FINAL
WORK PLAN/UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN

FOR A TREATABILITY STUDY AT
FORMER TITAN 1-A MISSILE FACILITY,
LINCOLN, CALIFORNIA

FORMERLY USED DEFENSE SITE (FUDS)
HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW)
PROJECT J09CA1108-01

CONTRACT NUMBER: W91238-21-D-0008
TASK ORDER NO. W9123823F0044

PREPARED FOR:
U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

FEBRUARY 2025

PREPARED BY:
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Title Page:

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Prepared for:
U.S. Army Corps of Engineers, Sacramento District

Prepared under:
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Task Order W9123823F0044

February 2025

Prepared by:

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Technical Review Signature Sheet

The following technical specialists have participated in the production and review of the relevant parts of this document and are satisfied with its technical adequacy regarding their fields of expertise.

Discipline	Reviewer, Title	Signature	Date
Technical Director	Mark Rigby, Ph.D.		02/10/2025
Technical Reviewer	Cynthia Oppenheimer, professional geologist (PG)	Cynthia Oppenheimer	02/10/2025

Approval signatures are shown on **Worksheets #1 & 2**.

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Acronyms and Abbreviations

>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
%	percent
±	plus, or minus
ºC	degrees Celsius
ºF	degrees Fahrenheit
§	section sign
1Q23	first quarter of 2023
4Q19	fourth quarter of 2019
AFB	Air Force Base
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
ASTM	ASTM International, formerly American Society for Testing and Materials
B.A.	Bachelor of Arts (degree)
BDI Plus®	Bio-Dechlor Inoculum Plus
BFB	bromofluorobenzene
bgs	below ground surface
BMP	best management practice
B.S.	Bachelor of Science (degree)
BTEX	benzene, toluene, ethylbenzene, and xylenes
CA	California
CAS	Chemical Abstracts Service (number)
CCB	continuing calibration blank
CCV	continuing calibration verification
CDFW	California Department of Fish and Wildlife
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Church	Roman Catholic Church
cm	centimeter(s)
CoC	chain of custody
COPC	contaminant of potential concern
COR	Contracting Officer’s Representative
CSM	conceptual site model
CVRWQCB	Central Valley Regional Water Quality Control Board
DFTPP	decafluorotriphenylphosphine
DL	detection limit
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective

DTSC	Department of Toxic Substances Control
DUA	data usability assessment
DUR	Data Usability Report
EAB	enhanced anaerobic bioremediation
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EM	electromagnetic
EMAX	EMAX Laboratories Inc.
eQAPP	electronic Quality Assurance Project Plan
FD	field duplicate
ft	foot/feet
ft/ft	foot per foot
FUDS	Formerly Used Defense Site
FUDSChem	Formerly Used Defense Sites Chemistry Database
GC	gas chromatography
GCS	geographic coordinate system
GIS	geographic information system
GPR	ground penetrating radar
GPS	global positioning system
H&S	health and safety
HSA	hollow-stem auger
HTRW	hazardous, toxic, and radioactive waste
IC	ion chromatography
ICAL	initial calibration
ICB	initial calibration blank
ICP	Inductive Coupled Plasma
ICP-ES	Inductive Coupled Plasma Emissions Spectrometer
ICV	Initial calibration verification
ICS	interference check solution(s)
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
ISCR	in situ chemical reduction
IT	IT Corporation
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LIMS	Laboratory Information Management System
LOD	limit of detection
LOQ	limit of quantitation
µg/L	micrograms per liter
MB	method blank
MD	matrix duplicate
mL	milliliter
MLD	most likely descendant
MPC	Measurement Performance Criteria

mph	miles per hour
MRL	method reporting limit
M.S.	Master of Science (degree)
MS_1	mass spectrometry
MS_2	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
N/A	not applicable
NA	not available
NAHC	Native American Heritage Commission
NAVD88	North American Vertical Datum of 1988
NCR	Nonconformance Report
NRHP	National Register of Historic Places
OM	oxygen/moisture indicator
PARCC	precision, accuracy, representativeness, comparability, and completeness
Parsons	Parsons Federal Solutions, Inc.
PDF	portable document format
PE	Professional Engineer
PFM	Passive Flux Meter™
PG	Professional Geologist
pH	potential of hydrogen
Ph.D.	Doctor of Philosophy (degree)
PlumeStop®	PlumeStop® Liquid Activated Carbon™
PM	Project Manager
PMP	Project Management Professional
PQLG	Project Quantitation Limit Goals
PQO	project quality objective
PRC	Public Resources Code
PSL	Project Screening Level
PUL	precision utility location
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QASP	Quality Assurance Surveillance Plan
QC	quality control
QSM	Quality Systems Manual
RCA	root cause analysis
RF	response factor(s)
RI	Remedial Investigation
RPD	relative percent difference
RRT	relative retention times
RSD	relative standard deviation
RT	retention time
S-MicroZVI	Sulfidated-Micro Zero Valent Iron
SDG	sample delivery group

SEDD	staged electronic data deliverable
SOP	standard operating procedure
SQL	structured query language
SSHO	site safety and health officer
SSHP	Site Safety and Health Plan
TBD	to be determined
TCE	trichloroethene
UFP-QAPP	Uniform Federal Policy - Quality Assurance Project Plan
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound
WGS84	World Geodetic System 1984
YSI	Yellow Springs Instruments

Introduction

The United States Army Corps of Engineers (USACE), Sacramento District has contracted Parsons Federal Solutions, Inc. (Parsons) to perform a treatability study at the Former Titan 1-A Missile Facility (referred to as "Beale Air Force Base Titan 1-A" in the FUDS Management Information System), located in Placer County, California, Formerly Used Defense Site (FUDS) Property Number J09CA1108, Hazardous, Toxic, and Radioactive Waste (HTRW) project J09CA1108-01 under contract W91238-21-D-0008 (**Figures Int.1** and **Int.2**). This HTRW project is being conducted as part of a Remedial Investigation/Feasibility Study and is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act of 1986 (42 United States Code [USC] 9601 et seq.), and applicable State requirements.

The Former Titan 1-A Missile Facility is located approximately 1.6 miles east of Lincoln, California in Placer County approximately 20 miles northeast of Sacramento, California (**Figure Int.1**). Construction of the facility began in 1960 and was finished in 1962. Once construction was finished, the facility consisted of three 160-foot-deep missile silos and support structures (**Figure Int.3**). The facility was closed in 1965 (Woodward-Clyde 1996).

In 1991, groundwater sampling on the Cal Sierra Limited parcel (formerly the Crocker Knoll parcel) to the west of the Former Titan 1-A Missile Facility (**Figure Int.4**) detected the presence of trichloroethene (TCE) in groundwater at up to 490 micrograms per liter (µg/L). Investigations began on the Former Titan 1-A Missile Facility in 1993 (Woodward-Clyde 1996) and have continued to the present. The current groundwater wells and TCE plume boundary are shown on **Figure Int.5**. Today, the contaminants of potential concern (COPCs) are:

- 1,1-Dichloroethene
- cis-1,2-Dichloroethene
- trans-1,2-Dichloroethene
- 1,4-Dichlorobenzene
- Benzene
- Ethylbenzene
- Toluene
- Trichloroethene
- Vinyl chloride
- o- and m,p-Xylenes

This work plan/site-specific Uniform Federal Policy–Quality Assurance Project Plan (UFP-QAPP) (also referred to as the "work plan") details the methods that will be used to complete a treatability study to evaluate injection treatment technologies at the Site, including a combination of in situ chemical reduction (ISCR) and enhanced anaerobic bioremediation (EAB). For this work plan, "the Site" refers to the Former Titan 1-A Missile Facility and downgradient areas to the southwest that are impacted by COPCs (**Figure Int.5**). Twenty-four injections will be completed in two areas to evaluate the effectiveness of ISCR and EAB as a source area treatment and a perimeter treatment (**Figure Int.6**). Baseline sampling events and post-treatment performance monitoring will be also conducted to evaluate the effectiveness of the treatment technologies. One additional monitoring well and one soil boring will also be installed to evaluate the effectiveness of treatment technologies (**Figure Int.6**).

This work plan has been prepared in accordance with requirements set forth in the United States Environmental Protection Agency (USEPA) (IDQTF 2005, 2012) guidance to ensure environmental data collected are scientifically sound, of known and documented quality, and suitable for their intended purposes. This work plan includes a review of site conditions, previous reports, and available data (**Worksheet 10**), which have been used to develop a conceptual site model (CSM). This work plan also describes the methods, procedures, and analytical methods that will be used to perform semi-annual groundwater and soil vapor sampling (**Worksheets 17** and **18**), and data management and validation procedures (**Worksheets 29-37**). The results of the activities described here will be reported in a Treatability Study Report following the completion of 4 quarters of performance monitoring. Quarterly progress updates will also be submitted to the Central Valley Water Board via email.

Supporting plans and information are included in the appendices, as follows:

A. Project Schedule: presents a detailed project schedule.
B. Waste Management Plan: describes the procedures that will be used to manage and track the waste generated as a result of the field investigation.
C. Meeting Minutes: provides full versions of meeting minutes and/or associated presentations discussed on Worksheet #9.
D. Field standard operating procedures (SOPs): contains SOPs related to field operations.
E. Field Forms: contains forms that will be used during the field operation.
F. Laboratory Accreditation: provides the Department of Defense (DoD) and California Environmental Laboratory Accreditation Program (ELAP) documentation for the laboratory that will perform chemical analyses.
G. Laboratory SOPs: contains the analytical laboratory SOPs.

Worksheets #1 & 2: Title and Approval Page

1.1 PROJECT IDENTIFYING INFORMATION

Site Name/ Project Name:	Beale Air Force Base (AFB), Titan 1-A Missile Facility Treatability Study
Site Location/No.:	Former Titan 1-A Missile Facility, Lincoln, California Formerly Used Defense Site (FUDS) # J09CA1108 HTRW Project # J09CA1108-01
Contract/Task Order (TO) No.:	W91238-21-D-0008 / W9123823F0044

1.2 CONCURRING SIGNATURES

The signatures below indicate that the representatives of the subject organizations have reviewed this work plan/UFP-QAPP and concur with its implementation as written.

Lead Organization/ Interim Project Manager

Linda Mercurio
United States Army Corps of Engineers (USACE)
Date

Lead Organization Chemist

Kyle Bayliff
USACE
Date

Prime Contractor Project Manager

Carrie Ross
02/10/2025

Carrie Ross
Parsons Federal Solutions, Inc. (Parsons)
Date

Prime Contractor Chemist

02/10/2025

Katherine LaPierre
Parsons
Date

Relevant plans and reports from previous investigations are described on **Worksheet #10.**

Worksheets #3 & 5: Project Organization and UFP-QAPP Distribution

The project team listed below will receive a copy of the UFP-QAPP. The organization of the project team is shown on **Figure 3.1.**

Table 3.1 – UFP-QAPP Recipients

UFP-QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Matt Marlatt	FUDS Program Manager	USACE	Retracted	Retracted
Tim Crummett	Contracting Officer's Representative (COR) and Project Manager (PM)	USACE	Retracted	Retracted
Linda Mercurio	Interim Project Manager	USACE	Retracted	Retracted
Charity Meakes	Technical Lead	USACE	Retracted	Retracted
Carrie Ross	Project Manager	Parsons	Retracted	Retracted
Mark Rigby	Technical Director	Parsons	Retracted	Retracted
Katherine LaPierre	Senior Project Chemist	Parsons	Retracted	Retracted
Cynthia Oppenheimer	Project Geologist	Parsons	Retracted	Retracted

Worksheets #4, 7, & 8: Personnel Qualifications and Sign-off Sheet

Table 4.1 – Key Project Personnel

Name	Project Title / Role	Contact Information	Education / Experience	Specialized Training/ Certifications	Signature/ Date
Tim Crummett	USACE COR and PM	Retracted	Not Applicable (N/A)	N/A	Signature on Worksheets #1 & #2
Linda Mercurio	Interim Project Manager	Retracted	N/A	N/A	Signature on Worksheets #1 & #2
Charity Meakes	Technical Lead	Retracted	N/A	N/A	N/A
Kyle Bayliff	Project Chemist	Retracted	N/A	N/A	Signature on Worksheets #1 & #2
John Ratz, Professional Engineer (PE) Parsons	Program Manager	Retracted	B.S. Civil Engineering; Colorado State University; M.S. Environmental & Water Resources Engineering, Vanderbilt University; 30+ years environmental experience	Professional Engineer (Colorado, #30292) Parsons Certified PM, 2006	N/A
Carrie Ross Parsons	PM	Retracted	M.S., Engineering Systems Management, 2009 B.S., Environmental Engineering, 2004 17 years of experience, including management of numerous remedial investigations and removal actions.	Professional Engineer, CA, No. 6853, WY, No. 14578, CO, No.44978 Project Management Professional (PMP) Certification, 2021 (PMI ID: 7459983) Parsons Certified PM, 2012	Signature on Worksheets #1 & #2

Table 4.1 – Key Project Personnel

Name	Project Title / Role	Contact Information	Education / Experience	Specialized Training/ Certifications	Signature/ Date
Mark Rigby, Ph.D. Parsons	Technical Director	Retracted	B.A. Aquatic Biology; M.S. Environmental Science and Ecology; Ph.D. Experimental Ecology; 21 years environmental experience	Parsons Certified PM, 2020	Signature on Technical Review Sheet
Cynthia Oppenheimer Parsons	Project Geologist	Retracted	B.S. Geology; B.S. Marine Science and Oceanography; M.S. Geology; 17 years environmental experience	Professional Geologist (California #9415)	Signature on Technical Review Sheet
Lauren Ranker Parsons	Contractor Quality Control Manager	Retracted	B.S. Geology 16 years environmental remediation experience	Professional Geologist, (Wyoming #3686) CQM-c Certification	N/A
Katherine LaPierre Parsons	Project Chemist	Retracted	B.S. Chemistry; 23 years' experience in analytical / environmental chemistry; Lead Chemist for Parsons Federal environmental program.	N/A	Signature on Worksheets #1 & #2
Dan Griffiths Parsons	Risk Manager	Retracted	B.S., Geology; M.S., Geology Experience: 26 years. Mr. Griffiths is also Parsons a Subject Matter Director for in-situ remedy design and installation.	Certified Professional Geologist, National Registered Geologist, AK Parsons Certified Project Manager	N/A

Table 4.2 – Other Project Personnel

Name	Project Title/Role	Contact Information	Education/Experience	Specialized Training/ Certifications
Mark Shibata USACE	Risk Assessor/ Toxicologist	Retracted	*NA*	*NA*
Chris Ajello USACE	Biologist	Retracted	*NA*	*NA*
Jessequa Parker USACE	Geologist	Retracted	NA	NA
James Wheeler USACE	Archaeologist	Retracted	*NA*	*NA*
Tyler Stalker USACE	Public Affairs	Retracted	NA	NA
Robert Fagerness, PE Central Valley Regional Water Quality Control Board (CVRWQCB)	CVRWQCB PM	Retracted	*NA*	*NA*
Caspar Pang EMAX Laboratories Inc. (EMAX)	Quality Assurance (QA) Manager	Retracted	B.A. in Economics / 22 years in the analytical chemistry industry with supervisory experience	*NA*
Richard Beauvil EMAX	PM	Retracted	B.S. in Biology / 32 years in the analytical chemistry industry; 30 years supervisory experience	*NA*

Table 4.2 – Other Project Personnel

Name	Project Title/Role	Contact Information	Education/Experience	Specialized Training/ Certifications
Jay Cho, Ph.D. Enviroflux	QA Manager, PM	Retracted	Ph.D. in Environmental Engineering and Sciences, 35 years experience in the environmental contaminant sciences, 20 years experience in academic environmental contaminant research	*NA*

Worksheet #6: Communication Pathways and Procedures

Table 6.1 – Communication Pathways and Procedures

Communication Driver	Initiator (role) (1)(2)	Recipient(s) (role) (1)	Procedure
General communication between USACE and other USACE staff	USACE PM or designee	Appropriate USACE staff	Communicates directly as needed (verbally and/or in writing).
Regulatory interface	USACE PM	Regulator	Provides project update via e-mail at least every other week during field activities.
Regulatory oversight	Regulators	USACE PM	Communicate directly as needed (verbally and/or in writing).
Project management, TO administration and logistics	Parsons PM	USACE PM and/or Parsons lead technical and site management personnel	Communicate directly as needed (in writing).
Monthly project conference calls	Parsons PM	USACE PM and appropriate USACE staff	Communicates project status verbally via monthly conference call.
Project management field coordination	Parsons PM/Site Manager	Landowner(s)	Verbal and or in writing communication a minimum of 10 days prior to field activities
Field progress reports/ Data Reports	Site Manager	Parsons PM and Parsons lead technical and site personnel	Documents progress in daily report and submits to Parsons PM for onward distribution to appropriate USACE staff. Daily reports will be submitted to USACE PM, within 24 hours of work completion that day whenever possible. USACE PM will submit reports weekly to CVRWQCB.
Stop work due to safety issues	All field personnel	Parsons Site Manager	Verbally notify the Parsons Site Manager that there is a safety issue requiring a work stoppage. Stop work.
	Parsons Site Manager	Parsons PM	Verbally notify Parsons PM as soon as possible after work stoppage.
	Parsons PM	USACE PM and appropriate USACE staff	Notify USACE PM verbally or via e-mail as soon as possible after work stoppage.

