit of Detection (LOD)**	Numeric	10	NO
DetectionLimitType	Specifies the type of detection limit (i.e., MDA, MDL, IDL, etc.).	Text	10	YES (See Table 4)
RetentionTime or Error	For radiochemistry methods only, enter the 2 Sigma Counting Error. The units for error are entered in the ResultUnits field. For GC/MS methods only, enter the time expressed in decimal minutes between injection and detection for GC/MS TICs only For target analytes in all other methods, leave this field blank. Note: GC retention times are not evaluated at this time.	Text	5	NO
AnalyteType	Defines the type of result, such as tracer, surrogate, spike, or target compound.	Text	7	YES (See Table 4)

Table 1
Field Descriptions for the Analytical Results Table (A1 file)

Contains laboratory test results and related information for field and QC samples (excluding instrument calibrations) on an analyte level for environmental chemistry including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
PercentRecovery	For radiochemistry methods: The tracer yield, if applicable. For all other analytical methods: The percent recovery value of a spiked compound or surrogate. If the spike or surrogate was not recovered because of dilution, enter "DIL". If a spike or surrogate was not recovered because of matrix interference, enter "INT". If a spike or surrogate was not recovered because it was not added to the sample, enter "NS".	Numeric	5	NO
RelativePercentDifference	The relative percent difference (RPD) of two QC results, such as MS/MSD, LCS/LCSD, and Laboratory Duplicates. Report RPD in Laboratory Duplicate, LCSD, and MSD records only. If the RPD is not calculable, enter "NC".	Numeric	5	NO
ReportingLimit	Reporting limit value for the measured analyte or isotope Factor in the dilution factor and percent moisture correction, if applicable. The Reporting Limit for each analyte and matrix in a given method is specified in the project library or QAPP. **For DoD QSM enter the Limit of Quantitation (LOQ)**	Numeric	10	NO
ReportingLimitType	Specifies the type of reporting limit (i.e., CRQL, PQL, SQL, RDL, etc). The Reporting Limit Type for each method and matrix is specified in the project library or QAPP.	Text	10	YES (specified by the project)

Table 1
Field Descriptions for the Analytical Results Table (A1 file)

Contains laboratory test results and related information for field and QC samples (excluding instrument calibrations) on an analyte level for environmental chemistry including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
ReportableResult	This field indicates whether or not the laboratory chooses an individual analyte or isotope result as reportable. Enter "YES" if the result is reportable. Enter "NO" if the result is not reportable. This field applies to target analytes only. If only one analysis is submitted for a particular sample and method, enter "YES" for all target compounds (where Analyte Type = TRG). For GC/MS methods enter yes for tentatively identified compounds (where Analyte Type = TIC). If two or more analyses are submitted for a particular sample and method (i.e. initial analysis, reanalysis and/or dilutions), enter "YES" from only <u>one</u> of the analyses for each target compound. For example: a sample was run a second time at dilution because benzene exceeded the calibration range in the initial, undiluted analysis. All target analytes are reported in each analysis. For the initial analysis, (Analysis Type = RES), enter "NO" for benzene and enter "YES" for all other compounds. For the diluted analysis (Analysis Type = DL), enter "YES" for benzene and enter "NO" for all other compounds. For TICs (Analyte Type = TIC), if more than one analysis is submitted for a particular sample and method, choose only one of the analyses where Reportable Result = YES for <u>all</u> TICs. For example, a sample was run a second time because one or more target compounds exceeded the calibration range in the undiluted analysis. Choose a particular analysis and enter "YES" for all TICS. In the other analysis enter "NO" for all TICs. Note that it is not necessary to report the full target analyte list for the initial result, dilution, re-analysis, or re-extraction. However, each target analyte must be reported YES once and once only in the case of multiple analyses for a given sample, method, and matrix. In the case of organics, all surrogates must be reported for all analyses submitted for a given sample, method, and, matrix.	Text	3	YES (See Table 4)
MDL_DoD	This field is not part of the standard ADR EDD format. **For DoD QSM enter the MDL, otherwise leave blank. (ADR does not perform error checks on this field)**	Numeric	10	NO

Table 2
Field Descriptions for the Laboratory Instrument Table (A2 file)

Contains related to laboratory instrument calibration on an analyte level and GC/MS Tune information. This table is optional depending on project requirements. Do not report Table A2 for radiochemistry methods.

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
InstrumentID	Laboratory instrument identification.	Text	15	NO
QCType	Type of instrument QC (i.e., Instrument_Performance_Check or type of calibration standard).	Text	10	YES (See Table 4)
Analyzed	Analysis date/time for BFB, DFTPP, initial calibration verification standards, calibration verification standards, and continuing calibration standards. For the initial calibration, enter date and time of the last standard analyzed. Also, see comments about initial calibrations in the Alternate_Lab_Analysis_ID field name description.	Date/ Time	*	NO
AlternateLab_AnalysisID	Common laboratory identification used for standards (i.e., VOA STD50, CCAL100, BFB50, etc). For initial calibration, enter ICAL. Information from the initial calibration is entered as one record for each analyte that summarizes the results of the initial calibration (i.e. %RSD, correlation coefficient, and avg RF). Records are not entered for each individual standard within the initial calibration.	Text	12	NO
LabAnalysisID	Unique identification of the raw data electronic file associated with the calibration standard or tune (i.e., 9812101MS.DV). Leave this field blank for the initial calibration. See comments about initial calibrations in the Alternate_Lab_Analysis_ID field description. This field is only applicable where an electronic instrument file is created as part of the analysis.	Text	15	NO
LabAnalysisRefMethodID	Laboratory reference method ID (i.e., 8260B, 8270C, 6010B, etc.). The method ID is specified by the project. The LabAnalysisRefMethodID must be in the standard value list for Method IDs.	Text	25	YES (specified by the project)
ClientAnalyteID	CAS number or unique client identifier for an analyte. If a CAS number is not available, use a unique identifier provided by the client. The unique identifier for a particular analyte should be specified by the project and must exist in the standard value list for ClientAnalyteID. Records for each calibration must report the full target analyte list including surrogates as applicable. The target analyte list is specified for each method and matrix in the project	Text	12	YES (specified by the project)
AnalyteName	The chemical name for the analyte. The project specifies how an analyte is named. The AnalyteName must be associated to a ClientAnalyteID in the standard values.	Text	60	YES (specified by the project)

Table 2
Field Descriptions for the Laboratory Instrument Table (A2 file)

Contains related to laboratory instrument calibration on an analyte level and GC/MS Tune information. This table is optional depending on project requirements. Do not report Table A2 for radiochemistry methods.