Table 6.1 – Communication Pathways and Procedures

Communication Driver	Initiator (role) (1)(2)	Recipient(s) (role) (1)	Procedure
	USACE PM	CVRWQCB	USACE PM will submit field progress reports weekly to CVRWQCB, which will describe any "stop work" issues.
Minor QAPP change (i.e., a revision that does not affect project procedures and/or quality control [QC] criteria)	Parsons Site Manager	Parsons PM	Communicates directly as needed (verbally and/or in writing) and submits draft Field Change Request form for discussion; does not implement change until approval is granted; consults with other personnel as needed.
	Parsons PM	USACE PM	Submits Field Change Request form to USACE for approval; does not implement change until approval is granted.
	USACE PM	Regulator	Forwards field change request for approval, if necessary.
	Parsons PM	USACE PM	Parsons PM notifies USACE PM of minor change.
Biological Resource finds	Parsons PM/Biologist	USACE PM/Biologist	Follow the procedures outlined in the Biological Resources Work Plan.
Field Corrective Actions	Parsons Site Manager	Parsons PM	The need for field Corrective Actions will be determined by the Site Manager in consultation with the Parsons PM, and/or Parsons technical personnel. Site Manager will notify Parsons PM of necessary field Corrective Actions and Parsons PM will respond within 24 hrs. Site Manager will document the occurrence using a root cause analysis (RCA)/Nonconformance Report (NCR).
	Parsons PM	USACE PM	Parsons PM notifies USACE PM and transmits copy of RCA/NCR for review and approval.
	USACE PM	CVRWQCB	USACE PM provides RCAs/NCRs to CVRWQCB as part of weekly field progress updates.
Identified impacts to receptors	USACE PM	CVRWQCB	USACE PM will notify CVRWQCB within 48 hours of identifying impacts to receptors or groundwater (e.g., spills or daylighting to surface waters, monitoring indicates negative impacts to groundwater, etc.)

Table 6.1 – Communication Pathways and Procedures

Communication Driver	Initiator (role) (1)(2)	Recipient(s) (role) (1)	Procedure
Sample receipt discrepancies (for example, broken or missing samples, improper preservation, or missing analysis requests)	Laboratory PM	Parsons Project Chemist	The laboratory PM will communicate discrepancies in sample receipt to Parsons Project Chemist on the same business day that the discrepancy is identified. The Project Chemist, in consultation with Parsons PM, will instruct the laboratory PM on the appropriate course of action.
Laboratory QC variances	Parsons Project Chemist	Parsons PM, USACE PM, USACE Chemist	The Project Chemist will prepare variance requests in collaboration with laboratory PMs for transmittal to USACE for approval.
Significant data quality issues	Parsons Project Chemist	Parsons PM, USACE PM, USACE Chemist, USACE Technical Lead	The Project chemist will notify the team of any significant data quality issues that might affect the integrity of the data.
	USACE PM	CVRWQCB	USACE PM provides notification to CVRWQCB as part of weekly field progress updates, should such an event occur.
Analytical Corrective Actions	Parsons Project Chemist	Parsons PM, USACE PM, USACE Chemist, USACE Technical Lead	Need for laboratory Corrective Actions will be determined by the Project Chemists and/or laboratory PM or QA Manager and will be documented in memoranda to Parsons PM or transmittal to USACE for approval.
Formerly Used Defense Sites Chemical Database (FUDSChem) electronic QAPP (eQAPP)	Parsons Project Chemist	Laboratory PM	The Project Chemist or designee will create the project eQAPP in FUDSChem and notify the laboratory when the eQAPP is complete. The Project Chemist will also upload a portable document format (PDF) copy of the final UFP-QAPP to the Project Library in FUDSChem for comparison to the eQAPP. The laboratory will then review and acknowledge the eQAPP in FUDSChem.
FUDSChem eQAPP	Parsons Project Chemist	Parsons PM, USACE Chemist	The Project Chemist will notify the USACE Chemist when the laboratory has acknowledged the eQAPP in FUDSChem. The USACE Chemist will approve the eQAPP prior to samples being collected.
FUDSChem Data Validation	Parsons Project Chemist	Parsons PM, USACE Chemist	The Project Chemist will complete validation in FUDSChem, supplementing with manual review as necessary. The

Table 6.1 – Communication Pathways and Procedures

Communication Driver	Initiator (role) (1)(2)	Recipient(s) (role) (1)	Procedure
			FUDSChem data validation report will be generated in FUDSChem and added to the Project Library. Once the validation files have been certified, the USACE Chemist will be automatically notified by FUDSChem that the files are ready for review. The USACE Chemist will review and approve the validation files.
FUDSChem Data Usability Assessment (DUA)	Parsons Project Chemist	Parsons PM, USACE PM, USACE Chemist	Upon approval of the Data Validation files by the USACE Chemist, the Project Chemist will complete the DUA in FUDSChem using the Assessment Checklist. When completed, the USACE Chemist will be automatically notified by FUDSChem that the DUA is ready for review. The USACE Chemist will review and approve the DUA and the final data submission will be made for the event.

Notes:
(1) Names and contact information for personnel provided on **Worksheets #4, 7, & 8**.

Worksheet #9: Project Planning Session Summary

9.1 PROJECT PLANNING SESSION SUMMARY

Date: 27 February 2024

Location: Webex Conference Call

Purpose: Discuss the goals, objectives, and scope of the treatability study. Meeting Minutes are provided in **Appendix C.**

Participants:

Name	Project Title / Role	Phone Number	Email Address
USACE			
Tim Crummett	USACE PM	916-557-6942	tim.r.crummett@usace.army.mil
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Parsons			
Carrie Ross	PM	303-764-8736	carrie.ross@parsons.us
Tom McManus	Deputy PM		thomas.mcmanus@parsons.us
Mark Rigby, Ph.D.	Technical Director	801-553-3350	mark.rigby@parsons.com
Abby Bazin, PE	Project Engineer	206-390-2324	abby.bazin@parsons.com
Craig Communications			
Tracy Craig	Craig Communications Principal	510-334-4866	tracy@craig-communications.com

Worksheet #10: Conceptual Site Model

10.1 OVERVIEW

A CSM is a description of a site and its environment that is used to depict the nature of potential contamination and the potential for exposure of human and environmental receptors to that contamination. The CSM is a comprehensive representation of the site that documents the potential for exposure (under current and future land use) to chemicals at a site based on the source(s) of contamination, the release mechanism(s), migration route(s), exposure pathway(s), and receptor(s) either at the site or that may reasonably be anticipated to be at the Site. The exposure models for human and ecological receptors are provided in **Figures 10.1** and **10.2**, respectively. A graphical representation of the CSM is provided in **Figure 10.3**.

The contaminants of potential concern (COPCs) for the former Titan 1-A Missile Facility are:

- 1,1-Dichloroethene
- cis-1,2-Dichloroethene
- trans-1,2-Dichloroethene
- 1,4-Dichlorobenzene
- Benzene
- Ethylbenzene
- Toluene
- Trichloroethene
- Vinyl chloride
- o- and m,p-Xylenes

The basis for this list of COPCs, as well as a preliminary CSM for the Site are described below. These are based on the available information that describes the sources of environmental contamination or hazards at the site, actual or potential pathways, current or proposed uses of the property, and potential receptors. The CSM is a living document and will be revised as additional information and investigation results are obtained throughout the investigation process.

The following is a discussion of site background, previous investigations, and the conceptual site model for the former Titan 1-A Missile Facility (also referred to as "Titan 1-A" or "Site").

10.2 SITE HISTORY AND SETTING

The former Titan 1-A Missile Facility is located approximately 1.6 miles east of the City of Lincoln at 401 Oak Tree Lane in Placer County. Lincoln is located approximately 20 miles north of Sacramento, California (**Figure Int.1**). The former Titan 1-A Missile Facility originally occupied approximately 46 acres (**Figures Int.2** and **Int.3**) with an additional 227-acre easement surrounding the missile complex to provide isolation and safety. The property was purchased by the U.S. Government from Floyd R. Bonnifield, et al in 1959 (Woodward-Clyde 1996).

Prior to its purchase by the U.S. Government, the Site was used as a cattle ranch (CEBMCO 1962). Aerial photographs from 1952 and 1957 show that there were no buildings, roads, row crops, or other improvements on the land that would become the Titan 1-A Missile Facility.

Construction began on January 22, 1960. Open cut excavation techniques were used as a partial excavation for the tunnels, launcher structures, and antenna silos. When the excavation encountered competent bedrock, it was removed by drilling and blasting. Excavation was slow due to muddy ground conditions, and groundwater was reportedly encountered at about 20-to 30-feet below ground surface (bgs). Approximately 470,000 cubic yards of soil were removed during the construction of the facility. The excavation was backfilled with stockpile materials obtained from the open cut excavation. Excavation was completed on June 27, 1960 (Woodward-Clyde 1996).

The Titan 1-A Missile Facility was completed in 1962 and consisted of three 160-foot deep missile silos, each with adjacent propellant and liquid oxygen terminals; a control center with living quarters; two antenna silos; a generator house; power room; entry portal; and system of connecting tunnels and air intake/exhaust vents. Underground utilities included storage tanks and distribution lines for #4 fuel oil, #2D fuel oil, Refined Petroleum-1 fuel (commonly referred to as RP-1), liquid oxygen, and liquid nitrogen; electrical wiring, water supply, wastewater collection system, and communications. Aboveground structured included a helicopter pad, quonset huts, hardstands for missile launches, watch towers, an oxidation pond and septic tank, and a communications system (Woodward-Clyde 1996). Historical above ground features are shown in **Figure Int.3**.

Information on specific uses of TCE at the Titan 1-A Missile Facility are sparse. Dynamac (1992) states that “subsurface components of the missile site were washed with TCE” and that “TCE was used during site maintenance” but that the quantity of TCE used and disposal methods were not known. A U.S. Air Force (1962) corrosion control manual from the time indicates that TCE was used for vapor degreasing, cleaning surfaces where liquid oxygen was used.

Titan 1 missiles were two stage missiles stored within the silos and lifted by elevator to the ground surface for launching. The missiles were 98-feet long, 10-feet in diameter, weighed 110 tons when loaded with fuel. The first stage consisted of a liquid rocket engine with two nozzles and the second stage consisted of a liquid rocket engine with a single nozzle. The rockets were propelled by a liquid oxygen/RP-1 liquid fuel mixture (Woodward-Clyde 1996).

Although groundwater did not present a serious problem for excavation activities, seepage of water into subsurface structures was a problem. Given the amount of water that seeped into subsurface structures, underground concrete surfaces were waterproofed (URS 2001). Surfaces that received waterproofing were initially covered with an asphalt primer. Five ply of thermoplastic bitumen-treated fibrous glass membrane was applied with hot asphalt and was protected on the outside surfaces by fiberboard. Leaks in the concrete walls were repaired with an epoxy grout or by channeling the water to the nearest sump (CEBMCO 1962).

The former Titan 1-A Missile Facility was deactivated in 1965, declared excess, and the property title was transferred to the General Services Administration, who dismantled the facility. The missiles were disassembled and shipped to the San Bernardino Air Material Area, at Norton Air Force Base (Woodward-Clyde 1996). Many of the features from the Former Titan 1-A Missile Facility, such as the air vents and silo doors are still visible. The underground structures are either partially or entirely flooded (Brown and Caldwell 2007).

In 1968, Placer County acquired the parcel that contained the former missile complex. Since 1968 the parcel had several uses (**Figure Int.3**):

- California Division of Forestry fire station
- Placer County Corporation Equipment Maintenance and Storage Yard (active)
- Trap and skeet club
- Pistol shooting range
- Gravel quarry

The Placer County Corporation Equipment Maintenance and Storage Yard is still actively used. The shooting ranges and fire station are no longer used.

The former Titan 1-A Missile Facility is bordered to the west by the Roman Catholic Church (Church), and to the southwest, south, southeast, and east by vacant land that is zoned for future residential use. To the north, the former Titan 1-A Missile Facility is bounded by a reservoir.

10.3 SITE GEOLOGY

10.3.1 REGIONAL GEOLOGY

The Former Titan 1-A Missile Facility lies between the dissected alluvial uplands of the Central Valley and the Sierra Nevada geomorphic provinces. The Sierra Nevada Geomorphic Province is underlain by hard, non-water bearing rocks and is characterized by steep-sided hills and narrow, rocky stream-channels. The dissected alluvial uplands border the Sierra Nevada to the west and are typified by rolling topography; i.e., rounded knolls and ridges separated by minor intermittent streams (Brown and Caldwell 2007).

10.3.2 SITE-SPECIFIC GEOLOGICAL CONDITIONS

The surficial alluvial material consists of lenses or layers of gravel, sand, silt, and clay in a silty matrix. Trenches advanced into the alluvium to depths of over 26 feet held vertical walls without collapsing, indicating that the alluvial material is partially cemented, compacted, or has a high dry strength (indicative of clays). Sieve analyses performed on soil samples indicate that the alluvial material has a high amount of silt and clay. A quartz cobble sedimentary deposit is present at the bottom of the alluvial material in some areas. The quartz cobble unit is distinguished by large (1 to 3 inches in diameter) rounded quartz cobbles in a sandy silt matrix (Brown and Caldwell 2007). Underlying the quartz cobble deposit is the Penryn Pluton. The pluton is granodiorite and tends to weather to clay or “saprolite” and, therefore, is relatively less permeable than the overlying alluvial sediments (URS 2001).

Below is a more comprehensive description of each lithologic unit present at the Site.

Surface Soil: Surface soil is typically characterized as a sandy silt or silty sand with gravel; clay is typically reported at concentrations ranging from trace to 15%. Gravel ranges in size from 1/8-inch to 2-inches in diameter and is usually moderately rounded to well rounded. The distinctive indicators for this lithologic unit are the fines content in the range of 15% to 35%, the reddish coloration, and the gravel. This lithologic unit typically extends from the surface to 2 to 5 feet below grade. The surface soil appears to be a diagenetic lithologic unit that conformably overlies the underlying lithologic unit (URS 2001).

Silty Sand: This lithologic unit is typically characterized as silty sand with sand size ranging from fine to coarse. Clay generally is not present in concentrations identifiable in hand samples. This lithologic unit is distinguished from the overlying surface soil facies by the absence of gravel, a shift in color from reddish browns to yellowish and grayish browns, and the reduction in fines content (particularly clay). The unit is sometimes identified as “reworked decomposed granite”; this sedimentary unit appears to have been produced by the erosion and deposition of a nearby granodiorite source rock. The silty sand unit typically ranges from 10 to 30 feet thick (URS 2001).

Basal Gravel / Cobble: A gravel is often identified in boring logs at the base of the sedimentary section just above the weathered bedrock. This layer ranges from approximately two to ten feet thick and was observed in boring logs between roughly 10 to 25 feet (ft) bgs. The gravel is moderately rounded to well rounded, ranges in diameter from 1 to more than 3 inches, and is composed of massive, milky white quartz (bull quartz). Cobbles larger than 8 inches in diameter are present in this unit as well (URS 2001).

Weathered Bedrock / Bedrock: The sedimentary lithologic units nonconformably overlie the granodiorite Penryn Pluton, which displays varying degrees of weathering across the site. Weathered bedrock is encountered between roughly 15 to 45 ft bgs at the Site. The overall effect of the weathering was the conversion of the competent igneous rock to material resembling a sandy silt or clay. The zone of highly weathered material appears to be about 30 feet thick, although the transition zone from highly weathered to moderately weathered rock is gradual and thicker in some areas. Below the highly weathered bedrock, the degree of weathering gradually decreases with depth, until competent bedrock is reached at 70 to 90 feet bgs (URS 2001). The weathered zone may be slightly saturated near the contact with the overlying sediments, but since the bedrock weathers to a clay, it is less permeable than the overlying sediments and effectively acts as an aquitard (URS 2001, Brown and Caldwell 2007).

10.4 SITE HYDROGEOLOGY

The depth to groundwater ranges from 1.5 to 29 feet bgs, depending on the location (Parsons 2024a). The groundwater gradient is toward the southwest (**Figure 10.4**), with a gradient of approximately 0.013 foot per foot (ft/ft), which also depends on location and year. The overall thickness of the water-bearing sediments encountered in the borings ranged from approximately 5 feet to 15 feet. Based on observation of sample wetness during drilling, the basal gravel portion of the sedimentary section (where present) appears to be the portion of the water-bearing zone that best produces water. Groundwater at the Site is generally found under unconfined conditions (URS 2001).

The practical lower limit of the groundwater flow zone is likely the contact between the sedimentary section and the highly weathered bedrock. This is because the bedrock does not yield groundwater readily – borings that did not encounter groundwater prior to encountering bedrock (common in wells drilled on the eastern side of the Site, where bedrock elevations are higher relative to the static water level) typically yielded water very slowly. Bedrock samples also do not appear to be saturated – drilling logs from borings that encountered bedrock below the water table typically indicate the moisture content of the bedrock samples as “damp,” “moist,” or “very moist,” they do not use the term “wet,” which typically is applied to saturated sediments. This is evident in many of the boring logs from URS (2001) and Ahtna (2023f). Additionally, the hydraulic conductivity of the weathered bedrock ranges from 10^{-6} to 10^{-8} cm/sec. That is at least 10 times lower than the hydraulic conductivity of the sandy water-bearing sediments that overlie the weathered bedrock, which have hydraulic conductivities in the range of 10^{-5} cm/sec (URS 2001). The description of the weathered bedrock in the boring logs, combined with its low hydraulic conductivity, indicate that it is not a water bearing unit.

The hydraulic conductivity of the weathered bedrock is in the range of 10^{-6} to 10^{-8} cm/sec. This is at least 10 times lower than the hydraulic conductivity of the sandy, water-bearing sediments that overlie the weathered bedrock, which have hydraulic conductivities in the range of 10^{-5} cm/sec (URS 2001).

This does not preclude the presence or movement of groundwater in the weathered bedrock, but does indicate that the movement of water in the weathered bedrock is very slow relative to the movement in the overlying sedimentary material. It is suspected that the formation of clay secondary minerals in the highly weathered bedrock decreases the hydraulic conductivity of the decomposed granite so that it acts essentially as an aquitard (URS 2001).

Given the relatively thin layer of water-bearing sediments overlying the bedrock, and how the bedrock effectively acts as an aquitard, groundwater flow can be influenced by bedrock elevations in the subsurface; i.e., groundwater may flow along dips/channels in the bedrock.

In the southern portion of the Site, the elevation of groundwater is sometimes higher than surface water. For example, at MW-19, groundwater elevation has ranged from 176.5 to 181.8 ft amsl from

2019 to 2023 (see **Table 2.5**; Ahtna 2023f). Approximately 25 feet downhill from MW-19, there is a pond that has a ground surface elevation of approximately 179 ft amsl[1]. Thus, during periods with higher groundwater elevations, the elevation of groundwater at MW-19 can be higher than the ground surface elevation at the pond downhill. Groundwater elevations can also exceed the elevation of the streambeds downhill from MW-54 and MW-55.

This suggests that there may be a potential hydraulic connection between a) groundwater and b) the ephemeral streams and ponds in the southern corner of the Site near MW-19, MW-54, and MW-55 (see **Figure 10.4**). A hydraulic connection may include both a) discharge of groundwater to surface water (e.g., a spring or infiltration of groundwater to surface water) or b) mixing of groundwater and surface water in the saturated soils surrounding the ephemeral streams and ponds (i.e., the hyporheic zone).

10.5 SITE CLIMATE

The mean daily temperature was 61 degrees Fahrenheit (° F) and mean annual precipitation was 12.5 inches. The coldest months are December and January, when temperatures average 45 and 46 ° F, respectively. The warmest months are July and August, when temperatures average 78 and 76 ° F, respectively. Southeasterly winds prevail from January to September, while northwesterly winds are most prevalent from October to December, with a mean annual windspeed of 6.0 miles per hour (data from the Lincoln Regional Airport for 2009 to 2022; IEM 2023).

10.6 SITE ECOLOGY

The majority of natural habitat at and adjacent to the former Titan 1-A Missile Facility has been greatly disturbed with the construction and operation of the former Titan 1-A Missile Facility (Brown and Caldwell 2004a), as well as construction on adjacent parcels (e.g., the Cal Sierra Limited parcel was used as a staging area for construction to the west).

When USACE (2018) conducted a site visit in 2018, it was observed that the majority of the former Titan 1-A Missile Facility and downgradient areas overlying the trichloroethene (TCE) groundwater plume were non-native annual grassland. Common grass species observed include foxtail barley (*Hordeum murinum*), medusa head (*Elymus caputmedusae*), wild oats (*Avena fatua*), soft brome/chess (*Bromus horaceaus*), ripgut brome (*Bromus diandrus*), and Italian ryegrass (*Lolium perenne*). Frequently occurring herbaceous non-native plants include red-stem filaree (*Erodium cicutarium*), prickly wild lettuce (*Lactuca serriola*), Italian thistle (*Carduus pycnocephalus*), English plantain (*Plantago lanceolata*), wild radish (*Raphunus sativus*), common mustard (*Brassica rapa*), milk thistle (*Silybum marianum*), bitter cress (*Cardamine californica*), winter vetch (*Vicia villosa*), curly dock (*Rumex crispus*), and Canadian horseweed (*Erigeron canadensis*). The majority of the former missile facility was covered in patches of dead yellow starthistle (*Centaurea solstitialis*) from past years. USACE's biologist has also noted that native vinegarweed (*Trichostema lanceolatum*) is common at the Site.

USACE (2018) found that there are several ephemeral drainages, ponded areas along the drainages, and seasonal wetlands on the former Titan 1-A Missile Facility, as well as on the Cal Sierra Limited and Century Communities parcels.

Species that were found in wet soils and near the ephemeral drainages and seasonal wetlands include: yellow owl's clover (*Castilleja campestris*), California goldfields (*Lasthenia californica*),

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[1] See https://apps.nationalmap.gov/3depdem/.

miniature lupine (*Lupinus bicolor*), butter ‘n’ eggs (*Triphysaria eriantha*), dwarf sack clover (Trifolium depauperatum), variegated clover (*Trifolium variegatum*), fiddleneck (*Amsinckia menziesii*), frying pans poppy (*Eschscholzia lobbi*), wild geranium (*Geranium dissectum*), narrow leaved owl’s clover (*Castilleja attenuata*), hop clover (*Trifolium aureum*), and wild hyacinth (*Triteleia hyacinthina*).

On the southern end of the Cal Sierra Limited and Century Communities parcels, there is a larger creek with mature oak trees. A pond on the corner of the Cal Sierra Limited parcel contained cattails (*Typha angustifolia*) and appeared to support a small population of red-winged blackbirds (*Agelaius phoeniceus*), which are prevalent on site (USACE 2018).

Common overstory trees include blue oaks (*Quercus douglasii*), valley oaks (*Quercus lobata*), interior live oaks (*Quercus wislizenii*), willows (*Salix* spp.) and Fremont cottonwood (*Populus fremontii*). Understory shrubs include coyote brush (*Baccharis pilularis*), poison oak (*Toxicodendron diversilobum*), willows (*Salix* spp.), and Himalayan blackberry (*Rubus armeniacus*).

While USACE (2018) did not observe any special status species at the Titan 1-A Missile Facility or the adjacent Praxis Properties and Century Communities parcels, they determined that the Site contains suitable habitat for federally-listed vernal pool branchiopods. There is suitable habitat throughout the area with known TCE contamination extending southwest from the former missile facility primarily to the Cal Sierra Limited parcel (formerly known as the Crocker Knoll parcel). The general area also contains suitable habitat for the federally-listed valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), with elderberry plants previously observed on the Century Communities parcel. A site assessment performed in 1994 also did not identify any special status species on the Site (Brown and Caldwell 2004a).

10.7 PREVIOUS INVESTIGATIONS

10.7.1 HISTORICAL OR CULTURAL RESOURCES

In 1994, as a part of an Environmental Assessment prepared by IT Corporation (IT), a cultural resources survey was performed to identify significant cultural resources at the Titan 1-A Missile Facility. No indications of prehistoric cultural resources were found during the field survey. Given the significant disturbance of the site during facility construction, it is unlikely that prehistoric cultural resources would be found (URS 2001).

10.7.2 SUMMARY OF PREVIOUS INVESTIGATIONS

Since 1991, numerous investigations and pilot tests have been performed on the Site. The investigations conducted between 1991 and 2002 are summarized in Brown and Caldwell (2007) and more recent investigations are summarized in the 2024 Draft Remedial Investigation (Parsons 2024a).

Quarterly groundwater monitoring and soil vapor sampling was completed by Ahtna Environmental, Inc. (Ahtna) from the fourth quarter of 2019 (4Q19) through the first quarter of 2023 (1Q23) (Ahtna 2020, 2021a-c, 2022a-d, 2023a-e). These activities were performed to assess current groundwater and soil vapor conditions at the Site and to fill data gaps previously identified. This investigation included the installation of 19 additional groundwater monitoring wells and 24 soil vapor probes. The monitoring confirmed that groundwater characteristics (e.g., flow direction and geochemistry) and the nature and extent of groundwater contamination were similar to previous investigations. Soil vapor impacts were further defined from this investigation, but the extent of soil vapor impacts were not fully delineated. The extent of the TCE plume in groundwater from the 1st semi-annual 2024 sampling event is shown in **Figure 10.5.**

10.8 EXPOSURE PROFILE

This section outlines the potential receptors, distribution of COPCs (see **Section 10.1** for the list of COPCs), and an overview of the potential exposure pathways.

The Continuing Remedial Investigation (RI) summarized investigations completed prior to and during the Continuing RI (Brown and Caldwell 2004b) and concluded that TCE and its daughter products (primarily cis-1,2-DCE) are the DoD-related COPCs that should be addressed under the FUDS program. The Continuing RI stated that additional contaminants, including metals and PAHs were identified, but were related to the skeet and pistol ranges that were constructed and operated subsequent to DoD operations. Because they were not related to past DoD use, they were not identified as COPCs in the Continuing RI.

Low concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected at the Church parcel and the Cal Sierra Limited parcel (**Figure Int.4**) as part of the Continuing RI. The response to comments on the Continuing RI (see appendix of the Continuing RI for the responses to comments) and a subsequent underground storage tank (UST) investigation (Brown and Caldwell 2005) ruled out the former missile facility as the source of the BTEX, and suggested that Placer County's gasoline storage tanks may have been the potential source (FA/BC 2004). Regardless, BTEX was carried forward as COPCs in the FS (Brown and Caldwell 2007) and in subsequent investigations. 1,4-Dichlorobenzene was selected as a COPC as it was used by the DoD as a toilet deodorizer and wastewater containing 1,4-dichlorobenzene was discharged by the DoD to the septic system leach field adjacent to the Placer County Corporation Yard (URS 2001).

10.8.1 POTENTIAL RECEPTORS AND LAND USE

Potential human receptors at the Site include commercial/industrial workers, utility and construction workers, and potential future residents. Residential housing is currently planned to be constructed over the groundwater and soil vapor plumes on the Cal Sierra Limit and Century Communities parcels; however, no housing currently exists over any portion of the groundwater plume. Residents are the most sensitive population either adjacent to or at the Site.

The Sun City community lies west of the Cal Sierra Limited parcel and is a developed residential subdivision. Groundwater is migrating towards the eastern margin of the community (**Figure 10.4**); however, current data suggests that the COPCs have not migrated to groundwater on this property. Nonetheless, if COPCs do migrate into groundwater within the Sun City community, residents would be potential receptors.

Although suitable habitat for the federally-listed valley elderberry longhorn beetle is present, the beetle is not exposed to the contaminants in shallow groundwater and is not fossorial (i.e., does not dwell in burrows where volatiles emitted from groundwater may concentrate). Similarly, vernal pools are present (although the locations are not mapped) that are suitable habitat for the federally-endangered Conservancy fairy shrimp (*Branchinecta conservatio*), vernal pool tadpole shrimp (*Lepidurus packardi*), and federally-threatened vernal pool fairy shrimp (*Branchinecta lynchi*). Although the exact location of the vernal pools are not known, they are assumed to be in the vicinity of MW-22, MW-42 through MW-45, and MW-59), groundwater occurs as shallow as 6 ft bgs, except at MW-43, where it can reach as shallow as 2.65 ft bgs (Parsons 2024a). In addition, vernal pools, if present, form over an impermeable bedrock or clay layer. Together, this suggests that TCE in the groundwater plume does not discharge to the vernal pools (even in the vicinity of MW-43) and, therefore, the listed species that may be present in the vernal pools are unlikely to be exposed. In addition, based on the lack of listed fossorial wildlife at the Site and highly disturbed habitat conditions, evaluation of an exposure pathway for terrestrial ecological receptors is unnecessary. Downgradient from the vernal pools, groundwater may discharge to Ingram Slough south of MW-19 (**Figure 10.4**). While ecological receptors may be present in the slough, no special status species have been identified there, nor is it suitable habitat for any special status species.

10.8.2 POTENTIAL SOURCE AND DISTRIBUTION OF CONTAMINANTS

Though no direct source of contamination has been confirmed, it is assumed that the original contamination was caused by spills, leaks, and other former operations on and around the Former Titan 1-A Missile Facility. No significant soil contamination has been found (Brown and Caldwell 2007).

As shown in **Figure 10.5**, the highest reported TCE concentrations in groundwater occur adjacent to, and southwest of, the current Placer County Corporation Yard. From there, TCE has migrated to the southwest in groundwater, following the general groundwater flow direction shown in **Figure 10.4**.

10.8.3 MIGRATION AND EXPOSURE PATHWAYS

Trichloroethene has been released to groundwater at the Site. A source has not been identified, but based on the TCE contours in groundwater, the release may have been in the vicinity of the current Placer County Corporation Yard. From there, the contamination in groundwater migrated to the southwest, resulting in the contaminant plume map shown in **Figure 10.5**. While contamination in groundwater migrated laterally, it does not appear to have migrated downward into the weathered bedrock, which, as noted above, acts essentially as an aquitard. Though the weathered bedrock acts as an aquitard, it also sorbs TCE, which may be released later.

Trichloroethene may also volatilize from groundwater. From there, TCE will migrate upwards through the soil column until it reaches the atmosphere. If there are any buildings overlying the plume, TCE may also be released to indoor air.

The potential groundwater exposure pathways for human receptors at the Site include:

- Child and adult residents using groundwater as drinking water (direct ingestion) and for showering (dermal absorption and inhalation of volatile organic compounds [VOCs])
- Commercial/industrial workers using groundwater as drinking water (direct ingestion) and for washing hands (dermal absorption and inhalation of VOCs)
- Construction workers encountering groundwater in a trench (incidental ingestion, dermal absorption, and inhalation of VOCs)

Although all groundwater in this part of the Central Valley is considered potentially suitable for domestic or agricultural purposes (CVRWQCB 2019), such uses are unlikely for the shallow groundwater at the Site. Groundwater production observed during the groundwater extraction pilot test was poor. Production from individual temporary groundwater sampling points was usually less than one gallon per minute on a sustainable basis (FA/BC 2004). In Placer County, to be considered adequate for domestic use, a well must produce a minimum of 1 gallon per minute and 1,200 gallons in a four-hour period (or 5 gallons per minute) at least once every 24 hours (Placer County Code Article 16.08.040.E.3.b and 16.20.180.C.3). Therefore, shallow groundwater at the Site does not meet County requirements for domestic water use.

While the area overlying the TCE plume remains undeveloped, terrestrial ecological receptors may be present at the Site, including plants, mammals, and birds. These receptors may be exposed to TCE via inhalation of outdoor and burrow air. If parts of the Site are developed, ecological receptors are assumed to no longer be present. On the southern end of the TCE plume, contaminated groundwater may be in contact with surface water. Ecological receptors could be exposed through dermal contact or ingestion of contaminated groundwater that discharges to surface water and/or sediment, as well as the ingestion of food items. Although the Site is suitable for several special status species, none have been observed. These exposure pathways and receptors are summarized in **Figures 10.1 and 10.2**.

Worksheet #11: Project Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality and level of data required to support the decision-making processes for a project. Guidance for DQO development is provided by USACE (2016) and USEPA (2006). Specific DQOs have been established and are presented in below. These DQOs follow USEPA's (2006) seven-step, iterative process for DQO development.

In addition to these DQOs, all data collected during this project are required to attain the measurement performance criteria (MPCs) described on **Worksheet #12** to be considered adequate to support environmental decisions, unless sufficient alternative justification is provided to and accepted by the project team. Before final environmental decisions are made, data will be verified and validated as described in **Worksheets #34** through **#37**.

11.1 STEP 1 - STATE THE PROBLEM

Previous investigations have identified the nature of contamination; i.e., TCE and its breakdown products, which are present in groundwater at the Site. Historically, the highest TCE concentrations in groundwater are found to the southwest of the Placer County Corporation Yard. TCE has also been detected in soil vapor in areas overlying the groundwater TCE plume. Remediation alternatives will be identified and evaluated in a Feasibility Study and are likely to include treatment using injections to chemically reduce COPC concentrations and/or enhance bioremediation in situ. A combination of three amendments has been selected to evaluate abiotic and biotic treatment:

- PlumeStop® Liquid Activated Carbon™ (PlumeStop®) is a colloidal form of activated carbon that provides a large sorption surface to capture COPCs. PlumeStop® abiotically treats TCE through sorption, which will reduce TCE concentrations in groundwater without the formation of cis-1,2-DCE or vinyl chloride.
- Sulfidated-Micro Zero Valent Iron (S-MicroZVI) is a concentrated suspension of sulfidated, colloidal zero-valent iron that provides a chemical reduction mechanism that will treat COPCs. ZVI works by abiotically degrading TCE to ethene without the production of daughter products, such as cis-1,2-DCE or vinyl chloride. It also creates a long-lasting reducing environment that can provide native and augmented bacteria with the conditions needed for reductive dechlorination.
- Bio-Dechlor Inoculum Plus (BDI Plus®) is a live microbial culture of dechlorinating bacteria that can be added to augment existing bacterial populations to ensure the necessary types of bacteria are present for enhanced anaerobic bioremediation. BDI+ will enhance anaerobic degradation through reductive dechlorination, which will degrade TCE to cis-1,2-DCE and then to vinyl chloride.

The optimal dosing rates and effectiveness of these amendments at the Titan 1-A site is unknown. Therefore, a treatability study is proposed to evaluate in situ chemical reduction (ISCR) and enhanced anaerobic bioremediation (EAB).

11.2 STEP 2 - IDENTIFY THE GOALS OF THE STUDY

The goals of the study are to answer the following questions:

- Are ISCR and EAB feasible groundwater treatment technologies in the source area?

- Are ISCR and EAB feasible as perimeter groundwater treatment technologies?
- How do contaminant concentrations and groundwater flow vary with depth?
- What volume of the amendments can be injected into the formation?
- How much treatment is achieved at the applied amendment dosing rate(s)?
- Are there any constraints that will limit the effectiveness of injections (e.g., daylighting, refusal, inability to inject in the desired zone, inadequate treatment response, formation of undesirable compounds, etc.)?
- Are high concentrations of COPCs present in the weathered bedrock that could be a long-term source of contaminants to groundwater?

Data should be gathered to evaluate the suitability of ISCR and EAB as remedial options for the Site in a Feasibility Study.

11.3 STEP 3 - IDENTIFY INFORMATION INPUTS

Data from the previous investigations and reports listed in **Worksheet #13** will be used to refine the technical approach and will be used to calculate planned amendment dosing and evaluate treatment performance.

Additional monitoring wells will be installed and sampled for volatiles, metals, dissolved gases, anions, total organic carbon (TOC) and water quality parameters (see **Worksheet #15**) to evaluate groundwater geochemical conditions. This data will establish groundwater geochemical conditions, which will be used to evaluate whether geochemical conditions are suitable for treatment and as one indicator of whether treatment can be effective (USEPA 1998).