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
RunBatch	Unique identifier for a batch of analyses performed on one instrument under the control of one initial calibration and initial calibration verification. The Run Batch ID links both the initial calibration and initial calibration verification to subsequently analyzed and associated continuing calibrations, field samples, and QC analyses. For GC/MS methods, the Run_Batch ID also links a BFB or DFTPP tune and the initial calibration and initial calibration verification standards to associated samples and method QC analyses. A new and unique Run Batch ID must be used with every new initial calibration.	Text	12	NO
AnalysisBatch	Unique laboratory identifier for a batch of analyses performed on one instrument and under the control of a continuing calibration or continuing calibration verification. The Analysis Batch ID links the continuing calibration or calibration verification to subsequently analyzed and associated field sample and QC analyses. For GC/MS methods, the Analysis Batch ID also links the BFB or DFTPP tune. A new and unique Analysis Batch ID must be used with every new continuing calibration or continuing calibration verification. For GC methods, only report opening standards, do not include closing standards (unless the closing standard functions as the opening standard for a subsequent set of analyses, in which case a new and unique Analysis Batch ID is assigned). When dual or confirmation columns/detectors are used, enter results from the primary column/detector only (this is similar to CLP Pesticide reporting).	Text	12	NO
LabReportingBatch	Unique laboratory identifier for a batch of samples including associated calibrations and method QC, reported as a group by the lab (i.e., lab work order #, log-in #, or SDG). Links all instrument calibrations, samples, and method QC reported as a group or SDG.	Text	12	NO
PercentRelativeStandard Deviation	The standard deviation relative to the mean used to evaluate initial calibration linearity. Organic methods may use either %RSD or Correlation Coefficient. If applicable, enter the %RSD. Leave this field blank if the Correlation Coefficient is used.	Numeric	5	NO
CorrelationCoefficient	The correlation coefficient resulting from linear regression of the initial calibration. For metals by ICAP, enter '1.0' if a two-point initial calibration was analyzed. Organic methods may use either %RSD or Correlation Coefficient. If applicable, enter the Correlation Coefficient. Leave this field blank if the %RSD is used	Numeric	5	NO
RelativeResponseFactor	This field applies to GC/MS only. For continuing calibration enter the relative response factor. For initial calibration enter the average relative response factor. Refer to comments about initial calibration records in the field description for Alternate_Lab_Analysis_ID.	Numeric	5	NO

Table 2
Field Descriptions for the Laboratory Instrument Table (A2 file)

Contains related to laboratory instrument calibration on an analyte level and GC/MS Tune information. This table is optional depending on project requirements. Do not report Table A2 for radiochemistry methods.

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
Percent_Difference (or Percent Recovery)	For organic methods, this field is the difference between 2 measured values expressed as a percentage. If %RSD is reported, enter the % difference between the average response factor of the initial calibration (IC) and the response factor of the initial calibration verification (ICV) or continuing calibration (CCV). If correlation coefficient is used, enter the % difference between the true value and the measured value. The Percent_Difference is expressed as a negative or positive value. Do not express Percent_Difference as an absolute value. Use a negative value if the CCV or ICV response factor is less than the IC average response factor or, in the case of correlation coefficient, the CCV or ICV measured value is less than the true value. Use a positive value if the CCV or ICV response factor is greater than the IC average response factor, or in the case of correlation coefficient, the CCV or ICV measured value is greater than the true value. For inorganic methods, this field is the recovery of an analyte expressed relative to the true amount (i.e., %R for a metal in the continuing calibration or initial calibration verification by Method 6010B).	Numeric	5	NO
PeakID01	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 50, for DFTPP enter 51.	Numeric	10	NO
PercentRatio01	For BFB enter the relative percent abundance of m/z 50 measured relative to the raw abundance of m/z 95. For DFTPP enter the relative percent abundance of m/z 51 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID02	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 75, for DFTPP enter 68.	Numeric	10	NO
PercentRatio02	For BFB enter the relative percent abundance of m/z 75 measured relative to the raw abundance of m/z 95. For DFTPP enter the relative percent abundance of m/z 68 measured relative to the raw abundance of m/z 69.	Numeric	10	NO
PeakID03	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 95, for DFTPP enter 69.	Numeric	10	NO
PercentRatio03	For BFB enter the ion abundance of m/z 95 as 100 percent. For DFTPP enter the relative percent abundance of m/z 69 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID04	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 96, for DFTPP enter 70.	Numeric	10	NO

Table 2
Field Descriptions for the Laboratory Instrument Table (A2 file)

Contains related to laboratory instrument calibration on an analyte level and GC/MS Tune information. This table is optional depending on project requirements. Do not report Table A2 for radiochemistry methods.

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
PercentRatio04	For BFB enter the relative percent abundance of m/z 96 measured relative to the raw abundance of m/z 95. For DFTPP enter the relative percent abundance of m/z 70 measured relative to the raw abundance of m/z 69	Numeric	10	NO
PeakID05	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 173, for DFTPP enter 127.	Numeric	10	NO
PercentRatio05	For BFB enter the relative percent abundance of m/z 173 measured relative to the raw abundance of m/z 174. For DFTPP enter the relative percent abundance of m/z 127 measured relative to the raw abundance of m/z 198	Numeric	10	NO
PeakID06	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 174, for DFTPP enter 197.	Numeric	10	NO
PercentRatio06	For BFB enter the relative percent abundance of m/z 174 measured relative to the raw abundance of m/z 95. For DFTPP enter the relative percent abundance of m/z 197 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID07	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 175, for DFTPP enter 198.	Numeric	10	NO
PercentRatio07	For BFB enter the relative percent abundance of m/z 175 measured relative to the raw abundance of m/z 174. For DFTPP enter the ion abundance of m/z 198 as 100 percent.	Numeric	10	NO
PeakID08	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 176, for DFTPP enter 199.	Numeric	10	NO
PercentRatio08	For BFB enter the relative percent abundance of m/z 176 measured relative to the raw abundance of m/z 174. For DFTPP enter the relative percent abundance of m/z 199 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID09	Identifies individual m/z ions for GC/MS tuning compounds. For BFB enter 177, for DFTPP enter 275.	Numeric	10	NO
PercentRatio09	For BFB enter the relative percent abundance of m/z 177 measured relative to the raw abundance of m/z 176. For DFTPP enter the relative percent abundance of m/z 275 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID10	Identifies individual m/z ions for GC/MS tuning compounds. For BFB leave blank, for DFTPP enter 365.	Numeric	10	NO

Table 2
Field Descriptions for the Laboratory Instrument Table (A2 file)

Contains related to laboratory instrument calibration on an analyte level and GC/MS Tune information. This table is optional depending on project requirements. Do not report Table A2 for radiochemistry methods.

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
PercentRatio10	For BFB leave blank. For DFTPP enter the relative percent abundance of m/z 365 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID11	Identifies individual m/z ions for GC/MS tuning compounds. For BFB leave blank, for DFTPP enter 441.	Numeric	10	NO
PercentRatio11	For BFB leave blank. For DFTPP the percent abundance of m/z 441 measured relative to the raw abundance of m/z 443	Numeric	10	NO
PeakID12	Identifies individual m/z ions for GC/MS tuning compounds. For BFB leave blank, for DFTPP enter 442.	Numeric	10	NO
PercentRatio12	For BFB leave blank. For DFTPP enter the relative percent abundance of m/z 442 measured relative to the raw abundance of m/z 198.	Numeric	10	NO
PeakID13	Identifies individual m/z ions for GC/MS tuning compounds. For BFB leave blank, for DFTPP enter 443.	Numeric	10	NO
PercentRatio13	For BFB leave blank. For DFTPP enter the relative percent abundance of m/z 443 measured relative to the raw abundance of m/z 442.	Numeric	10	NO

* Date/time format is: MM/DD/YYYY hh:mm where MM = month, DD = day, YYYY = four digits of the year, hh = hour in 24 hour format, and mm = minutes.

Table 3
Field Description for the Sample Analysis (A3 file)

This table contains information related to analyses of field samples and laboratory QC samples (excluding calibrations and tunes) on a sample level for environmental chemical analyses including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
ProjectNumber	Project number assigned by the client.	Text	30	YES (specified by project)
ProjectName	Project name assigned by the client.	Text	90	YES (specified by project)
ClientSampleID	Client or contractor's identifier for a field sample If a sample is analyzed as a laboratory duplicate, matrix spike, or matrix spike duplicate, append suffixes DUP, MS and MSD respectively to the Client Sample ID with no intervening spaces or hyphens (i.e. MW01DUP, MW01MS, and MW01MSD). For Method Blanks, LCS, and LCSD enter the unique LaboratorySampleID into this field Do not append suffixes to the ClientSampleID for dilutions, reanalyses, or re-extracts (the Analysis_Type field is used for this distinction). For example, MW01DL and MW01RE are not allowed Parent sample records must exist for each MS and MSD. If an MS/MSD is shared between two EDDs, records for the MS/MSD and its parent sample must exist in the Sample Analysis table for both EDDs.	Text	25	NO
Collected	For radiochemistry methods the Date of sample collection. Refer to the date format for radiochemistry methods at the end of this table. For all other methods the Date and Time of sample collection. Refer to the date/time format at the end of this table. Leave this field blank for Method Blank, LCS, and LCSD	Date/ Time	16*	NO
MatrixID	Sample matrix (i.e., AQ, SO, etc.)	Text	10	YES (See Table 4)
LabSampleID	Laboratory tracking number for field samples and lab generated QC samples such as method blank, LCS, and LCSD. There are no restrictions for the LabSampleID except field length and that the LabSampleID must be unique for a given field sample or lab QC sample and method.	Text	25	NO
QCType	This record identifies the type of quality control sample QC (i.e., Duplicate, LCS, Method Blank, MS, or MSD). For regular samples, leave this field blank.	Text	10	YES (See Table 4)
ShippingBatchID	Unique identifier assigned to a cooler or shipping container used to transport client or field samples. Links all samples to a cooler or shipping container. No entry for method blanks, LCS, and LCSD. This field is optional.	Text	25	NO
Temperature	Temperature (in centigrade degrees) of the sample as received. This field is not required for radiochemistry methods.	Numeric	10	NO

Table 3
Field Description for the Sample Analysis (A3 file)

This table contains information related to analyses of field samples and laboratory QC samples (excluding calibrations and tunes) on a sample level for environmental chemical analyses including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
LabAnalysisRefMethodID	Laboratory reference method ID. The method ID may be an EPA Method number or laboratory identifier for a method such as a SOP number, however; values used for Laboratory Method IDs are specified by the project and must be contained in the standard value list for method IDs.	Text	25	YES (Specified by the project)
PreparationType	Preparation Method Number (i.e., 3010A, 3510C, 3550C, 5030B, etc.) For analytical procedures that do not have a specific preparation method number, use "Gen Prep".	Text	25	YES (See Table 4)
AnalysisType	Defines the type of analysis such as initial analysis, dilution, re-analysis, etc. This field provides distinction for sample records when multiple analyses are submitted for the same sample, method, and matrix, for example: dilutions, re-analyses, and re-extracts.	Text	10	YES (See Table 4)
Prepared	For radiochemistry leave this field blank. For all other methods enter the date and time of sample preparation or extraction. Refer to the date/time format at the end of this table.	Date/ Time	16*	NO
Analyzed	For radiochemistry methods the date of sample analysis. Refer to the date format for radiochemistry methods at the end of this table. For all other methods the date and time of sample analysis. Refer to the date and time format at the end of this table.	Date/ Time	*	NO
LabID	Identification of the laboratory performing the analysis.	Text	7	NO
QCLevel	The level of laboratory QC associated with the analysis reported in the EDD. If only the Analytical Results Table (A1) and the Sample Analysis Table (A3) information are submitted for the sample, enter "COA". If the Laboratory Instrument Table (A2) information is also submitted for the sample, enter "COCAL"	Text	6	YES (See Table 4)
ResultBasis	Indicates whether results associated with this sample record are reported as wet or percent moisture corrected. This field is only required for soils and sediments. Enter "WET" if results are not corrected for percent moisture. Enter "DRY" if percent moisture correction is applied to results.	Text	3	YES (See Table 4)
TotalOrDissolved	This field indicates if the results related to this sample record are reported as a total or dissolved fraction. This field is only required for metal methods. For all other methods leave this field blank.	Text	3	YES (See Table 4)
Dilution	Dilution of the sample aliquot. Enter "1" for method blanks, LCS, and LCSD, or if the field samples was analyzed without dilution.	Numeric	10	NO
HandlingType	Indicates the type of leaching procedure, if applicable (i.e., SPLP, TCLP, WET). Leave this field blank if the sample analysis was not performed on a leachate.	Text	10	YES (See Table 4)

Table 3
Field Description for the Sample Analysis (A3 file)