Soil samples from the soil borings will be collected and analyzed for volatiles to assess COPC concentrations in the weather bedrock and to qualitatively assess soil type. Passive flux meters (PFMs) will be installed in existing monitoring wells and sorbent media from the PFMs will be sampled for VOCs and alcohol tracers to calculate groundwater flow velocities and COPC flux at discrete depths. The PFMs will be installed within the planned treatment areas (EW-1 and MW-43), as well as areas outside the planned injection locations (MW-19 and MW-50) to assess groundwater flow and contaminant flux throughout the plume.

Groundwater samples will be collected prior to implementing the amendment injections to evaluate baseline conditions. Baseline conditions will be established a) in the source area with a sample from well EW-1 and b) near the perimeter by collecting samples from wells MW-43 and MW-67. After the amendments are injected, groundwater samples will be collected to evaluate treatment performance and changes in geochemical conditions. Source area treatment will be evaluated using samples from EW-1. Perimeter treatment will be evaluated using samples from MW-67 (upgradient) and MW-43 (downgradient).

See **Worksheet #18** for a summary of the sampling locations and methods. See **Appendix D** for Standard Operating Procedures (SOPs) used for data collection and **Worksheet #15** for the analyte list and methods.

11.4 STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY

Spatial Boundaries: Injections will be completed in the area immediately surrounding EW-1 and in a row upgradient of MW-43 (**Figure 11.1**). Injections will be spaced 6 to 7 feet apart near EW-1 and 5 to 6 feet apart upgradient of MW-43. A new monitoring well (MW-67) will be installed upgradient of the injections near MW-43 and a soil boring (B-01) will be installed adjacent EW-1. Groundwater samples will be collected from EW-1 and MW-43 and MW-67. PFMs will be installed in EW-1, MW-19, MW-43, and MW-50. Soil samples will be collected from B-01. Planned injection locations may be modified in the field based on accessibility, the presence of utilities and other obstructions, or surface water bodies, logistical factors, and/or rights of entry. The vertical boundary is the depth to bedrock (approximately 30 feet bgs).

Temporal Boundary: Well installation, sampling, and PFM installation will be conducted prior to completing injections. The injections are planned for early 2025. Performance sampling will be conducted quarterly for one year following the completion of the injections. It is expected that the results of the treatability study will be substantial and immediately apparent and that four quarters will be sufficient to identify the impact of the treatability study, or lack thereof. The impacts are expected to be observed within the first quarter and the remaining events will establish the additional evidence to support the evaluation of the outcomes. The project schedule is shown in **Appendix A.**

11.5 STEP 5 - DEVELOP THE ANALYTIC APPROACH (DECISION RULES)

Injection and sampling locations have been chosen to evaluate the effectiveness of in situ treatment of COPCs in the source area and as a downgradient perimeter treatment technology.

11.5.1 GROUNDWATER MONITORING

In general, TCE concentrations are expected to decrease because the three amendments that are intended to treat TCE. ZVI will abiotically degrade TCE to ethene without the production of daughter products. PlumeStop will sorb TCE leading to reduced concentration in groundwater. BDI+ will enhance anaerobic degradation and will produce daughter products (cis-1,2-DCE and vinyl chloride). Therefore, decreases in TCE concentrations may be attributable to any of these three amendments. However, only BDI+/EAB is associated with the generation of daughter products. Therefore, we are using the presence of daughter products as an indicator that EAB is a feasible technology at the Site. In this context, the term suitable is meant to state that conditions are such that reductive dechlorination can and do occur.

The following decision rules will be applied to groundwater monitoring well sampling:

- The new well (MW-67) will be sampled quarterly for one year. Once the four quarterly performance monitoring events are complete, MW-67 will be abandoned.
- At EW-1, if post-injection TCE concentrations in the performance monitoring samples are lower than the TCE concentration in the baseline sample, then ISCR is a feasible source treatment technology that can be considered for the Site remedy. As noted in the RI (Parsons, 2024a), TCE concentrations do not have a statistically significant trend up or down in EW-1 and do not appear to be correlated with groundwater elevations. Therefore, historical data from EW-1 will be graphed as a control chart, with new TCE concentration data compared to the pre-injection (i.e., from 2019 up to the injection) 95% upper and lower confidence limits and the pre-injection median to evaluate whether the injections have affected TCE concentrations in groundwater at EW-1. Note, however, that with the recent construction in the area, groundwater flow patterns may have changed and the effect on TCE concentrations in the vicinity of EW-1 has not yet been determined. Therefore, alternative methods to evaluate the effects of the injection on TCE concentrations at EW-1 may be required.
- At MW-43, if TCE concentrations after treatment are lower than the TCE concentration in the baseline sample, then ISCR is a feasible perimeter treatment technology that can be considered for the Site remedy. Samples collected before and after treatment in the upgradient well (MW-67) will be used as a control to assess if treatment is effective. As MW-67 is close enough to MW-43 that TCE concentrations in groundwater should not be different,

a control chart (as described above for EW-1) will be developed for MW-43 and the data for both MW-43 and MW-67 will be plotted on the control chart to evaluate whether the injections have affected TCE concentrations in groundwater at MW-43. The expectation is that post-injection, a decrease in contaminant concentrations should be observed in MW-43 compared to the control chart confidence interval if the treatment is effective, but no decrease should be observed in MW-67.

- If TCE daughter products are detected (cis-1,2-DCE and/or vinyl chloride) and geochemical parameters measured during performance monitoring indicate groundwater conditions are suitable for reductive dechlorination (groundwater is anaerobic and groundwater conditions are reducing), then EAB is a feasible treatment technology for reducing TCE concentrations. Any of the three amendments used may result in lower TCE concentrations; however, only BDI+/EAB is associated with the generation of daughter products. Therefore, the presence of daughter products is an indicator that EAB is a feasible technology at the Site. Because all three amendments will work to reduce daughter product concentrations, it is not expected that vinyl chloride will accumulate as a result of EAB. However, concentrations of vinyl chloride and their overall persistence should be evaluated to consider if these amendments should be selected as the Site remedy.

11.5.2 MONTORING WELL DEPTH AND SOIL SAMPLES

One new groundwater monitoring well (MW-67) and one new soil boring (B-01) will be installed (**Figure 11.1**). **Appendix D** includes procedures for installing soil borings and collection soil samples (SOP 05) for installing monitoring wells (SOP SESDGUID-101). Soil samples will be collected for VOCs and a qualitative assessment of soil type. Soil type samples will be collected every 2 feet from 15 to 24 feet bgs in B-01 and from 3 to 26 feet bgs in MW-67. The following decision rules will be applied to collecting soil samples:

- If field personnel note that the water bearing zone appears to be shallower than anticipated or if the depth to bedrock is deeper than expected, then more samples will be collected to cover the entire water bearing zone. Soil type samples will be collected so that the entire water bearing zone is sampled every two feet.

11.5.3 AMENDMENT INJECTIONS

The following decision rules will be applied to amendment injections:

- If daylighting of injected material is observed, injection at that interval will cease. The release will be managed by containing and collecting the surfaced groundwater and reagents. The injection plan will then be modified to limit the possibility of daylighting occurring again.

Exceptions to the injection approach that may be implemented based on decision inputs are:

- If the formation cannot accept the volume of injectate prescribed, then the planned injection volume may be adjusted. Examples of the formation not accepting the injectate include daylighting, unacceptable injection pressures, injectate loss in trenches, utility corridors, and other unforeseen circumstances. If an injection cannot be completed, then the location of one or more planned injections may be adjusted. Examples of when a location would be modified include drilling refusal before reaching target depth, daylighting of injectate, and surface obstructions in the injection location (e.g., surface water, existing trenches, etc.).

11.6 STEP 6 - SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

Injections and sampling and analysis shall achieve applicable MPCs as agreed upon in the work plan, unless MPC failures can be adequately explained and/or justified.

Analytical data quality will meet the MPCs outlined in **Worksheet #12**, **Section 12.2** and data performance criteria in **Worksheets #19/30, 35, 36**, and **37**.

11.7 STEP 7 - DEVELOP THE PLAN FOR OBTAINING DATA (TECHNICAL APPROACH SUMMARY)

The sampling design is provided in **Worksheet #17** and the analytical design is provided in **Worksheets #19/30, 20**, and **24-28**. SOPs for data collection are provided in **Appendix D**. Data will be gathered with a focus toward determining if amendment injections can be effectively applied in order to evaluate remedial options in a Feasibility Study.

One soil boring and one additional monitoring well will be installed to approximately 30 feet bgs. Soil samples will be collected every two feet from the water-bearing zone in each boring and submitted for visual analysis of soil type. Each boring will be completed at least six-inches into the bedrock and a bedrock sample will be collected from each boring and analyzed for VOCs. The well will be screened in the first water-bearing zone (approximately 5–30 feet bgs), sampled, and analyzed for VOCs and geochemical parameters.

Baseline groundwater sampling will be conducted prior to implementing the injection program to verify the planned amendment dosing and to provide baseline data for evaluating the effectiveness of the treatment. New and existing monitoring wells will be sampled for VOCs using PFMs and for geochemical parameters using low-flow groundwater sampling techniques. Amendment dosing and injection spacing will be verified based on the baseline sampling and the screening level PFM data collected prior to injection mobilization.

Amendment injections will be completed in two areas.

- Sixteen injections will be completed in a grid pattern around EW-1 (see **Figure 11.1**).
    - ➢ The injections will be placed 6 to 7 feet apart laterally.
    - ➢ The injection interval will include the entire water bearing zone down to bedrock, estimated to be 15 to 24 feet bgs.
- Eight injections will be completed upgradient of MW-43.
    - ➢ The injections will be placed in a single row perpendicular to groundwater flow direction (see **Figure 11.1**).
    - ➢ The injections will be spaced approximately 5-6 feet apart laterally.
    - ➢ The row will be located approximately 10 feet from MW-43 and at least 15 feet from MW-67. All injection points will be at least 10 feet from the existing extraction trenches and at least 6 feet from surface water bodies.

Groundwater sampling will be conducted at least one month after the injections are complete to evaluate treatment performance. Groundwater treatment performance samples will be collected quarterly for one year (four sampling events) from wells EW-1, MW-43, and MW-67 and qualitatively compared to the baseline sample results to evaluate treatment performance. Samples will be analyzed for VOCs and geochemical parameters.

Worksheet #12: Measurement Performance Criteria

12.1 MPC FOR FIELD-RELATED TASKS

The field operations for this project involve multiple elements, or "definable features of work." These definable features of work are listed on **Worksheet #14** and a discussion of each one is included in the Field Investigation Plan (**Worksheet #18**). Standard operating procedures (SOPs) for each field activity are provided in **Appendix D**. **Table 12.1** summarizes the MPCs that have been established for the definable features of work associated with the tasks to be conducted during this investigation. The quality of these procedures and the related results will be evaluated for compliance with project quality objectives (PQOs) through a review of overall precision, accuracy, representativeness, comparability, and completeness (PARCC), in accordance with the procedures described in **Worksheet #37**. (*Note that MPCs are required to indicate that the relevant data are of adequate quality to support project decisions.*)

Table 12.1 – Definable Features of Work

Definable Feature of Work (*Data Type*)	Data Quality Indicator(s)	Activity to Assess Measurement Performance and/or Quality Control (QC) Sample	Measurement Performance Criteria	Frequency	Action in Event of Failure
Borehole logging *(documentation)*	Completeness	Geologist completes the drilling log (ASTM D2488-17)	Borehole logging documentation is correctly recorded.	Each boring installed	Correct entry if critical details cannot be resolved, resampling may be required.
Soil sampling from boreholes *(documentation)*	Completeness	Geologist collects samples from the boreholes	The proper samples are submitted for analysis.	Each boring installed	Correct entry. If critical details cannot be resolved, resampling may be required.
Soil sampling from boreholes *(field measurements)*	Accuracy	Perform equipment calibration and checks per **Worksheet #22.**	All equipment is calibrated per requirement of **Worksheet #22**, prior to field parameter collection.	See **Worksheet #22.**	Recalibrate or replace equipment as necessary.

Table 12.1 – Definable Features of Work

Definable Feature of Work (*Data Type*)	Data Quality Indicator(s)	Activity to Assess Measurement Performance and/or Quality Control (QC) Sample	Measurement Performance Criteria	Frequency	Action in Event of Failure
Well installation *(documentation)*	Completeness	Geologist accurately details well installation and construction procedure (SESDGUID-101)	Well construction details are correctly recorded.	Each well installed	Correct entry. If critical details cannot be resolved.
Well development *(documentation)*	Completeness	Geologist completes the well development log and records development parameters (SESDGUID-101)	Development logging documentation is correctly recorded.	Each monitoring well developed	Correct entry. If critical details cannot be resolved, redevelopment may be required.
Well development *(field measurements)*	Accuracy	Perform equipment calibration and checks per **Worksheet #22.**	All equipment is calibrated per requirement of **Worksheet #22**, prior to field parameter collection.	See **Worksheet #22.**	Recalibrate or replace equipment as necessary.
Low-Flow Groundwater Sampling *(documentation)*	Completeness	Sampler completes the low-flow groundwater sample log (SOP 02)	Sample documentation is correctly recorded.	End of each sample collection.	Correct entry. If critical details cannot be resolved, resampling may be required.
Low-Flow Groundwater Sampling	Accuracy	Perform equipment calibration and checks per **Worksheet #22.**	All equipment is calibrated per requirement of **Worksheet #22**, prior to	See **Worksheet #22.**	Recalibrate or replace equipment as necessary.

Table 12.1 – Definable Features of Work

Definable Feature of Work (*Data Type*)	Data Quality Indicator(s)	Activity to Assess Measurement Performance and/or Quality Control (QC) Sample	Measurement Performance Criteria	Frequency	Action in Event of Failure
(field measurements)			field parameter collection.		
Groundwater Sampling with PFMs *(documentation)*	Completeness	Sampler notes the details of PFM construction, installation, retrieval, and sampling for each PFM in the field logbook	Documentation is correctly recorded.	During deployment, retrieval, and sampling of each PFM	Correct entry. If critical details cannot be resolved, resampling may be required.
Amendment Injections (Completeness)	Completeness	Driller completes the correct number of injection points and injects the correct amount of amendments in each treatment area.	Injection documentation is correctly recorded.	End of each injection.	Correct entry. If critical details cannot be resolved, resampling may be required.
Waste Characterization Sampling *(documentation)*	Completeness	Sampler documents sample on Waste Tracking Log (**Appendix B**)	Documentation is complete.	For each waste characterization sample collected	Correct entry. If critical details cannot be resolved, resampling may be required.
Waste Management *(documentation)*	Accuracy	Geologist or sampler completes the Waste Tracking Log, Waste Disposal Tracking Log, and Waste	Documentation is on file for all waste generated on-site.	Each time a new waste drum/ container is generated, sampled, characterized,	Immediately report discrepancies to, Site Manager, and Parsons PM.

Table 12.1 – Definable Features of Work

Definable Feature of Work (*Data Type*)	Data Quality Indicator(s)	Activity to Assess Measurement Performance and/or Quality Control (QC) Sample	Measurement Performance Criteria	Frequency	Action in Event of Failure
		Transportation Tracking Log.		disposed of, or transported	Parsons PM notifies USACE PM to reconcile any differences.
Data Storage and Management	Completeness	Scientist manages and stores project data.	Documentation is complete and accurate.	All applicable data.	Correct entry.

12.2 MEASUREMENT PERFORMANCE CRITERIA FOR SAMPLE COLLECTION

The following table summarizes the MPCs that have been established for the related tasks to be conducted during the sampling at Former Titan 1-A. The quality of the sampling procedures and laboratory results will be evaluated for compliance with PQOs through a review of overall PARCC, in accordance with the procedures described in **Worksheet #37**. The results will be summarized in a DUA. These criteria are not applicable to injections or waste characterization.

Table 12.2.1 – Measurement Performance Criteria for Analysis of Volatiles in Soil and Groundwater

Laboratory:	EMAX
Matrix:	Soil and Groundwater
Analytical Group or Method:	Volatile Organic Compounds by SW8260C
Concentration Level:	All
Procedure:	Soil Sampling and Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	One per cooler	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Equipment/Rinsate Blank[1]	One per up to five (5) consecutive days of sampling when non-disposable sampling tools are used	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Source Blank[1]	One per rinse water source	Representativeness, Accuracy/Bias	All target compounds ≤ ½ LOQ
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25% for water and < 50% for soil
Matrix spike (MS) / Matrix spike duplicate (MSD)	One MS/MSD pair per 20 field samples	Accuracy, Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
laboratory control sample duplicate (LCSD)	One per preparation batch when MSD is not applicable or available	Analytical Accuracy, Analytical Precision	See **Worksheet #28**

Table 12.2.1 – Measurement Performance Criteria for Analysis of Volatiles in Soil and Groundwater

Laboratory:	EMAX
Matrix:	Soil and Groundwater
Analytical Group or Method:	Volatile Organic Compounds by SW8260C
Concentration Level:	All
Procedure:	Soil Sampling and Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Surrogate	All field and QC samples	Analytical Accuracy/Bias	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Notes:

[1] Rinsate/Source blanks are only collected when reusable equipment comes in contact with the sample matrix.

Table 12.2.2 – Measurement Performance Criteria for Analysis of Metals in Groundwater

Laboratory:	EMAX
Matrix:	Groundwater
Analytical Group or Method:	Metals by SW6010C
Concentration Level:	All
Procedure:	Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment/Rinsate Blank[1]	One per up to five (5) consecutive days of sampling when non-disposable sampling tools are used	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Source Blank[1]	One per rinse water source	Representativeness, Accuracy/Bias	All target compounds ≤ ½ LOQ
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
MS/MSD	One MS/MSD pair per 20 field samples	Accuracy, Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
laboratory control sample duplicate (LCSD)	One per preparation batch when MSD is not applicable or available	Analytical Accuracy, Analytical Precision	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Notes:

[1] Rinsate/Source blanks are only collected when reusable equipment comes in contact with the sample matrix.