This table contains information related to analyses of field samples and laboratory QC samples (excluding calibrations and tunes) on a sample level for environmental chemical analyses including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
HandlingBatch	Unique laboratory identifier for a batch of samples prepared together in a leaching procedure (i.e., SPLP, TCLP, or WET preparation). The HandlingBatch links samples with leaching blanks. Leave this field blank if the sample analysis was not performed on a leachate	Text	12	NO
LeachateDate	Date and time of leaching procedure (i.e., date for SPLP, TCLP, or WET preparation). Refer to the date and time format at the end of this table. Leave this field blank if the sample analysis was not performed on a leachate	Date /Time	16*	NO
Percent_Moisture	Percent of sample composed of water. Enter for soil and sediment samples only.	Numeric	10	NO
MethodBatch	Unique laboratory identifier for a batch of samples of similar matrices analyzed by one method and treated as a group for matrix spike, matrix spike duplicate, or laboratory duplicate association The method batch links the matrix spike and/or matrix spike duplicate or laboratory duplicates to associated samples. Note, the MethodBatch association may coincide with the PreparationBatch association. The MethodBatch is specifically used to link the MS/MSD and/or DUP to associated samples.	Text	12	NO
PreparationBatch	Unique laboratory identifier for a batch of samples prepared together for analysis by one method and treated as a group for method blank, LCS and LCSD association. The PreparationBatch links method blanks and laboratory control samples (blank spikes) to associated samples. Note, the PreparationBatch association may coincide with the MethodBatch association but the PreparationBatch specifically links the Method Blank and LCS to associated samples.	Text	12	NO
RunBatch	For radiochemistry methods leave this field blank. For all other methods the RunBatch is the unique identifier for a batch of analyses performed on one instrument under the control of one initial calibration and initial calibration verification. The RunBatch links both the initial calibration and initial calibration verification to subsequently analyzed and associated continuing calibrations, field samples, and QC analyses. For GC/MS methods, the RunBatch also links a BFB or DFTPP tune. A distinct RunBatch must used with every new initial calibration within a method The value entered in this field links a particular sample/method/analysis type record to a set of associated initial calibration and initial calibration verification records from Table A2. This field is only required if the A2 table is included with the EDD.	Text	12	NO

Table 3
Field Description for the Sample Analysis (A3 file)

This table contains information related to analyses of field samples and laboratory QC samples (excluding calibrations and tunes) on a sample level for environmental chemical analyses including radiochemistry

Field Name	Field Name Description	Field Type	Field Length	Standard Value List
AnalysisBatch	For radiochemistry methods leave this field blank. For all other methods the AnalysisBatch is the unique identifier for a batch of analyses performed on one instrument and under the control of a continuing calibration or continuing calibration verification. The AnalysisBatch links the continuing calibration or calibration verification to subsequently analyzed and associated field sample and QC analyses. For GC/MS methods, the AnalysisBatch also links the BFB or DFTPP tune. A distinct AnalysisBatch must be used with every new continuing calibration or continuing calibration verification within a method The value entered in this field links a particular sample/method/analysis type record to a set of associated continuing calibration records in the Laboratory Instrument table. This field is only required if the A2 table is included with the EDD.	Text	12	NO
LabReportingBatch	Unique laboratory identifier for the EDD. This is equivalent to the sample delivery group, lab work number, login ID, etc. The LabReportingBatch links all records in the EDD reported as one group. The value entered in this field must be the same in all records.	Text	12	NO
LabReceipt	Date and time the sample was received in the lab. A time value of 00:00 may be entered. Refer to the date/time format at the end of this table.	Date/ Time	16*	
LabReported	Date and time hard copy reported delivered by the lab. A time value of 00:00 may be entered. Refer to the date/time format at the end of this table.	Date/ Time	16*	

* For radiochemistry methods format Date as MM/DD/YYYY (where MM = two digit month, DD = two digit day, and YYYY = four digit year)

For all other methods format Date and Time as MM/DD/YYYY hh:mm YYYY (where MM = two digit month, DD = two digit day, and YYYY = four digit year, hh = hour in 24 hour format, and mm = minutes)

Table 4
Standard Value List

Field Name	Standard Value	Standard Value Description
Analysis_Type	DL	Dilution of the original sample
	DL2	Second dilution of the original sample
	DL3	Third dilution of the original sample
	DL4	Fourth dilution of the original sample
	RE	Reanalysis/re-extraction of sample
	RE2	Second reanalysis/re-extraction of sample
	RE3	Third reanalysis/re-extraction of sample
	RE4	Fourth reanalysis/re-extraction of the original sample
	RES	The initial or original sample.
Analyte_Name	Refer to QAPP and Project Library	Analyte names are specified by the project and entered into the library for each method and matrix. Analyte Names used in project libraries must first exist in the standard value table. The same holds true for the ClientAnalyteID
Analyte_Type	IS	Internal standard as defined per CLP usage
	SPK	Spiked analyte
	SURR	Surrogate as defined as per CLP usage
	TIC	Tentatively identified compound for GC/MS analysis
	TRG	Target compound
Detection_Limit_Type [1]	CRDL	Contract required detection limit
	IDL	Instrument detection limit
	MDA	Minimum detectable activity
	MDL	Method detection limit
Handling_Type [2]	WET	Wet leaching procedure
	SPLP	Synthetic Precipitation Leaching Procedure
	TCLP	Toxicity Characteristic Leaching Procedure
Lab_Analysis_Ref_Method_ID	Refer to QAPP and Project Library	Method IDs are specified by the project and entered into the library. Methods used in project libraries must first exist in the standard value table
Lab_Qualifiers [3]	*	INORG: Duplicate analysis was not within control limits
	*	ORG: Surrogate values outside of contract required QC limits
	+	INORG: Correlation coefficient for the method of standard additions (MSA) was less than 0.995
	A	ORG: Tentatively identified compound (TIC) was a suspected aldol-condensation product
	B	INORG: Value less than contract required detection limit but greater than or equal to instrument detection limit
	B	ORG: Compound is found in the associated blank as well as in the sample
	C	ORG: Analyte presence confirmed by GC/MS
	D	Result from an analysis at a secondary dilution factor
	E	INORG: Reported value was estimated because of the presence of interference
	E	ORG: Concentrations exceed the calibration range of the instrument
	H	Analysis performed outside method or client-specified holding time requirement
	J	Estimated value
	M	INORG: Duplicate injection precision was not met
	N	INORG: Spiked sample recovery was not within control limits
	N	ORG: Presumptive evidence of a compound
	P	ORG: Difference between results from two GC columns unacceptable (>25% Difference)
	S	Reported value was determined by the method of standard additions (MSA)
	U	Compound was analyzed for but not detected. Analyte result was below the Reporting Limit.
	W	INORG: Post digestion spike was out of control limits
	X	Reserved for a lab-defined data qualifier
	Y	Reserved for a lab-defined data qualifier
	Z	Reserved for a lab-defined data qualifier
Matrix_ID	AIR	Air
	AQ	Water
	ASH	Ash

Table 4
Standard Value List

Field Name	Standard Value	Standard Value Description
Matrix_ID (continued)	BIOTA	Biological matter
	FILTER	Filter
	LIQUID	Non-aqueous liquid
	OIL	Oil
	SED	Sediment
	SLUDGE	Sludge
	SO	Soil
	SOLID	Non-soil/sediment solid
	TISSUE	Tissue
	WASTE	Waste
	WIPE	Wipe
Preparation_Type [4]	3005A	Acid Digestion of Waters for Total Recoverable or Dissolved Metals by FLAA or ICP
	3010A	Acid of Aqueous Samples and Extracts for Total Metals by FLAA or ICP
	3015	Microwave Assisted Acid Digestion of Aqueous Samples and Extracts
	3020A	Acid Digestion of Aqueous Samples and Extracts for Total Metals by GFAA
	3031	Acid Digestion of Oils for Metals Analysis by AA or ICP
	3050B	Acid Digestion of Sediments, Sludges, and Soils
	3051	Microwave Assisted Acid Digestion of Sediments, Sludges, Soils and Oils
	3052	Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices
	3060A	Alkaline Digestion for Hexavalent Chromium
	3510C	Separatory Funnel Liquid-Liquid Extraction
	3520C	Continuous Liquid-Liquid Extraction
	3535	Solid Phase Extraction
	3540C	Soxhlet Extraction
	3541	Automated Soxhlet Extraction
	3545	Pressurized Fluid Extraction
	3550B	Ultrasonic Extraction
	3560	Supercritical Fluid Extraction of Total Recoverable Petroleum Hydrocarbons
	5030B	Purge and Trap for Aqueous Samples
	5035	Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples
	7470A	Acid digestion of waters for Mercury analysis
	7471A	Acid digestion of soils and solids for Mercury analysis
	Gen Prep	Generic preparation type when a preparation method ID does not exist (used mostly for general chemistry methods)
QC_Level	COA	Certificate of Analysis (accuracy and precision, no calibration)
	COACAL	Certificate of Analysis (accuracy and precision including calibration)
QC_Type	MB	Analytical control consisting of all reagents and standards that is carried through the entire procedure (Method Blank)
	CV	(Calibration Verification) Analytical standard run at a specified frequency to verify the calibration of the analytical system
	CCV	(Continuing Calibration Verification) Analytical standard run every 12 hours to verify the calibration of the GC/MS system
	DUP	A second aliquot of a sample that is treated the same as the original aliquot to determine the precision of the method
	IC	(Initial Calibration) Analysis of analytical standards for a series of different specified concentrations
	ICV	(Initial Calibration Verification) Analytical standard run at a specified frequency to verify the accuracy of the initial calibration of the analytical system
	IPC	(Instrument Performance Check) Analysis of DFTPP or BFB to evaluate the performance of the GC/MS system
	LCS	(Laboratory Control Sample) A control sample of known composition
	LCSD	(Laboratory Control Sample Duplicate) A duplicate control sample of known composition
	MS	(Matrix Spike) Aliquot of a matrix spiked with known quantities and subjected to the entire analytical procedure to measure recovery
	MSD	(Matrix Spike Duplicate) A second aliquot of the same matrix as the matrix spike that is spiked in order to determine the precision of the method
Reporting_Limit_Type [1]	CRDL	Contract required detection limit
	CRQL	Contract required quantitation limit

Table 4
Standard Value List

Field Name	Standard Value	Standard Value Description
Reporting_Limit_Type (continued)	PQL	Practical quantitation limit
	SQL	Sample quantitation limit
	RDL	Reportable detection limit
Result_Basis	DRY	Result was calculated on a dry weight basis
	WET	Result was calculated on a wet weight basis
Result_Units [5]	ug/L	Micrograms per liter
	mg/L	Milligrams per liter
	ug/Kg	Micrograms per kilogram
	mg/Kg	Milligrams per kilogram
	pg/L	Picograms per liter
	ng/Kg	Nanograms per kilogram
Total_Or_Dissolved	DIS	Dissolved
	TOT	Total

1 **Additional Detection Limit Types and Reporting Limit Types may be used. These must be added to the application standard values.**
2 **Additional Handling Types (leachate procedures) may be used. These must be added to the application standard values**
3 **Additional Lab Qualifiers may be used, or listed Lab Qualifiers may be used in a different manner than described in this table. New lab qualifiers must be added to the application standard value tables. NOTE: The "U" Lab Qualifier must be used for all non-detects.**
4 **Additional Preparation Types may be used. These must be added to the application standard value tables.**
5 **Additional Result Units may be used. The project library specifies the reporting limit used for each method and matrix**

Note: If new standard values are used then these standard values must be entered in the software standard values for both the lab and contractor. The application will automatically update the standard values tables if an importing library contains standard values (method, client analyte ID, and analyte name) that do not exist in the software importing the new library.

Table 5
Required Fields in the Analytical Results Table for GC/MS, GC, and HPLC Methods

Field	GC/MS Methods			GC and HPLC Methods		
	Regular Sample*	MS/MSD	Method Blank, LCS/LCSD	Regular Sample*	MS/MSD	Method Blank, LCS/LCSD
Client_Sample_ID	X	X	X	X	X	X
Lab_Analysis_Ref_Method_ID	X	X	X	X	X	X
Analysis_Type	X	X	X	X	X	X
Lab_Sample_ID	X	X	X	X	X	X
Lab_ID	X	X	X	X	X	X
Client_Analyte_ID	X	X	X	X	X	X
Analyte_Name	X	X	X	X	X	X
Result	X	X	X	X	X	X
Result_Units	X	X	X	X	X	X
Lab_Qualifiers	Q	Q	Q	Q	Q	Q
Detection Limit	X	X	X	X	X	X
Detection_Limit_Type	X	X	X	X	X	X
Retention_Time	T		T			
Analyte_Type	X	X	X	X	X	X
Percent_Recovery	S	R	R	S	R	R
Relative_Percent_Difference		D	D		D	D
Reporting_Limit	X	X	X	X	X	X
Reporting_Limit_Type	X	X	X	X	X	X
Reportable_Result	X	X	X	X	X	X