Table 12.2.3 – Measurement Performance Criteria for Analysis of Dissolved Gases in Groundwater

Laboratory: EMAX
Matrix: Groundwater
Analytical Group or Method: Dissolved Gases by RSK-175
Concentration Level: All
Procedure: Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment/Rinsate Blank[1]	One per up to five (5) consecutive days of sampling when non-disposable sampling tools are used	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Source Blank[1]	One per rinse water source	Representativeness, Accuracy/Bias	All target compounds ≤ ½ LOQ
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
MS/MSD	One MS/MSD pair per 20 field samples	Accuracy, Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
laboratory control sample duplicate (LCSD)	One per preparation batch when MSD is not applicable or available	Analytical Accuracy, Analytical Precision	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Notes:

[1] Rinsate/Source blanks are only collected when reusable equipment comes in contact with the sample matrix.

Table 12.2.4 – Measurement Performance Criteria for Analysis of Anions in Groundwater

Laboratory:	EMAX
Matrix:	Groundwater
Analytical Group or Method:	Anions by SW9056A
Concentration Level:	All
Procedure:	Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment/Rinsate Blank[1]	One per up to five (5) consecutive days of sampling when non-disposable sampling tools are used	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Source Blank[1]	One per rinse water source	Representativeness, Accuracy/Bias	All target compounds ≤ ½ LOQ
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
MS/MSD	One MS/MSD pair per 20 field samples	Accuracy, Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
laboratory control sample duplicate (LCSD)	One per preparation batch when MSD is not applicable or available	Analytical Accuracy, Analytical Precision	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Notes:

[1] Rinsate/Source blanks are only collected when reusable equipment comes in contact with the sample matrix.

Table 12.2.5 – Measurement Performance Criteria for Analysis of Alkalinity in Groundwater

Laboratory:	EMAX
Matrix:	Groundwater
Analytical Group or Method:	Alkalinity by SM2320B
Concentration Level:	All
Procedure:	Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
sample duplicate	One matrix duplicate (MD) or sample duplicate per 20 field samples	Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 °C
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ or >1/10 sample concentration
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Table 12.2.6 – Measurement Performance Criteria for Analysis of Hardness in Groundwater

Laboratory:	EMAX
Matrix:	Groundwater
Analytical Group or Method:	Hardness by SM2340C
Concentration Level:	All
Procedure:	Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
sample duplicate	One MD or sample duplicate per 20 field samples	Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**

Table 12.2.7 – Measurement Performance Criteria for Analysis of Total Organic Carbon (TOC) in Groundwater

Laboratory:	EMAX
Matrix:	Groundwater
Analytical Group or Method:	TOC by SW9060A
Concentration Level:	All
Procedure:	Groundwater Sampling using Low-Flow Sampling

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Equipment/Rinsate Blank[1]	One per up to five (5) consecutive days of sampling when non-disposable sampling tools are used	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Source Blank[1]	One per rinse water source	Representativeness, Accuracy/Bias	All target compounds ≤ ½ LOQ
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 25%
MS, MD	One MS and MD per 20 field samples	Accuracy, Precision	See **Worksheet #28**
Temperature Blank	One per cooler	Representativeness	≤ 6 ºC
Method Blank	One per preparation batch	Representativeness, Accuracy/Bias	No analytes detected > 1/2 LOQ, >1/10 sample concentration, or >1/10th of the regulatory limit, whichever is greater
Laboratory control sample (LCS)	One per preparation batch	Analytical Accuracy	See **Worksheet #28**
laboratory control sample duplicate (LCSD)	One per preparation batch when MSD is not applicable or available	Analytical Accuracy, Analytical Precision	See **Worksheet #28**
LOQ Verification Sample	Quarterly	Sensitivity	Laboratory in-house limits

Notes:

[1] Rinsate/Source blanks are only collected when reusable equipment comes in contact with the sample matrix.

Table 12.2.8 – Measurement Performance Criteria for VOCs and Alcohol Tracers in PFM Media

Laboratory:	EnviroFlux
Matrix:	PFM Media
Analytical Group or Method:	VOCs by SW8260C and alcohols by SW8015C
Concentration Level:	All Concentrations
Procedure:	Groundwater Sampling using Passive Flux Meters

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Trip Blank	One per cooler including VOC samples	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Field Blank	One per every PFM deployed	Representativeness, Accuracy/Bias	All target compounds ≤ LOQ or ≤ 5 times the LOQ for common laboratory contaminants
Field duplicate (FD)	One per 20 field samples	Precision	Relative percent difference (RPD) < 50%
Method Blank	One per batch of 20 samples	Representativeness, Accuracy/Bias	No analytes detected > method reporting limit (MRL) or LOQ
Temperature Blank	One per cooler	Representativeness	≤ 4 ºC
Laboratory control sample (LCS)	One per batch of 20 Samples	Analytical Accuracy	See **Worksheet #2**8

Worksheet #13: Secondary Data Uses and Limitations

Secondary data will be used to make decisions during the environmental investigation at the Former Titan 1-A Missile Facility. The following table lists the primary supporting documents for this project and the ways they might be used during project implementation.

Table 13.1 – Secondary Data Uses and Limitations

Secondary Data	Data Source	How Data Will Be Used	Limitations on Data Use
Site history and CSM	Previous investigations include: • Monitoring Well Installation and Ground Water Sampling at Ferrari Eastlake Ranch Site (now Cal Sierra Limited; Radian 1991) • Records Research Report (Woodward-Clyde 1996) • Field Investigation Report, Passive Soil Vapor Survey (Woodward-Clyde 1997) • Focused Remedial Investigation Report (URS 2001) • 2001-2006 Annual Groundwater Monitoring Reports (FA/BC 2002, Brown and Caldwell 2003, 2004c, 2006) • Continuing Remedial Investigation Report (Brown and Caldwell 2004b) • Report of Soil Vapor Survey, Crocker Knoll Property (now Cal Sierra Limited; AEG 2012) • Report of Groundwater Investigation, Crocker Knoll Property (now Cal Sierra Limited; AEG 2015a)	Data will be used as reference for site history, types of contaminants, nature and extent of contamination, temporal trends, and general site information. Data will be used to evaluate potential location of new groundwater monitoring wells and/or injection locations.	Professional judgment will be required to determine data usability. The reports produced following this work plan will document the usability of secondary data, including any changes to the site history and CSM.

Table 13.1 – Secondary Data Uses and Limitations

Secondary Data	Data Source	How Data Will Be Used	Limitations on Data Use
	• Report of Soil Vapor Survey, Oak Tree Lane Property (now 2 parcels, Praxis Properties and Century Communities; AEG 2015b) • Surface Soil and Soil Vapor Investigation Report. Hidden Hills Property (now 2 parcels, Praxis Properties and Century Communities; Wallace-Kuhl 2015) • Report of Groundwater Investigation, Former Titan 1-A Missile Facility (AEG 2016) • 2019-2023 Quarterly Groundwater and Soil Vapor Monitoring Reports (Ahtna 2020, 2021a, b, c, 2022a, b, c, d, 2023a, b, c, d, e) • 2023 Supplemental Remedial Investigation and Feasibility Study Report (Ahtna 2023f)		
Soil and groundwater data collected under an approved work plan and QAPP using approved analytical methods, with appropriate detection limits to meet project goals.	Previous investigations (see above).	If proper data collection, analysis, and validation can be verified, data may be used for all applicable DQO purposes including determination of the nature and extent of contamination. Otherwise, data will be used as screening-level data to assist with CSM development and placement of samples.	None if proper collection, analysis and validation can be verified. If not, data will be considered screening-level data and will not be used for determination of nature and extent or for risk assessment purposes.

Table 13.1 – Secondary Data Uses and Limitations

Secondary Data	Data Source	How Data Will Be Used	Limitations on Data Use
Lithology and boring logs	Previous investigations (see above).	Data will be used to support the development of the hydrogeologic CSM, including the development of geologic cross sections.	Review of logs and professional judgment will be required to determine the data quality and data usability. The usability of secondary data from lithology and boring logs will be assessed during the refinement of the hydrogeologic CSM. The RI report (Parsons 2024a) documents the usability of secondary data.
Geographic Information System (GIS) Layers and Site Maps	Previous investigations (see above).	Data will be used to determine site features and previous sampling locations and will later support the determination of nature and extent of contamination.	Professional judgment will be required to determine usability of maps from previous reports. The RI report will document the usability of secondary data.

Worksheet #14 & 16: Project Tasks and Schedule

14.1 DEFINABLE FEATURES OF WORK

To perform the treatability study, the field investigation will include amendment injections and soil and groundwater sampling. Non-sampling investigation tasks may include measurements of water levels and geophysical investigations. The field operations involve multiple elements, or "definable features of work," that will be required to achieve the project goals. **Table 14.1** provides a summary of these definable features of work and the associated component tasks. A detailed discussion of each of the definable features of work is included in **Section 17.5** of **Worksheet #17 & 18**, and the specific field procedures to be used for the activities described in this summary are included in the various SOPs in **Appendix D**.

Table 14.1 – Definable Features of Work and Associated Tasks

Definable Feature of Work	Associated Tasks
Site and Project Preparation	
Mobilization	• Preparation (review plans, make travel arrangements, etc.) • Preconstruction biological surveys and ongoing biological monitoring • Arrange for equipment and vehicles, and get them delivered to the site • Set up site communications • Conduct site-specific training and briefing for required field personnel
GIS data management	• Manage geospatial data in suitable formats • Prepare maps and GIS for field use and final reports • Prepare GIS deliverable
Field Activities	
Geophysical survey	• Perform appropriate QC checks • Perform surveys, mark locations of utilities and buried objects, and record point data for documentation of object locations • Prepare deliverable survey results report including maps
Point acquisition / sample location staking	• Establish a handheld global positioning system (GPS) control point • Conduct QC checks for handheld GPS units • Locate and stake proposed sample locations
Drill Soil Boring and Collect Samples *(SESDGUID-101 and SOP 05)*	• Drill borehole using hollow-stem auger (HSA) • Collect soil samples. • Decontaminate drilling equipment. • Abandon borehole or construct monitoring well. • Dispose of soil cuttings and other wastes in accordance with Waste Management Plan (**Appendix B**)

Table 14.1 – Definable Features of Work and Associated Tasks

Definable Feature of Work	Associated Tasks
Groundwater Monitoring Well Installation *(SESDGUID-101)*	• Drill borehole using HSA • Construct monitoring well • Decontaminate drilling equipment • Install surface completion • Dispose of soil cuttings and other wastes in accordance with Waste Management Plan (**Appendix B**)
Groundwater Monitoring Well Development *(SESDGUID-101)*	• Develop wells through surging and pumping • Decontaminate equipment • Dispose of development water in accordance with Waste Management Plan (**Appendix B**)
Groundwater Sampling using Low-Flow Sampling *(SOP 02)*	• Follow the procedures in the SOP to collect groundwater sample • Ship groundwater samples to laboratory for analysis • Decontaminate equipment • Dispose of purge water in accordance with Waste Management Plan (**Appendix B**)
Groundwater Sampling using Passive Flux Meters (**Appendix G**; *PFM Standard Operation Procedure)*	• Install the PFM in the well • Wait 4-8 weeks • Retrieve the PFM from the well • Fill sample jars with PFM sorbent for laboratory analysis • Ship samples to laboratory for analysis • Decontaminate equipment
Field Equipment Decontamination *(SOP 04)*	• Follow the procedures based on the type/size of equipment that needs decontamination • Follow the Waste Management Plan (**Appendix B**) for disposal of all waste generated during field activities and decontamination process.
Demobilization	• Upon completion of field activities all personnel, equipment, materials, and wastes will be removed from the site
Waste characterization sampling (**Appendix B**)	• Collect and analyze waste samples. • Document sampling on Waste Tracking Log (**Appendix B**) • Document Final Characterization on Waste Tracking Log (**Appendix B**)
Waste management (**Appendix B**)	• Label and properly store waste • Inspect waste storage • Profile waste for proper disposal • Track waste from generation to disposal • Complete all waste tracking and logging documentation

Table 14.1 – Definable Features of Work and Associated Tasks

Definable Feature of Work	Associated Tasks
Data storage and management	• Upload data to appropriate server(s) • Accurate and current data are available • Data are managed in an organized manner

14.2 PROJECT SCHEDULE

A detailed schedule is provided in **Appendix A.**

Worksheet #15: Project Screening Levels and Laboratory-Specific Detection / Quantitation Limits

Yellow highlighted values indicate achievable laboratory LOQs, limits of detection (LODs), and/or detection limits (DLs) that are greater than the Project Quantitation Limit Goals (PQLGs). In these cases, the LOD will become the de facto PQLG.

If the sensitivity requirements are not met for a particular analyte, the team will evaluate whether the data can still be used for project decisions. If non-detect values exceed the PQLGs, data are considered usable if the analyte is not a site-related compound. Analytes that are not site-related chemicals, and thus are not expected to be found, do not impact decision making. For analytes that are site-related, the team will use a “weight of evidence” approach to evaluate the likelihood of the chemical’s presence. This approach uses available data that does meet sensitivity requirements to evaluate the presence or absence of the compound in other samples or other similar compounds and/or degradation products for the analyte in question.

Samples will be analyzed in accordance with the DoD Quality Systems Manual Version 5.4 (QSM 5.4; DoD, 2021) by a DoD and California ELAP accredited laboratory. Refer to **Appendix G** for the analyzing laboratories records of accreditations.

Note: The screening levels in this UFP-QAPP are used to select the most appropriate analytical methods and analyses for the project. These initial screening levels are used in the UFP-QAPP for project planning and may not be appropriate for use in subsequent steps of the project (e.g., quarterly monitoring reports and/or remedial investigation report).

Table 15.1 - Reference Levels and Evaluation Table: Water, VOCs (8260C)

Laboratory: EMAX
Matrix: Water
Analytical Group: Volatile Organic Compounds (SW8260C)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
1,1-Dichloroethene	75-35-4	µg/L	280	130	7.0	6.0	6.0	CA MCL	2.0	1.0	0.20	0.10
1,4-Dichlorobenzene	106-46-7	µg/L	0.48	N/A	75.0	5.0	0.48	USEPA RSL	0.20	1.0	0.20	0.10
Benzene	71-43-2	µg/L	0.46	0.15	5.0	1.0	0.46	USEPA RSL	0.20	1.0	0.20	0.10
cis-1,2-Dichloroethene	156-59-2	µg/L	25	12	70.0	6.0	6.0	CA MCL	2.0	1.0	0.20	0.10
Ethylbenzene	100-41-4	µg/L	1.5	N/A	700	300	1.5	USEPA RSL	0.50	1.0	0.20	0.10
m,p-Xylene	179601-23-1	µg/L	190	N/A	10,000	1,750	190	USEPA RSL	63	2.0	0.50	0.21
o-Xylene	95-47-6	µg/L	190	N/A	10,000	1,750	190	USEPA RSL	63	1.0	0.20	0.10
Toluene	108-88-3	µg/L	1,100	410	1,000	150	150	CA MCL	50	1.0	0.20	0.10
trans-1,2-Dichloroethene	156-60-5	µg/L	68	110	100	10	10	CA MCL	3.3	1.0	0.20	0.10
Trichloroethene	79-01-6	µg/L	0.49	N/A	5.0	5.0	0.49	USEPA RSL	0.20	1.0	0.20	0.10
Vinyl chloride	75-01-4	µg/L	0.019	0.0098	2.0	0.50	0.019	USEPA RSL	0.30	1.0	0.30	0.11

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

N/A = Not available

PSL - Project Screening Level

USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.

Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.2 - Reference Levels and Evaluation Table: Water, Metals (6010C)

Laboratory: EMAX
Matrix: Water
Analytical Group: Metals (6010C)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Aluminum	7429-90-5	mg/L	20	N/A	N/A	1.0	1.0	CA MCL	0.33	0.20	0.05	0.025
Calcium	7440-70-2	mg/L	-	N/A	N/A	N/A	0.3	LOD	0.3	1.00	0.30	0.15
Iron	7439-89-6	mg/L	14	N/A	N/A	N/A	14	USEPA RSL	4.7	0.20	0.05	0.025
Magnesium	7439-95-4	mg/L	-	N/A	N/A	N/A	0.10	LOD	0.10	0.50	0.10	0.05
Manganese	7439-96-5	mg/L	0.43	N/A	N/A	N/A	0.43	USEPA RSL	0.14	0.01	0.003	0.002

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level.
https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024
CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 202
CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.
DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.
N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.3 - Reference Levels and Evaluation Table: Water, Dissolved Gases (RSK-175)

Laboratory: EMAX
Matrix: Water
Analytical Group: Dissolved Gases (RSK-175)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Ethane	74-80-0	µg/L	N/A	N/A	N/A	N/A	1.28	LOD	1.28	2.00	1.28	0.64
Ethene	74-85-1	µg/L	N/A	N/A	N/A	N/A	1.20	LOD	1.20	2.00	1.20	0.60
Methane	74-82-8	µg/L	N/A	N/A	N/A	N/A	0.68	LOD	0.68	2.00	0.68	0.34
Carbon dioxide	124-38-9	µg/L	N/A	N/A	N/A	N/A	600	LOD	600	1200	600	300

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024.

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.4 - Reference Levels and Evaluation Table: Water, Anions (9056A): Sulfate and Nitrate

Laboratory: EMAX
Matrix: Water
Analytical Group: Anions (9056A): Sulfate and Nitrate

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Nitrate	14797-55-8	mg/L	32	-	10 as N	10 as N	10	CA MCL	3.3	0.10	0.05	0.025
Sulfate	14808-79-8	mg/L	-	-	-	-	0.25	LOD	0.3	0.50	0.25	0.13

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024.