Key

- X Required Field
- D Required field for spiked compounds in the LCSD and MSD only
- Q Required field if laboratory has qualified result. The "U" qualifier MUST be entered if the result is non-detect.
- R Required field if Analyte_Type = "SPK" or "SURR"
- S Required field for surrogate compounds only
- T Required field for tentatively identified compounds by GC/MS only
- * Also includes Equipment Blanks, Field Blanks, and Trip Blanks

Table 6
Required Fields in the Analytical Results Table for ICAP, AA, and IC Methods

Field	ICAP and AA Methods			IC and Wet Chemistry Methods		
	Regular Sample*	Sample Duplicate, MS/MSD	Method Blank, LCS/LCSD	Regular Sample*	Sample Duplicate MS/MSD	Method Blank, LCS/LCSD
Client_Sample_ID	X	X	X	X	X	X
Lab_Analysis_Ref_Method_ID	X	X	X	X	X	X
Analysis_Type	X	X	X	X	X	X
Lab_Sample_ID	X	X	X	X	X	X
Lab_ID	X	X	X	X	X	X
Client_Analyte_ID	X	X	X	X	X	X
Analyte_Name	X	X	X	X	X	X
Result	X	X	X	X	X	X
Result_Units	X	X	X	X	X	X
Lab_Qualifiers	Q	Q	Q	Q	Q	Q
Detection Limit	X	X	X	X	X	X
Detection_Limit_Type	X	X	X	X	X	X
Retention_Time						
Analyte_Type	X	X	X	X	X	X
Percent_Recovery		S	S		S	S
Relative_Percent_Difference		R	R		R	R
Reporting_Limit	X	X	X	X	X	X
Reporting_Limit_Type	X	X	X	X	X	X
Reportable_Result	X	X	X	X	X	X

Key

X Required field
Q Required field if laboratory has qualified result. The "U" qualifier MUST be entered if the result is non-detect
R Required field for spiked compounds in LCSD or MSD, or target compounds in the Sample Duplicate only
S Required field if Analyte_Type = "SPK"
* Also includes Trip Blanks, Equipment Blanks, and Field Blanks

Table 7
Required Fields in the Laboratory Instrument Table

	GC/MS Tunes		Initial Calibration				Initial Calibration Verification				Calibration Verification, Continuing Calibration
Field	VOA	SVOA	GC/MS	GC HPLC	ICP/AA	IC*	GC/MS	GC HPLC	ICP/AA	IC*	ALL METHODS
Instrument_ID	X	X	X	X	X	X	X	X	X	X	X
QC_Type	X	X	X	X	X	X	X	X	X	X	X
Analyzed	X	X	X	X	X	X	X	X	X	X	X
Alternate_Lab_Analysis_ID	X	X	X	X	X	X	X	X	X	X	X
Lab_Analysis_ID	X	X					X	X	X	X	X
Lab_Analysis_Ref_Method_ID	X	X	X	X	X	X	X	X	X	X	X
Client_Analyte_ID	X	X	X	X	X	X	X	X	X	X	X
Analyte_Name	X	X	X	X	X	X	X	X	X	X	X
Run_Batch	X	X	X	X	X	X	X	X	X	X	X
Analysis_Batch	C	C									X
Lab_Reporting_Batch	X	X	X	X	X	X	X	X	X	X	X
Percent_Relative_Standard_Deviation			X	X							
Correlation_Coefficient			B	B	X	X					
Relative_Response_Factor			X				X				M
Percent_Difference							X	X	X	X	X
Peak_ID_01	X	X									
Percent_Ratio_01	X	X									
Peak_ID_02	X	X									
Percent_Ratio_02	X	X									
Peak_ID_03	X	X									
Percent_Ratio_03	X	X									
Peak_ID_04	X	X									
Percent_Ratio_04	X	X									
Peak_ID_05	X	X									
Percent_Ratio_05	X	X									
Peak_ID_06	X	X									
Percent_Ratio_06	X	X									
Peak_ID_07	X	X									
Percent_Ratio_07	X	X									
Peak_ID_08	X	X									
Percent_Ratio_08	X	X									
Peak_ID_09	X	X									
Percent_Ratio_09	X	X									
Peak_ID_10		X									
Percent_Ratio_10		X									
Peak_ID_11		X									
Percent_Ratio_11		X									
Peak_ID_12		X									
Percent_Ratio_12		X									
Peak_ID_13		X									
Percent_Ratio_13		X									

Key

X Required field (some fields are not applicable to some General (Wet) Chemistry tests)

B Required field if reporting best fit

C Required field if BFB or DFTPP associated with a continuing calibration only

M Required field for GC/MS continuing calibration only

*IC Includes Ion Chromatography and Classical or Wet Chemistry methods. Methods such as pH, Conductivity, and others do not use traditional calibration procedures: therefore some fields marked as a required field under the "IC" column do not apply for these methods.

Table 8
Required Fields in the Sample Analysis Table

Field	GC, GC/MS, HPLC Methods		ICAP and AA Methods		IC and Wet Chemistry Methods	
	Method Blanks, LCS/LCSD	Regular Samples*, Sample Duplicate, MS/MSD	Method Blanks, LCS/LCSD	Regular Samples*, Sample Duplicate, MS/MSD	Method Blanks, LCS/LCSD	Regular Samples*, Sample Duplicate, MS/MSD
Client_Sample_ID	X	X	X	X	X	X
Collected		X		X		X
Matrix_ID	X	X	X	X	X	X
Lab_Sample_ID	X	X	X	X	X	X
QC_Type	X	Q	X	Q	X	X
Shipping_Batch_ID		X		X		X
Temperature		X				X
Lab_Analysis_Ref_Method_ID	X	X	X	X	X	X
Preparation_Type	X	X	X	X	X	X
Analysis_Type	X	X	X	X	X	X
Prepared	A	A	X	X	N	N
Analyzed	X	X	X	X	X	X
Lab_ID	X	X	X	X	X	X
QC_Level	X	X	X	X	X	X
Results_Basis		S		S		S
Total_Or_Dissolved			W	W		
Dilution	X	X	X	X	X	X
Handling_Type	L	L	L	L	L	L
Handling_Batch	L	L	L	L	L	L
Leachate_Date	L	L	L	L	L	L
Percent Moisture		S		S		S
Method_Batch	X	X	X	X	X	X
Preparation_Batch	X	X	X	X	X	X
Run_Batch	C	C	C	C	C	C
Analysis_Batch	C	C	C	C	C	C
Lab_Reporting_Batch	X	X	X	X	X	X
Lab_Receipt		X		X		X
Lab_Reported	X	X	X	X	X	X