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.5 - Reference Levels and Evaluation Table: Water, Alkalinity (SM 2320B)

Laboratory: EMAX
Matrix: Water
Analytical Group: Alkalinity (SM 2320B)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Alkalinity	N/A	mg/L	N/A	N/A	N/A	N/A	5.0	LOQ	5.0	5.0	NA	NA

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD. If an LOD is not available, the LOQ will be used.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024.

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

N/A = Not available

PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.6 - Reference Levels and Evaluation Table: Water, Hardness (SM 2340C)

Laboratory: EMAX
Matrix: Water
Analytical Group: Hardness (SM 2340C)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Hardness	N/A	mg/L	N/A	N/A	N/A	N/A	10	LOQ	10	10	NA	NA

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD. If an LOD is not available, the LOQ will be used.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024.

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.7 - Reference Levels and Evaluation Table: Water, Total Organic Carbon (9060A)

Laboratory: EMAX
Matrix: Water
Analytical Group: TOC (9060A)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	USEPA MCL	CA MCL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
										LOQ	LOD	DL
Total Organic Carbon	N/A	mg/L	N/A	N/A	N/A	N/A	0.50	LOD	0.5	1.0	0.50	0.25

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD. If an LOD is not available, the LOQ will be used.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations. Accessed 29 April 2024.

CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.

DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.

N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.8 - Reference Levels and Evaluation Table: Soil, VOCs (8260C)

Laboratory: EMAX

Matrix: Soil

Analytical Group: Volatile Organic Compounds (SW8260C)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
								LOQ	LOD	DL
1,1-Dichloroethene	75-35-4	mg/kg	230	83	230	USEPA RSL	77	5.0	1.0	0.50
1,4-Dichlorobenzene	106-46-7	mg/kg	2.6	N/A	2.6	USEPA RSL	1.0	5.0	1.0	0.50
Benzene	71-43-2	mg/kg	1.2	0.33	1.2	USEPA RSL	1.0	5.0	1.0	0.50
cis-1,2-Dichloroethene	156-59-2	mg/kg	63	18	63	USEPA RSL	21.0	5.0	1.0	0.50
Ethylbenzene	100-41-4	mg/kg	5.8	N/A	5.8	USEPA RSL	1.9	5.0	1.0	0.50
m,p-Xylene	179601-23-1	mg/kg	580	N/A	580	USEPA RSL	193	10	2.0	1.0
o-Xylene	95-47-6	mg/kg	640	N/A	640	USEPA RSL	213	5.0	1.0	0.50
Toluene	108-88-3	mg/kg	4,900	1,100	4,900	USEPA RSL	1,633	5.0	1.0	0.50
trans-1,2-Dichloroethene	156-60-5	mg/kg	70	130	70	USEPA RSL	23	5.0	1.0	0.50
Trichloroethene	79-01-6	mg/kg	0.94	N/A	0.94	USEPA RSL	1.0	5.0	1.0	0.50
Vinyl chloride	75-01-4	mg/kg	0.059	0.0082	0.059	USEPA RSL	2.0	5.0	2.0	1.00

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used.
2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.
3 - Non-detects (< DL) will be reported to the LOD. If an LOD is not available, the LOQ will be used.

Definitions:

DTSC-SL = California Department of Toxic Substances Control May 2022 residential soil screening levels.
N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 residential soil Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Table 15.9 - Reference Levels and Evaluation Table: PFM, VOCs (8260C)

Laboratory: EnviroFlux
Matrix: PFM
Analytical Group: Volatile Organic Compounds (SW8260C)

Analyte	CAS Number	Units	USEPA RSL	DTSC-SL	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
								LOQ	LOD	DL
Tetrachloroethene flux	N/A	mg/m^2-day	N/A	N/A	0.01	LOD	0.01	0.01	0.004	0.002
Trichloroethene flux	N/A	mg/m^2-day	N/A	N/A	0.01	LOD	0.01	0.01	0.004	0.002
1,2-cis-dichloroethene flux	N/A	mg/m^2-day	N/A	N/A	0.10	LOD	0.10	0.10	0.045	0.02
Vinyl chloride flux	N/A	mg/m^2-day	N/A	N/A	0.30	LOD	0.30	0.30	0.15	0.06
Darcy velocity	N/A	cm/day	N/A	N/A	0.1-0.3	LOD	0.1-0.3	0.1-0.3	0.1-0.3	0.1-0.3

Notes:

1 - The PSL is the USEPA RSL. If there is no USEPA RSL, the DTSC-SL is used. If the CA MCL is lower than the selected value, the CA MCL is used instead.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD. If an LOD is not available, the LOQ will be used.

Definitions:

USEPA MCL - United States Environmnetal Protection Agency Maximum Contaminant Level.
CA MCL - California Maximum Contaminant Level. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.
CA PHG - California Public Health Goal. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html. Accessed 29 April 2024.
DTSC-SL = California Department of Toxic Substances Control May 2022 tapwater screening levels.
N/A = Not available
PSL - Project Screening Level
USEPA RSL = USEPA May 2024 tapwater Regional Screening Level. Target HQ = 1.
Yellow highting indicates a detection limit greater than the Project Quantitation Limit Goal.

Worksheet #17: Sampling Design and Rationale

This worksheet summarizes the rationale for the sample and injection locations and how they will be sampled. Note that precise sampling locations are not described here but will be developed in consultation with the project team based on the results of geophysical and intrusive investigations. The process for sampling, including determining sample locations, is discussed further on **Worksheet #18**.

17.1 GROUNDWATER SAMPLING DESIGN/RATIONALE

Groundwater sampling will be conducted before and after treatment to assess treatment performance and to gather data that will assist with designing a full-scale remedy.

Prior to implementing the injections, one round of baseline samples will be collected. The baseline sampling will include new and existing wells, as follows (**Figure 11.1**):

- Monitoring wells
  - All monitoring wells listed below will be sampled once.
  - Discrete groundwater samples will be collected from the well listed below and analyzed for as described in **Section 18.6.2.**
  - EW-1: an existing monitoring well that is within the EW-1 injection area. The location is judgmental in the source area.
  - MW-19: an existing monitoring well that is downgradient of both injection areas. The location is judgmental and is on the perimeter.
  - MW-43: an existing well that is downgradient of the planned injections at MW-43. The location is judgmental and is on the perimeter.
  - MW-50: an existing monitoring well that is side-gradient from both injection areas. The location is judgmental and is on the perimeter.
  - MW-67: a new monitoring well (MW-67) will be placed upgradient of the planned injections at MW-43. The location is judgmental and is on the perimeter of the source area.
- PFMs
  - PFMs will be installed in monitoring wells listed below and sampled once prior to treatment. Samples will be analyzed for as described in **Section 18.6.2.**
  - PFMs are considered composite samples as the sample is time-integrated.
  - EW-1: an existing monitoring well that is within the EW-1 injection area. The location is judgmental in the source area.
  - MW-19: an existing monitoring well that is downgradient of both injection areas. The location is judgmental and is on the perimeter.
  - MW-43: an existing well that is downgradient of the planned injections at MW-43. The location is judgmental and is on the perimeter.
  - MW-50: an existing monitoring well that is side-gradient from both injection areas. Understanding mass flux in this area is important for evaluating the treatment design in areas that are outside plume core. The location is judgmental and is on the perimeter.

MW-43 and MW-67 will be used to compare groundwater conditions upgradient and downgradient of the barrier injections. Groundwater samples will be collected before and after treatment to establish baseline and post-treatment VOC concentrations and geochemical conditions to assess the treatment effectiveness

After implementing the injections, performance monitoring will be conducted quarterly for one year (four events). The performance monitoring will consist of the following:

- Discrete samples from new and existing monitoring wells will be collected from each treatment zone, including the source zone (EW-1) and the perimeter (MW-43 and MW-67). These samples will be analyzed as described in **Section 18.6.3**. It is expected that the effects of the treatability study will be obvious and apparent, such that a judgmental approach is adequate to observe whether the injections are effective. The three wells selected for performance monitoring are suitably located to observe the impacts of the injections in both the source and perimeter treatment areas.

17.2 SOIL SAMPLING DESIGN/RATIONALE

Prior to treatment soil samples will be collected from a boring in each treatment zone and the soil type will be qualitatively evaluated. These data will be used to optimize the treatability study injection plan and to design a full-scale alternative in the FS. These sample locations were selected because they represent the areas to be treated. Full-scale injection, if selected, will be based on additional data, as appropriate. Soil samples will be collected from the boring used to install MW-67 (perimeter area) and from boring B-01 (source area) (**Figure 11.1**).Discrete samples will be collected every two feet throughout the planned vertical treatment zone (15 to 24 feet bgs at B-01 and 3 to 26 feet bgs at MW-67). Based on available boring logs, this distribution is adequate to identify variability with depth.

In addition, one sample of the weathered bedrock will be collected from each new boring (MW-67 at the perimeter and B-01 in the source area). These discrete samples will be collected before treatment and will be analyzed for VOCs (**Table 15.8**) to assess if the weathered bedrock will be an ongoing source of COPCs to groundwater.

17.3 INJECTION LOCATION DESIGN/RATIONALE

The locations of the proposed injections (**Figure 11.1**) were determined using professional judgement, as follows:

- The injections surrounding EW-1 were located in the area of highest groundwater concentrations to evaluate source area treatment. The injection locations may have to be slightly adjusted from what is shown in **Figure 11.1** to avoid the EW-1 vault.
- The injections upgradient of MW-43 were located to evaluate a perimeter type treatment.
- Injection spacing is based on the soil types in existing adjacent borings. Previous experience was used to estimate the radius of influence for these soil types.

17.4 REPORTING

The results of the activities described here will be reported in a Treatability Study Report following the completion of 4 quarters of performance monitoring. The schedule is provided in **Appendix A** (see Subtask 12.3 Treatability Study Report). Following the injections, quarterly progress updates will also be submitted to the Central Valley Water Board via email.

Worksheet #18: Sampling Locations and Methods

This section describes the approach for evaluating groundwater conditions at the Site to achieve the goals of the project (**Worksheet #11**).

18.1 MOBILIZATION

Preparations for mobilization will commence upon approval of the final Work Plan. Upon receipt of document approval, the field team will be notified, coordination with subcontractors will be finalized, and requisite copies of applicable documents will be assembled.

Prior to initiating field activities, all team members will be given site-specific training involving:

- Activities to be performed
- Safe work practices
- Emergency procedures
- Threatened and endangered species awareness

The field team will be briefed each day prior to commencement of field activities. Daily briefings will include a discussion of weather conditions, the previous day's findings (if related to safety issues), emergency response and evacuation procedures. The daily meetings will ensure all project personnel are familiar with the Accident Prevention Plan (APP) / Site Safety and Health Plan (SSHP) (Parsons 2024b), and that all pertinent Activity Hazard Analyses (AHAs) included in the APP/SSHP have been reviewed and discussed.

18.2 VEGETATION CLEARANCE

Prior to sampling, installing a monitoring well, or completing injections, the potential staging areas for any vehicles and/or drill rigs will be evaluated. If grass is present and long enough such that it could contact hot engine parts, the grass will be cut using a handheld string trimmer.

18.3 UTILITY CLEARANCE

Utility clearance must be obtained prior to installing monitoring wells and completing injections to ensure that drilling equipment will not hit overhead or underground utility lines. Underground Service Alert (https://usanorth811.org/) will be called for utility location and marking. In addition, a third-party geophysical subcontractor will conduct precision utility location (PUL), electromagnetic (EM), and/or precision utility location (GPR) surveys to locate underground utilities throughout the work area. Identified utilities will be marked on the ground surface and will be surveyed. Utilities will be located within an approximate 10-foot buffer around the proposed monitoring well(s) and injection areas to accommodate relocation, if needed (**Figure 11.1**). If any underground utilities are present within 5 feet of a monitoring well location, the monitoring well location will be relocated. If any underground utilities are present within 10 feet of an injection point, the overall injection footprint will be evaluated for adjustment.

The PUL survey shall be conducted using a precision electromagnetic pipe and cable locator. Each location will be surveyed in passive mode to detect active utilities emitting a live electrical signal. If active utility pipes or cables are located near the survey areas, then the PUL will be operated in active mode to transmit a signal along the pipe or cable, and the path of the line and a buffer will be located and marked within the survey area.

If necessary, the EM survey will be performed using a time domain EM induction metal detector (EM61, or similar) capable of detecting and resolving the extent of large metallic buried objects up to 12 feet bgs. EM data shall be collected along transect lines at 5-foot spacing.

If necessary, the GPR survey will be conducted using instruments and software with resolutions sufficient to interpret potential buried objects up to 12 feet bgs. The GPR data will be acquired along orthogonal transects at 5-foot spacing, or as required for resolution requirements. The GPR survey will employ a real time display to identify areas potentially requiring greater data coverage, and to quickly adjust field procedures as needed to obtain the best data possible. Raw data from the EM and GPR surveys will be obtained from the geophysical subcontractor.

Locations of utilities will be marked on the ground surface with color indicators for the assumed type of utility. Monitoring wells will be hand-augured (or similar method) to a minimum depth of 5 feet bgs to verify the absence of obstructions. Injections will be completed with a direct-push rig through their entire depth.

18.4 FIELDWORK CONSIDERATIONS

The investigation area is not expected to be constrained by logistical or safety considerations. Heavy or extended rain events may result in access issues for large equipment (i.e., drill rigs, development trucks) due to the undeveloped nature of the investigation area. Access may be restricted based upon biological and cultural resource considerations. USACE will be notified 48-hours prior to investigation activities to evaluate site conditions and train workers as necessary. Biological avoidance and minimization procedures will be implemented as necessary.

18.4.1 FIELD DOCUMENTATION

A field logbook will be kept by the Site Manager/Site Safety and Health Officer. The field logbook is intended to record events during sampling activities in sufficient detail to allow field personnel to reconstruct events that transpired during the project. If task-specific field sheets (e.g., field sampling forms) are used, they will be referenced, but not reiterated, in the logbook.

Documentation of site activities will also include color photographs. Photographs will be taken to document sample locations, important field observations (e.g., stained soil), progress of work, and the procedures used for different sampling activities.

A Daily Status Report (see **Appendix E**) will be submitted by the Site Manager/Site Safety and Health Officer. The form will provide a quick reference for work completed that day, work planned for the next field day, a log of people onsite, record of safety meetings/inspections, equipment and/or material that arrived or left the jobsite and note any investigation-derived waste (IDW) generated. The Daily Status Report will be signed by the Site Manager/Site Safety and Health Officer as verification of the information. When appropriate, the Daily Status Report may include a log of groundwater wells installed/developed, soil vapor probes installed and/or samples collected. Daily Status Reports will include a minimum of two photographs.

18.5 SOIL BORING AND MONITORING WELL INSTALLATION AND AMENDMENT INJECTIONS

18.5.1 SOIL BORINGS AND MONITORING WELLS

Soil borings and groundwater monitoring wells will be installed to support the design and assessment of the treatability study, as shown in **Figure 11.1**.

Prior to drilling, Placer County will be contacted to discuss the substantive requirements of their well installation permitting process, but CERCLA actions are exempt from the administrative requirements (40 CFR 300.400(e)). Written property access agreements will be obtained, borings and monitoring wells will be drilled and installed by a C-57 licensed drilling subcontractor, and the Site Manager will notify Placer County Environmental Health at least two working days in advance of drilling to schedule grout inspections.

Borings and monitoring wells will be drilled and installed under the oversight of a Parsons' field technician. Sampling methods will follow SOP 05. Well installation methods will follow Field SOP SESDGUID-101, except where the SOP potentially conflicts with California Department of Water Resources Bulletin 74-81, subsequent supplements, and Placer County Code Section 13.08. The differences from SOP SESDGUID-101 are as follows:

- Grout: following Placer County's recommendation, neat cement will be used as the grout mix for all wells.
- Well Development: wells will be developed 48 hours after installation to ensure that cement/grout is set and will not be pulled into the well screen during development.

An HSA drill rig will be used to advance 8-inch diameter augers to a depth of approximately 30 feet bgs. The Parsons' field technician will log the lithological descriptions for each borehole as described in ASTM D2488-17. The boring logs will be reviewed by a California licensed geologist. Where possible, the well installation will position the top of the screen interval approximately one foot above the water table. The Parsons' field technician will select the location of the screen interval based on the lithologic information collected, and will verify its placement with the driller. The wells will be screened in the first water-bearing zone (5–30 feet bgs).

An 8-inch diameter hollow stem auger will create an approximately 6-inch annular space. Monitoring wells will be constructed of 2-inch inner diameter, schedule 40, flush-threaded polyvinyl chloride (PVC) casing with 10 foot long 0.02-inch factory-slotted PVC well screens. The filter pack material shall be clean, well-rounded, #3 quartz or silica sand, or equivalent. The sand will extend a minimum of 4-inches below the end cap and approximately 2-feet above the top of screen. Example monitoring well completion diagrams are provided in **Appendix E**.

An annular 2-foot-thick bentonite seal shall be placed above the sand filter pack. The bentonite seal shall be constructed of compressed bentonite pellets. Wells shall be completed with cement/bentonite grout slurry placed above the bentonite seal to just below ground surface. Cement grout will be placed from top down because there will be 5 feet or less of grout between the top of the seal and bottom of the concrete used to set the above-ground well monument.

All equipment used during the installation will be decontaminated prior to the start of drilling (before first use) and before moving to the next location by dry decontamination and steam cleaning (Field SOP 04).

Wells will be developed a minimum of 48-hours after final grout placement using bailing, pumping and/or surging, as described in Field SOP SESDGUID-101. In previous investigations, wells were not able to be developed using pumping methods. Water quality parameters will be monitored during development. Wells will be allowed to recover prior to sampling. Following installation, a lockable, aboveground stove pipe will be constructed to protect the well. The stove pipe will be protected by up to four yellow bollards set in concrete, as necessary.

18.5.2 AMENDMENT INJECTIONS

Injections will not be completed in wetlands, swales, or areas prone to ponding. Injections will be installed at the locations shown in **Figure 11.1** Injections will be completed using a direct-push rig down to bedrock which is anticipated to be between approximately 30-35 feet bgs, under the oversight of a Parsons field technician. The volume injected into each depth interval will be determined from analytical results and from the PFM data. Prior to mobilization, the volume to be injected in each depth interval will be calculated by Regenesis using their proprietary modeling software to optimize treatment within each interval. The dose will be calculated using the PFM data and will take into account the synergistic effects of the three amendments. Once mobilized to the site, and before injections begin, water levels will be measured in EW-1, MW-19, MW-43, MW-50, and MW-67.

The treatment reagents will be injected into the aquifer using the following “top-down” injection procedure at each location:

1. Using a direct push technology (DPT) rig, advance the injection rod to the first planned injection interval. The first injection interval will be the shallowest injection interval. Use a pressure-activated injection tip with a check valve to allow lateral delivery of the reagent(s) and to prevent backflow.
2. Once the target injection depth has been reached, connect the reagent(s) delivery hose to the DPT rod header using an injection cap and ensure proper hose restraints are in place to prevent hose whip in the case of fitting or hose failure.
3. Follow the manufacturer’s instructions for proper mixing and dosing of the amendments.
4. Once the reagent(s) delivery hose has been securely attached to the DPT rod header, activate the injection pump and begin injecting the amendments. Use a pressure gauge to monitor the injection pressure. Injection volume(s) will be determined based on changes in tank volume. Due to the physical characteristics of the reagents that commonly plug flow meters, reagent flow cannot be monitored continuously.
5. Inject the planned volume of amendments, including PlumeStop®, S-MicroZVI, and BDI Plus®.
6. After injecting the planned volume of solution, isolate the DPT rod from the reagent delivery hose by shutting the appropriate isolation valve on the injection cap, depressurize the DPT rod at the injection cap, confirm the pressure has dissipated before removing the injection cap, remove the injection cap from the DPT rod, and then advance the DPT rod to the next injection interval, 2.5 feet below the previous completed injection interval. While depressurizing the DPT rod and proceeding to the next interval, backflow of reagents from the rod may occur and shall be contained. If the amount of reagents is significant, the volume will be recorded to correct the actual amount of reagent(s) injected into that interval.
7. Repeat the injection Steps 2 through 7 until the final injection interval has been completed for the injection point.
8. Upon completing reagent injection at each point, abandon each injection borehole by backfilling with a neat cement grout. The grout will be pumped through a tremie pipe from the bottom injection interval to within 6 inches of the ground surface.
9. Finish the borehole appropriately in accordance with the surrounding surface materials and survey nail set flush-to-grade marking the injection point location for final survey. The boreholes must be finished flush-to-grade.
10. Upon completion of the reagent injections, clean the injection equipment and injection rods by circulating hot water and detergent through the pump and delivery hose.
11. Repeat the previous steps at each injection point.

Excessive buildup of hydrostatic pressure will be avoided by monitoring the backpressure in each point and adjusting injection parameters such as injection pressure, flow rates, and sequencing of injection points to allow the aquifer time to equilibrate.

All equipment used during the installation will be decontaminated before moving to the next location by dry decontamination and steam cleaning (Field SOP 04).

18.6 SAMPLING

To collect groundwater and soil samples, field staff will follow the sampling route map shown in **Figure 18.1.**

18.6.1 SOIL SAMPLING

Soil samples will be collected from two borings, MW-67 and B-01 (**Figure 11.1**, **Table 18.1**) as described in Field SOP 05. Soil samples will be collected every two feet throughout the planned vertical treatment zone (15 to 24 feet bgs at B-01 and 3 to 26 feet bgs at MW-67). Soil samples from this water bearing zone will be qualitatively evaluated to determine the soil type.

One sample of the weathered bedrock will be collected from each new boring (MW-67 and B-01). These samples will be analyzed for VOCs to assess if the weathered bedrock will be an ongoing source of COPCs to groundwater. Soil samples collected from bedrock will be analyzed for the chemicals listed in **Table 15.8.**

Soil samples will not be collected from the unsaturated zone.

18.6.2 BASELINE GROUNDWATER SAMPLING

Prior to injecting amendments, baseline groundwater samples will be collected from EW-1, MW-19, MW-43, MW-50, and MW-67 (**Figure 11.1**, **Table 18.1**) using low-flow groundwater sampling methods**,** as described in Field SOP 02. Purge rates will be no more than 200 mL/minute and groundwater elevation during purging and sampling will be monitored to ensure drawdown is no more than 0.3 feet.

Field indicator parameters including temperature, pH, specific conductivity, dissolved oxygen, and oxidation-reduction potential will be measured during purging in accordance with Field SOP 02. Total dissolved solids will be estimated from electrical conductivity, which will be measured in the field. After parameter stabilization criteria have been met, groundwater samples will be collected in appropriate containers (**Worksheets #19 & 30**).

Groundwater samples will be analyzed for the chemicals listed in **Tables 15.1**, **15.3** through **15.7**, and the total and dissolved metals listed in **Table 15.2.**

Immediately following the baseline sampling, PFMs will be deployed in EW-1, MW-19, MW-43, and MW-50.

- PFMs consist of a nylon mesh tube filled with a sorbent that is preloaded with alcohol tracers. The PFMs are inserted into groundwater monitoring wells where they passively intercept groundwater flow. As groundwater flows through the PFM, the sorbent retains dissolved contaminants, and the tracers are leached from the sorbent. The concentrations of contaminants and tracers in the media provide a screening-level assessment of the vertical profile of contaminant flux and groundwater flow velocity in each well.
- Each PFM will be ten feet long to cover the entire screened interval of each well. The PFMs will be loaded with sorbent every 1.5 feet to evaluate the vertical profile of groundwater flow and contaminant mass flux. This will result in a six PFM sorbent samples per well. Each sample will be a composite of the sorbent within a given depth interval. Because the PFMs are deployed over a period of weeks, the results from the PFMs represent a time-averaged groundwater flow and contaminant flux.

- The PFM sorbent will be sampled for volatiles and for alcohol tracers to allow a screening level calculation of contaminant flux and groundwater flow velocities at discrete depth intervals throughout the plume.

Water levels will be measured in each well prior to installing the PFM. The PFMs will be deployed for 4-8 weeks. The PFMs will then be retrieved from the well and the sorbent will be removed and placed in sample jars for analysis. Water levels will be measured immediately upon removing the PFM and again once the samples from all four of the PFMs are collected. The PFM sorbent will be sampled and analyzed for the chemicals listed in **Tables 15.1** and **15.9**.

Project reporting limits and screening levels can be found in **Worksheet #15**.

18.6.3 PERFORMANCE MONITORING

At least one month after the injections are complete, performance monitoring will begin. Performance monitoring groundwater samples will be collected from EW-1, MW-43, and MW-67 (**Figure 11.1**, **Table 18.1**) using low-flow groundwater sampling methods, as described in Field SOP 02. Purge rates will be no more than 200 mL/minute and groundwater elevation during purging and sampling will be monitored to ensure drawdown is no more than 0.3 feet.

Field indicator parameters including temperature, pH, specific conductivity, dissolved oxygen, and oxidation-reduction potential will be measured during purging in accordance with Field SOP 02. Total dissolved solids will be estimated from electrical conductivity, which will be measured in the field. After parameter stabilization criteria have been met, groundwater samples will be collected in appropriate containers (**Worksheets #19 & 30**).

Groundwater samples will be analyzed for the following chemicals:

- 1,1-Dichloroethene
- cis-1,2-Dichloroethene
- trans-1,2-Dichloroethene
- 1,4-Dichlorobenzene
- Benzene
- Ethylbenzene
- Toluene
- Trichloroethene
- Vinyl chloride
- o- and m,p-Xylenes
- Nitrate
- Total organic carbon
- Total and dissolved metals (see **Table 15.2**)
- Methane, ethane, and ethene

Project reporting limits and screening levels can be found in **Worksheet #15**.

Table 18.1 – Proposed Sampling Locations and Methods

Sampling Location / Location ID 1	Matrix	Basis/Rationale	Sample Type	Depth	Analytical Groups	Estimated No. of Samples	Sampling SOP	Comments
EW-1, MW-19, MW-43, and MW-50	Water	Judgmental / Assess vertical flux and groundwater velocity in groundwater.	Passive Flux Meter	5-35 feet bgs	VOCs and Alcohol Tracers	24 samples: 6 samples per well, with 1 sampling event total	PFM SOP (**Appendix G**)	See **Sections 17.1** and **18.6.2**
EW-1, MW-19, MW-43, MW-50, and MW-67	Water	Judgmental / Assess geochemical conditions in groundwater that will impact treatment design (baseline sampling).	Discrete	5-35 feet bgs	Geochemical parameters, VOCs, nitrate, methane, ethane, ethene, and metals (see **Tables 15.1** – **15.7** for list)	5 samples: 1 sample per well, with 1 sampling event total	SOP 02 (**Appendix D**)	See **Sections 17.1** and **18.6.2**
EW-1, MW-43, and MW-67	Water	Judgmental / Post-treatment performance monitoring	Discrete	5-30 feet bgs	VOCs, nitrate, methane, ethane, ethene, total organic carbon, and metals	12 samples: 1 sample per well with 4 sampling events total	SOP 02 (**Appendix D**)	See **Sections 17.1** and **18.6.3**
MW-67 and B-01	Soil	Judgmental / Assess soil type in each treatment zone to optimize treatment design	Discrete	5-30 feet	Visual Soil Type Evaluation	17 samples, with 1 sampling event total	SOP 05 (**Appendix D**)	See **Sections 17.2** and **18.6.1**
MW-67 and B-01	Soil	Judgmental / Assess VOC concentrations in the weathered bedrock	Discrete	20-30 feet	VOCs	2 samples, with 1 sampling event total	SOP 05 (**Appendix D**)	See **Sections 17.2** and **18.6.1**

1- Sample numbering is described on **Worksheets #26 & 27.**

Table 18.1 – Proposed Sampling Locations and Methods

Sampling Location / Location ID [1]	Matrix	Basis/Rationale	Sample Type	Depth	Analytical Groups	Estimated No. of Samples	Sampling SOP	Comments

Definitions:
bgs – Below ground surface

VOCs - 1,1-dichloroethene, 1,4-dichlorobenzene, benzene, cis-1,2-dichloroethene, ethylbenzene,_m,p-xylenes, o-xylene, toluene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride

18.7 SURVEY REQUIREMENTS

The horizontal location of all newly installed monitoring wells will be surveyed by a licensed surveyor to <1-foot horizontal accuracy and elevations will be surveyed to 0.01-foot vertical accuracy. Horizontal control shall be referenced to the geographic coordinate system (GCS) World Geodetic System of 1984 (WGS84) latitude/longitude in decimal degrees. Vertical control shall be North American Vertical Datum of 1988 (NAVD88). Injection point locations will be measured with a handheld GPS device with a level of precision of ± 3 to 5 meters.

18.8 WASTE MANAGEMENT

Investigation derived solid and liquid wastes (IDW) will be disposed in accordance with the waste management plan (**Appendix B**).

18.9 BIOLOGICAL MITIGATIONS

USACE (2018) performed an aquatic resource delineation of the Titan 1-A FUDS project site. USACE found seasonal wetlands that are suitable habitat for vernal pool branchiopods, including the federally-endangered Conservancy fairy shrimp, vernal pool tadpole shrimp, and federally-threatened vernal pool fairy shrimp.

Avoidance and Minimization Measures

The following is a list of avoidance and minimization measures to be implemented during all fieldwork.

- All equipment and vehicles will be weed-free and cleaned of attached mud, dirt, and plant materials prior to arriving on-site.
- Erosion and sediment control measures will be implemented and maintained, as necessary.
- Speed limits will be enforced with a maximum speed limit of 15-mph.
- All trash will be enclosed in sealed containers and removed from the Site daily.
- Project activities near/in wetlands will be avoided to the greatest extent practicable.
- Intrusive activities will be scheduled for the dry season, to the extent practicable, to reduce impacts to aquatic resources.
- Driving in wetlands will be avoided to the greatest extent practicable. If streambeds or wetlands cannot be avoided, the use of high-density polyethylene mats is required for heavy equipment and vehicles, even if currently dry (see **Figure 18.1**). Approval must be sought from the USACE Biologist for any work of this kind.
- If intrusive activities are to be performed:
  - Nesting bird surveys will be performed within five days prior to intrusive work commencing by a qualified biologist. The biologist will survey the work area and all potential habitats within 500 feet of the work area, to identify any active nests which may be present. Weekly nesting bird surveys will be conducted to check for potential new nests if intrusive activities last longer than one week. If nesting birds are found during focused surveys, the USACE biologist will be immediately notified and will coordinate with other agencies as needed. The nest location(s) shall be identified on a map. If project activity is within 250 feet of identified nests for raptors and 100 feet for other non-listed birds, the biologist will determine whether project activities are disturbing the nesting birds. If the nesting birds are not being disturbed, project activity will continue. If the nesting birds are being disturbed, project activity will halt within 250 feet of identified nests for raptors and 100

feet for other non-listed birds until the young have fledged (as determined by the biologist) or until the project receives authorization from California Department of Fish and Wildlife (CDFW) and U.S. Fish and Wildlife Service (USFWS) to proceed. Nesting birds within these distances will continue to be monitored at least twice a week when acting normally to ensure their status does not change.

- On the first day of intrusive activities, field personnel shall attend an environmental awareness training. The awareness training shall be conducted by a USACE-approved biologist. A record shall be kept to document that all employees have received the training. New employees shall not begin work on the site without receiving the environmental awareness training. The training shall include the following:
    - Description and status of all listed species with the potential to occur at the site;
    - Description of suitable habitat and designated critical habitat, including any areas of these habitat occurrences at the site;
    - Avoidance and minimization measures to be implemented during activities with penalties for non-compliance;
    - Contact information for the Government biologist(s) and the biologists.
- During all intrusive activities at the Site, a USACE-approved biological monitor will be on-site. The biological monitor will have stop work authority, flag sensitive biological communities for avoidance, and check protected resources each day for indications of disturbance.

Best Management Practices (BMPs) shall be implemented to avoid and minimize effects to water resources during project activities. These BMPs shall include, but are not limited to:

- Parsons will implement and maintain erosion and sediment control measures as necessary and as directed by the Contracting Officer, such that water quality standards are not violated as a result of project activities (Clean Water Act 33 U.S. Code [USC] § 1251 et seq.).
- Equipment maintenance shall occur outside the project site to reduce the possibility of mechanical and chemical waste discharge from entering the water.
- Equipment shall be stored in areas outside the natural surface drainage patterns and away from areas where storm water could pool and percolate to groundwater. Place absorbent pads to catch all leaks from equipment parked overnight.
- Equipment refueling shall occur only in designated areas, with appropriate hazardous material containment measures in place.
- Equipment storage, cleaning, and fueling shall be maintained in a manner to prevent any contaminants from adversely affecting storm water runoff.
- Construction water shall not be allowed to run off the project site.

18.10 ARCHAEOLOGICAL REQUIREMENTS (INADVERTENT DISCOVERY CLAUSE)

18.10.1 PROCEDURES FOR DISCOVERY OF CULTURAL RESOURCES

If previously unidentified cultural resources are discovered during construction, all construction will immediately stop within 100 feet (30 meters) of the discovery and the location of the discovery will be flagged for avoidance. Parsons will notify USACE, and then USACE will notify the Native American Tribes with interest in the project area. USACE will determine whether the discovery is a potential National Register of Historic Places (NRHP)-eligible resource by evaluating the resource following the criteria in 36 Code of Federal Regulations (CFR) 60.4. If USACE, in consultation with the American Indian tribal governments, determines that the discovery is not an NRHP-eligible resource, the discovery will be documented, and construction may proceed at the direction of the USACE. If the resource is considered an NRHP-eligible resource, the location will be temporarily fenced for protection during construction.

18.10.2 PROCEDURES FOR DISCOVERY OF HUMAN REMAINS

If human remains are discovered during the execution of the project, USACE will follow the California Health and Safety Code Section 7050.5 and Public Resources Code (PRC) Section 5097.98. In addition, USACE will consider and implement, to the extent feasible, the principles adopted in the ACHP's (2023) recommendations. Relevant principles included in the policy statement include but are not limited to respectful treatment of human remains, disturbance of such remains only when necessary, and early consultation with affiliated tribes to manage such resources.

The specific requirements of the PRC and Health and Safety Code are as follows.

- The USACE will notify the Placer County Coroner; the Coroner will then determine if an investigation regarding the cause of death is required (such investigation would be necessary if the find is not archaeological, but modern, Cal. Health and Safety Code Section 7050.5). If the find is archaeological and no investigation is required, the find shall then be treated as an archaeological discovery.
- If the coroner determines that the remains are of Native American origin, the USACE will contact the Native American Heritage Commission (NAHC). The NAHC will designate a most likely descendant (MLD). The MLD will have the power to make recommendations for the reburial or alternate treatment of the remains with appropriate dignity.
- If the MLD and landowner cannot reach an agreement, or the MLD fails to make a recommendation, the landowner will reinter the remains at a location where further disturbance will be avoided and record the location through one of the methods specified in California PRC Section 5097.98.