Key

X Required field
A Required field for samples prepared by methanol extraction
C Required field if Instrument Calibration Table (A2) is included in EDD
L Required field if analysis performed on SPLP, TCLP, or WET extracts
N Required field only for samples that require preparation before analysis
Q Required field for Sample Duplicate, MS, and MSD only
S Required field if "Matrix_ID" = "SO" or "SED"
W Required field for aqueous samples only
* Includes Trip Blanks, Equipment Blanks, and Field Blanks

Reviewed EDD Export File Specifications - Analytical Results (A1)
Comma Delimited Text File

Order	Field Name*	Field Description
1	RecordID	Record number.
2	ClientSampleID	Client field sample identifier.
3	LabAnalysisRefMethodID	Laboratory reference method (i.e. 8260B, 6010B, etc.).
4	AnalysisType	Defines type of analysis (i.e. dilution, reanalysis, etc.).
5	LabSampleID	Internal laboratory sample tracking number for samples and lab generated QC.
6	LabID	Identifier of laboratory performing the analysis.
7	ClientAnalyteID	CAS number or unique analyte identifier.
8	AnalyteName	Chemical name for analyte.
9	Result	Reportable result for the analyte.
10	ResultUnits	Units of measure for the result (i.e. mg/Kg, ug/L, etc.).
11	LabQualifiers	A string of letter or symbol qualifiers assigned by the lab based on contractor defined rules and values.
12	DetectionLimit	Detection limit for the analyte being measured.
13	DetectionLimitType	Specifies the type of detection limit (i.e. MDL, IDL, etc.).
14	RetentionTime	The time expressed in decimal minutes between injection and detection for GC/MS TICs only.
15	AnalyteType	Defines the type of result such as surrogate, spike, or target analyte.
16	PercentRecovery	The percent recovery of a spiked QC compound such as a matrix spike, LCS spike, or surrogate.
17	RelativePercentDifference	RPD between to QC results such as MS/MSD.
18	ReportingLimit	Analyte reporting limit.
19	ReportingLimitType	Defines the type of reporting limit (PQL, CRQL, etc.).
20	ReportableResult	(YES or NO) Indicates which result is the useable result when results from two or more analyses for the same sample and method (ie dilutions, reanalyses, etc) are reported in the EDD.
21	**Filename**	File name of the EDD. The same as the LabReportingBatch in the Sample Analysis table (A3).
22	**DVModifiedConcentration**	ADR modified analyte result due to blank contamination.
23	**DVQualTemperature**	Data review qualifier for temperature outlier.
24	**DVQualPreservation**	Data review qualifier for preservation anomaly.
25	**DVQualHTSamplingToAnalysis**	Data review qualifier for holding time violation from sampling time to analysis time.
26	**DVQualHTSamplingToExtraction**	Data review qualifier for holding time violation from sampling time to extraction.
27	**DVQualHTExtractionToAnalysis**	Data review qualifier for holding time violation from extraction time to analysis time.
28	**DVQualHoldingTime**	Overall data review qualifier for holding time violation.
29	**DVQualMethodBlanks**	Data review qualifier for contamination in an associated method blank.
30	**DVQualSurrogateRecovery**	Data review qualifier for surrogate recovery outlier.
31	**DVQualMS**	Overall data review qualifier for associated MS and MSD recovery and/or RPD outlier.
32	**DVQualMSRecovery**	Data review qualifier for MS and/or MSD recovery outlier.
33	**DVQualMSRPD**	Data review qualifier for MS/MSD RPD .outlier.
34	**DVQualLCS**	Overall data review qualifier for LCS and LCS recovery and/or RPD outlier.
35	**DVQualLCSRecovery**	Data review qualifier for associated LCS and/or LCSD recovery outlier.
36	**DVQualLCSRPD**	Data review qualifier for LCS/LCSD RPD outlier.
37	**DVQualRepLimits**	Data review qualifier for result reported below the reporting limit.
38	**DVQualReportingLimits**	Data review comment (“OutX”) when reporting limit exceeds the project reporting limit.
39	**DVQualFieldQC**	Overall data review qualifier for Field QC.
40	**DVQualFieldBlank**	Data review qualifier for contamination in an associated Field Blank.
41	**DVQualEquipmentBlank**	Data review qualifier for contamination in an associated Equipment Rinsate or Equipment Blank.
42	**DVQualTripBlank**	Data review qualifier for contamination in an associated Trip Blank.
43	**DVQualFieldDuplicate**	Data review qualifier for an associated Field Duplicate RPD outlier.
44	**DVQualIC**	Overall data review qualifier for associated initial calibration outliers.
45	**DVQualInitialCalibrationRRF**	Data review qualifier for an associated initial calibration relative response

Order	Field Name*	Field Description
		factor outlier.
46	**DVQualInitialCalibrationRSD**	Data review qualifier for an associated initial calibration relative percent difference outlier.
47	**DVQualInitialCalibrationCC**	Data review qualifier for an associated initial calibration corrrelation coefficient outlier.
48	**DVQualICV**	Overall data review qualifier for an associated initial calibration verification.
49	**DVQualInitialCalibration VerificationRRF**	Data review qualifier for an associated initial calibration verification relative response factor outlier.
50	**DVQualInitialCalibration VerificationPD**	Data review qualifier for an associated initial calibration verification percent difference outlier.
51	**DVQualCCV**	Overall data review qualifier for associated continuing calibration outliers.
52	**DVQualContinuingCalibration VerificationRRF**	Data review qualifier for an associated continuing calibration relative response factor outlier.
53	**DVQualContinuingCalibration VerificationPD**	Data review qualifier for an associated continuing calibration percent difference outlier.
54	**DVQualOverall**	Overall data review qualifier for all QC and calibration qualifiers.
55	**TagLabSampleID (see comment)**	Temporary placeholder.
56	**TagDetQual01 (see comment)**	Temporary placeholder.
57	**TagNonDetQual01 (see comment)**	Temporary placeholder.
58	**TagDetQual02 (see comment)**	Temporary placeholder.
59	**TagNonDetQual02 (see comment)**	Temporary placeholder.
60	**surDVQualDet (see comment)**	Temporary placeholder.
61	**surDVQualNonDet (see comment)**	Temporary placeholder
62	**DVQualInstrumentPerformance CheckRunBatch**	Data review qualifier for GC/MS Tune outlier related to initial calibration.
63	**DVQualInstrumentPerformance CheckAnaBatch**	Data review qualifier for GC/MS Tune outlier related to continuing calibration.
64	**DVQualIPC**	Overall data review qualifier for GC/MS tune outliers.
65	**DVQualLabDup**	Data review qualifier for RPD outlier in laboratory duplicate.
66	**DVQualCode**	User-defined Reason Code
67	**FieldDupRPD**	RPD calculated from Field duplicate and parent sample
68	**DVQualMergedQualifier**	Merged lab and data review qualifiers
69	**DVQualMergedResult**	Final result (modified concentration if applicable)
70	**DVQualPercMoi**[1]	Data review qualifier for percent moisture
71	**DVQualLabDupNR**[1]	Data review qualifier for laboratory duplicate not reported
72	**DVQualLcsNR**[1]	Data review qualifier for laboratory control sample(s) not reported
73	**DVQualDissTotDiff**[1]	Data review qualifier for dissolved and total fraction differing by more than 10%
74	**Error**	Radiochemistry error
75	**DVQualSampleDupCount**[1]	Data review qualifier for sample count being >20 in a duplicate batch
76	**DVQualMsSampleCount**[1]	Data review qualifier for sample count being >20 in a matrix spike batch
77	**DVQualLcsCount**[1]	Data review qualifier for sample count being >20 in a laboratory control sample batch
78	**DVQualMbMissing**[1]	Data review for missing method blank
79	**DVQualPercMoiDissTotDiff**[1]	Combined data review qualifier for percent moisture and total vs dissolved difference outliers
80	**DVQualInternalStandard**[2]	Data review qualifier for internal standard outlier
81	**DVQualCalibrationBlank**[2]	Data review qualifier for calibration blank contamination
82	**DVQualRcm**[2]	Data review qualifier for resolution check mixture problem
83	**DVQualPem**[2]	Data review qualifier for performance evaluation mixture problem
84	**DVQualProfessionalJudgement**[2]	Data review qualifier for any reason deemed necessary by data-review chemist
85	**DOD_MDL**	Method detection limit for QSM 5.4

Comment: Fields that contain temporary placeholders hold information contributed during the review process that is used in generating reports. This information is kept with the output file so that if the file is ever imported back into the application, reports can be generated without having to rerun the review module.

* Field Names in bold font are added to the EDD during review and included in the exported reviewed EDD file

[1] Data review qualifiers in these cases are added for EPA Region II assessment. ADR.Net does not currently perform EPA Region II assessment.

[2] Data review qualifiers in these cases are added manually by the user and not assessed by automated data review.

Reviewed EDD Export File Specifications - Sample Analysis (A3)
Comma Delimited Text File

Order	Field Name*	Field Description
1	RecordID	Record number.
2	ProjectNumber	Project Number assigned by client.
3	ProjectName	Project Name assigned by client.
4	ClientSampleID	Client field sample identifier.
5	Collected	Date and time sample was collected.
6	MatrixID	Sample matrix.
7	LabSampleID	Internal laboratory sample tracking number for samples and lab generated QC.
8	QCType	Identifies the type of quality control sample, regular field samples are null.
9	ShippingBatchID	Unique identifier assigned to a cooler or shipping container used to transport field samples.
10	Temperature	Temperature in degrees C of the samples as received in the lab.
11	LabAnalysisRefMethodID	Laboratory reference method (i.e. 8260B, 6010B, etc.).
12	**PreparationType**	Preparation method number (i.e. 3010A, 3510C, etc.).
13	**AnalysisType**	Defines type of analysis (i.e. dilution, reanalysis, etc.).
14	**Prepared**	Date and time of sample preparation/extraction.
15	**Analyzed**	Date and time of sample analysis.
16	**LabID**	Identifier of laboratory performing analysis.
17	**QCLevel**	Level of analytical QC associated with analysis (i.e. Level III, etc.).
18	**ResultBasis**	Indicates if a result is expressed as wet or dry.
19	**TotalorDissolved**	Indicates if a result is expressed as total or dissolved (for metals only).
20	**Dilution**	Sample dilution during analysis.
21	**HandlingType**	Type of leaching procedure, if applicable (i.e. SPLP, TCLP, etc.).
22	**HandlingBatch**	Unique laboratory identifier for a batch of samples prepared together for a leaching procedure.
23	**LeachateDate**	Date and time of leaching procedure.
24	**PercentMoisture**	Percent moisture of sample.
25	**MethodBatch**	Unique laboratory identifier for a batch of samples with similar matrix and analyzed together by one method. Links samples to matrix spikes and duplicates.
26	**PreparationBatch**	Unique laboratory identifier for a batch of samples prepared together for analysis by one method. Links samples with method blanks and laboratory control samples.
27	**RunBatch**	Unique laboratory identifier for a batch of analyses performed on one instrument under the control of on an initial calibration. Links the initial calibration to associated samples.
28	**AnalysisBatch**	Unique laboratory identifier for a batch of analyses performed on one instrument under the control of a continuing calibration. Links continuing calibrations to associated samples.
29	**LabReportingBatch**	Unique laboratory identifier for a batch of samples, QC, and calibration standards reported as a group by the lab (i.e. order number, SDG #, etc.).
30	**LabReceipt**	Date samples received in laboratory.
31	**LabReported**	Date laboratory hardcopy submitted.
32	DataReviewCompany**	Company running the automated review software.
33	DataReviewDate	Date and time EDD was validated.
34	ValidatedBy**	Person running the automated review.
35	ValidationDate**	Date and time when automated data review qualifiers were reviewed
36	ApprovedBy**	Person performing secondary review of data review flags.
37	ApprovalDate**	Date and time of secondary review by "ApprovedBy".
38	FileName	File name of EDD (same as LabReportingBatch).
39	TagLabSampleID (see comment)	Temporary place holder.
40	TagDetQual (see comment)	Temporary place holder.
41	TagNonDetQual (see comment)	Temporary place holder.
42	TempFlag (see comment)	Temporary place holder.
43	LabMethodCategory	The category of the method, used by EDMS

Comment: Fields that contain temporary placeholders hold values created during the validation process. These values are used in generating reports. This information is kept with the output file so that if the file is ever imported back into the application, reports can be generated without having to rerun the validation module.

* Field Names in bold font are added to the EDD during automated data review and included in the exported data-reviewed EDD file

**Automated data review does not update these fields with any information but these fields are still part of the exported data-reviewed file. These fields may be populated manually by the user from various forms in the application prior to exporting.

*** Date/Time format: MM/DD/YYYY hh:mm