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

This worksheet summarizes the laboratory information and analytical methods for each sampling matrix, including the required sample volume, containers, preservation, and holding time requirements. Laboratory certifications are presented in **Appendix F.** Contact information for the laboratory PMs are provided in **Worksheets #4, 7, & 8.** Details concerning sampling handling, sample shipment, and the laboratory sample receipt address, are included on **Worksheets #26 & 27.**

Table 19.1 – EMAX: Sample Containers, Preservation, and Hold Times: Groundwater and Soil Samples

Laboratory: EMAX

Matrix	Analytical Group and Method	Analytical Method/ SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Water	VOCs	Preparation Method/SOP: SW5030C / EMAX-5030 Analysis Method/SOP: SW8260C / EMAX-8260	3 x 40mL volatile organic analysis (VOA) vials with septa	40 mL	HCl to pH ≤2, Cool to ≤ 6 °C	14 days
Soil	VOCs	Preparation Method/SOP: SW5035A / EMAX-5035 Analysis Method/SOP: SW8260C / EMAX-8260	3 x pre-weighed VOA vials or 5g Encore tubes	5 g	Cool to ≤ 6 °C 2 x vials with 5mL deionized water and Sodium Bisulfate 1 x vial with 5mL MeOH	14 days or 48 hours (encores only)
Water	Total and Dissolved Metals	Preparation Method/SOP: SW3050B / EMAX-3050 Analysis Method/SOP: SW6010C / EMAX-6010	1 x 250 mL plastic	250 mL	HNO_3 to pH < 2	180 days

Table 19.1 – EMAX: Sample Containers, Preservation, and Hold Times: Groundwater and Soil Samples

Laboratory: EMAX

Matrix	Analytical Group and Method	Analytical Method/ SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Water	Dissolved Gases (Methane, Ethane, Ethene, Carbon Dioxide)	Analysis Method/SOP: RSK-175 / EMAX-RSK175	3 x 40 mL VOA vials with septa	40 mL	HCl to pH ≤2, Cool to ≤ 6°C	14 days
Water	Sulfate and Nitrate	Analysis Method/SOP: SW9056A / EMAX-9056	1 x 250 mL plastic	250 mL	Cool to ≤ 6°C	28 days- for Sulfate 48 hours for Nitrate
Water	Alkalinity	Analysis Method/SOP: SM2320B / EMAX-2320B	1 x 125 mL plastic	125 mL	Cool to ≤ 6°C	14 days
Water	Hardness	Analysis Method/SOP: SW2340C / EMAX-2340C	1 x 250 mL plastic	250 mL	HNO_3 to pH < 2	180 days
Water	Total Organic Carbon	Analysis Method/SOP: SW9060A/ EMAX-9060	1 x 125 mL plastic	125 mL	HCl or H_2SO_4 to pH≤2 Cool to ≤ 6°C	28 days

Table 19.2 – Regenesis: Sample Containers, Preservation, and Hold Times: Soil

Laboratory: Regenesis

Matrix	Analytical Group	Analytical Method/ SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Soil	Visual Soil Type Assessment	N/A	Polyethylene, Glass	8 Ounce	Cool to ≤ 6°C	None

Table 19.3 – EnviroFlux: Sample Containers, Preservation, and Hold Times: PFM Media

Laboratory: EnviroFlux

Matrix	Analytical Group	Analytical Method/ SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
PFM Media	VOCs/alcohol tracers	SW8260C and 8015C/ EnviroFlux PFM SOP	125 mL glass jar	125 mL	Cool to ≤ 4°C	1 month at 4°C

Worksheet #20: Field Quality Control

This worksheet summarizes the field QC samples to be collected and analyzed for the project. The table below shows the relationship between the number of field samples and associated QC samples for each combination of analyte/analytical group and matrix. Note that if additional samples are collected over the estimated number shown, additional QC samples will be collected at the rate shown below.

Table 20.1 – Field Quality Control Sampling per Sampling Event

Matrix	Analytical Group	Method	Estimated No. of Field Samples	Field Duplicates	MS/MSD [1]	Source Blanks	Equipment Blanks [2, 3]	Trip Blanks [4]	Total No. of Samples to Lab [5]
Water	Volatiles	SW8260C	3	1 FD per 10 field samples	1 MS/MSD pair per 20 field samples	1 per rinse water source	1 per no more than 5 consecutive days of sample collection when non-disposable sampling tools are used	1 per cooler	9
Sample Count			3	1	2	1	1	1	9
Soil	Volatiles	SW8260C	2	1 FD per 10 field samples	1 MS/MSD pair per 20 field samples	1 per rinse water source	1 per no more than 5 consecutive days of sample collection when non-disposable sampling tools are used	1 per cooler	8
Sample Count			2	1	2	1	1	1	8
Soil	Soil Type Evaluation	N/A	12	0	N/A	N/A	N/A	N/A	12
Sample Count			12	0	0	0	0	0	12

Table 20.1 – Field Quality Control Sampling per Sampling Event

Matrix	Analytical Group	Method	Estimated No. of Field Samples	Field Duplicates	MS/MSD [1]	Source Blanks	Equipment Blanks [2, 3]	Trip Blanks [4]	Total No. of Samples to Lab [5]
PFM Media	Volatiles and Alcohol Tracers	SW8260C SW8015C	24	1 FD per 10 field samples	1 MS/MSD pair per 20 field samples	1 per rinse water source	1 per no more than 5 consecutive days of sample collection when non-disposable sampling tools are used	1 per cooler	34
Sample Count			24	3	4	1	1	1	34

Notes:

1 – MS/MSD pairs are counted as two samples.

2 – Equipment blanks will only be collected if decontaminated equipment comes into contact with the sample matrix.

3 – Assumes both borings are completed and in one day, 3 groundwater samples can be collected in one day, and four PFMs can be retrieved and sampled in one day.

4 – Assumes 1 cooler per event for each type of sample

Definitions:

N/A – Not applicable

MS/MSD – Matrix spike/matrix spike duplicate

TBD – To be determined

Worksheet #21: Field Standard Operating Procedures

The applicable field SOPs to be used during the remedial investigation at the Former Titan 1-A Missile Facility are listed in the below table. Copies of these field SOPs are provided in **Appendix D.**

Table 21.1 – Field Standard Operating Procedures

Reference Number	Title, Revision Date, and/or Number	SOP Originating Organization	Related Equipment Types	Modified for Project? (Y/N)	Comments
SOP 01	Personal Protective Equipment	Parsons	see SOP (**Appendix D**)	Y	See **Appendix D**
SOP 02	Low Flow Groundwater Sampling	Parsons	see SOP (**Appendix D**)	Y	See **Appendix D**
SOP 03	Water Level Measurement	Parsons	See SOP (**Appendix D**)	Y	See **Appendix D**
SOP 04	Field Equipment Decontamination	Parsons	see SOP (**Appendix D**)	Y	See **Appendix D**
SOP 05	Direct Push Soil Sampling	Parsons	see SOP (**Appendix D**)	Y	See **Appendix D**
SOP 06	Organic Vapor Screening Using a Photoionization Detector / Flame Ionization Detector	Parsons	see SOP (**Appendix D**)	Y	See **Appendix D**
SOP 07	Standard Practice for Description and Identification of Soils (Visual-Manual Procedures), D2488-17	ASTM	See ASTM standard	N	See ASTM standard
SESDGUID-101	Design and Installation of Monitoring Wells, R2	USEPA	see SOP (**Appendix D**)	N	See **Appendix D**

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

Table 22.1 summarize the calibration, maintenance, testing, and inspection procedures for field equipment.

Table 22.1 – Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration, Verification, Testing, or Maintenance Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Photoionization Detector	Check calibration to 100 parts per million isobutylene	Once per day before first use	± 5% of standard value	Recalibrate	Operator	SOP 06
YSI (Yellow Springs Instruments; or equivalent) water quality meter with flow cell	Check calibration against two of the following three traceable standards with nominal pH of 4.0, 7.00 and 10.00	Once per day before first use	± 0.05 pH units	Recalibrate	Sampler	SOP 02
	Check calibration against specific conductance standard	Once per day before first use	± 5% of standard value	Recalibrate	Sampler	SOP 02
	Check calibration against dissolved oxygen (ambient air)	Once per day before first use	± 10% of 100% saturation	Recalibrate	Sampler	SOP 02
	Check calibration against oxygen reduction potential standards	Once per day before first use	± 10% standard value	Recalibrate	Sampler	SOP 02

Worksheet #23: Analytical Standard Operating Procedures

The applicable SOPs to be used for preparation and analysis of samples collected are listed in **Tables 23.1** and **23.2** below. The specific analytical method SOPs referenced are provided in **Appendix G**.

Table 23.1 – Analytical Standard Operating Procedures: VOCs (8260C)

Lab SOP Number	Title, Revision Date, and/or Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EMAX-5030	Purge and Trap; Revision 5, 07/19/2022	Definitive	Water: VOCs	None	EMAX	N
EMAX-5035	Closed System Purge and Trap, Revision 5, 07/19/22	Definitive	Soil: VOCs	None	EMAX	N
EMAX-8260	Volatile Organic Compounds by Gas Chromatography (GC) / Mass Spectrometry (MS); Revision 1, 10/23/15	Definitive	Soil/Water: VOCs	GC-MS	EMAX	N

Notes:

1 - Revision numbers and dates are subject to change over the life of the project.

Table 23.2 – Analytical Standard Operating Procedures: Geochemical Parameters

Lab SOP Number	Title, Revision Date, and/or Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EMAX-3050	Acid Digestion, Total Metals for Solids	Definitive	Water: Metals	None	EMAX	N
EMAX-6010	Inductive Coupled Plasma Emissions Spectrometric Method for Trace Metal Analyses, Revision 9, 08/24/22	Definitive	Water: Metals	Inductive Coupled Plasma Emissions Spectrometer (ICP-ES)	EMAX	N
EMAX-9056	Ion Chromatography Analysis, Revision 10, 08/31/22	Definitive	Water: Sulfate and Nitrate	Ion Chromatography (IC)	EMAX	N
EMAX-2320B	Alkalinity, Revision 8, 12/06/22	Definitive	Water: Alkalinity	Titrimetric	EMAX	N
EMAX-2340C	Total Hardness, Revision 6, 09/12/22	Definitive	Water: Hardness	None	EMAX	N
EMAX-5310B	Total Organic Carbon, Revision 4, 10/11/17	Definitive	Water: Total Organic Carbon	Total Organic Carbon Analyzer	EMAX	N
EMAX-RSK175	Dissolved Gases, Revision 5, 09/28/22	Definitive	Water : Dissolved Gases (Methane, Ethane, Ethene, Carbon Dioxide)	Gas Chromatography (GC)	EMAX	N

Notes:

1 - Revision numbers and dates are subject to change over the life of the project.

Table 23.3 – Analytical Standard Operating Procedures: VOCs and Alcohol Tracers in PFM Solid Samples

Lab SOP Number	Title, Revision Date, and/or Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EnviroFlux PFM SOP	EnviroFlux PFM SOP	Screening	Solid: VOC and alcohols	GC/MS and GC	EnviroFlux	Y

Notes:

1 - Revision numbers and dates are subject to change over the life of the project.

Table 23.4 – Analytical Standard Operating Procedures (Miscellaneous)

Lab SOP Number	Title, Revision Date, and/or Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
EMAX-SM02	Sample Receiving; Revision 12, 04/08/2022	NA	All	NA	EMAX	N
EMAX-SM03	Waste Disposal; Revision 7, 07/19/2022	NA	All	NA	EMAX	N

Notes:

1 - Revision numbers and dates are subject to change over the life of the project.

Worksheet #24: Analytical Instrument Calibration

Table 24.1 – Analytical Instrument Calibration: VOCs (8260C)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
GC-MS (Method 8260)	Tune Check	Prior to ICAL and prior to each 12-hour period of sample analysis.	Specific ion abundance criteria of 4-Bromofluorobenzene (BFB) or Decafluorotriphenylphosphine (DFTPP) from method.	Retune instrument and verify.	Analyst	EMAX-8260 EnviroFlux PFM SOP
GC-MS (Method 8260)	Initial Calibration (ICAL) for all analytes (including surrogates)	At instrument set-up, prior to sample analysis	Each analyte must meet one of the three options below: Option 1: Relative standard deviation (RSD) for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$; Option 3: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Locate the source of the problem. If expected response factors (RFs) are not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem then repeat initial calibration If SPCC is non-compliant, it could be a result of standard degradation or active presence to active sites in the system. Correct the problem and repeat calibration. If CCC is non-compliant, it could be a result of system leaks, or reactive column sites or standard degradation. Correct the problem and recalibrate. If RSD is non-compliant, check for outlier and repeat that ICAL point;	Analyst	EMAX-8260 EnviroFlux PFM SOP

Table 24.1 – Analytical Instrument Calibration: VOCs (8260C)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
				otherwise perform instrument troubleshooting and repeat calibration.		
GC-MS (Method 8260)	Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial continuing calibration verification (CCV) is used.	N/A	Analyst	EMAX-8260 EnviroFlux PFM SOP
GC-MS (Method 8260)	Evaluation of relative retention times (RRT)	With each sample.	RRT of each reported analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst	EMAX-8260 EnviroFlux PFM SOP
GC-MS (Method 8260)	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 20% of true value.	Prepare fresh standard and reanalyze second source to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance, and rerun initial calibration and second source verification standard. If problem continues, new standards may need to be purchased, prepared, and analyzed.	Analyst	EMAX-8260 EnviroFlux PFM SOP

Table 24.1 – Analytical Instrument Calibration: VOCs (8260C)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
GC-MS (Method 8260)	CCV	Daily before sample analysis; after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ± 20% of true value. All reported analytes and surrogates within ± 50% for end of analytical batch CCV.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; *or* Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst	EMAX-8260 EnviroFlux PFM SOP

Table 24.2 – Analytical Instrument Calibration: Geochemical Parameters

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
GC (RSK-175)	5 point ICAL for all target analytes	At instrument set up, after ICV or CCV failure, prior to sample analysis	≤ 20% RSD or r2 >/= 0.99 for target analytes	Correct the problem then repeat ICAL	Analyst	EMAX-RSK 175
GC (RSK-175)	ICV	Once after each ICAL, and prior to sample analysis.	All reported analytes within ± 25% of true value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-RSK 175
GC (RSK-175)	CCV	Before sample analysis, after every 10 field samples and at the end of the analytical sequence	All reported analytes within ± 15% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst	EMAX-RSK175
GC (RSK-175)	Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not	NA	Analyst	EMAX-RSK175

Table 24.2 – Analytical Instrument Calibration: Geochemical Parameters

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
			performed, the initial CCV is used.			
GC (RSK-175)	Retention Time (RT) window width	At method set-up and after major maintenance (e.g. column change).	RT width is ± 3 times standard deviation for each analyte RT from the 72-hour study or 0.03 minutes, whichever is greater.	NA	Analyst	EMAX-RSK175
ICP (6010C)	ICAL	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r2 ≥ 0.99.	Locate the source of the problem. Check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem and then repeat initial calibration	Analyst	EMAX-6010
ICP (6010C)	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Diagnose the problem. Prepare fresh standard and re-analyze to rule out standard degradation or inaccurate injection. If problem persists perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-6010
ICP (6010C)	CCV	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If	Analyst	EMAX-6010

Table 24.2 – Analytical Instrument Calibration: Geochemical Parameters

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
				both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.		
ICP (6010C)	Low Level Calibration Check Standard (low Level CCV)	Daily.	All reported analytes within ± 20% of true value.	Diagnose the problem. Prepare fresh standard and re-analyze to rule out standard degradation or inaccurate injection. If problem persists perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-6010
ICP (6010C)	Initial and Continuing Calibration Blank (ICB/CCB)	Immediately after the ICV and immediately after every CCV.	The absolute values of all analytes must be < ½ LOQ or < 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL. All samples following the last acceptable Calibration Blank must be reanalyzed. CCBs may not be reanalyzed without reanalysis of the associated samples and CCV(s).	Analyst	EMAX-6010
ICP (6010C)	Interference Check Solutions (ICS) (also called Spectral	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non- spiked project analytes < 1/2 LOQ	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.	Analyst	EMAX-6010

Table 24.2 – Analytical Instrument Calibration: Geochemical Parameters

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
	Interference Checks)		(unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.			
IC (9056A)	ICAL	ICAL prior to sample analysis.	r2 ≥ 0.99.	Locate the source of the problem. If expected RSD is not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem then repeat initial Calibration.	Analyst	EMAX-9056
IC (9056A)	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within established RT windows. All reported analytes within ± 10% of true value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-9056
IC (9056A)	CCV	Before sample analysis; after every 10 field samples; and at the end of the analysis sequence.	All reported analytes within established retention time windows. All reported analytes within ± 10% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If	Analyst	EMAX-9056

Table 24.2 – Analytical Instrument Calibration: Geochemical Parameters

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
				either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.		
TOC Analyzer (TOC)	ICAL	Daily before sample analysis	Correlation coefficient (r) ≥ 0.995	Correct problem and re-calibrate prior to sample analysis.	Analyst	EMAX-9060
TOC Analyzer (TOC)	ICV	Once after each ICAL.	% recovery within ± 10% of true value.	Reanalyze ICV to rule out bad injection and/or standard degradation. Otherwise, repeat ICAL	Analyst	EMAX-9060
TOC Analyzer (TOC)	CCV	Every 15 samples and at the end of analysis sequence.	% recovery within ± 10% of true value.	Reanalyze CCV to rule out bad injection and/or standard degradation. Otherwise repeat calibration.	Analyst	EMAX-9060
Auto-Titrator (Alkalinity)	ICAL	Daily before sample analysis	±0.05 pH units	Correct problem and re-calibrate prior to sample analysis.	Analyst	EMAX-2320B

Table 24.3 – Analytical Instrument Calibration: Alcohol Tracers

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Personnel Responsible for Corrective Action	SOP Reference
GC (PFM-Alcohol Tracers)	ICAL	At instrument set-up, prior to sample analysis.	≤ 20% RSD or $r^2 \geq 0.990$ for target analytes	Correct problem and recalibrate prior to sample analysis.	Analyst	EnviroFlux PFM SOP
GC (PFM-Alcohol Tracers)	ICV	Once after each ICAL, and prior to sample analysis.	70-130% for all target analytes. Analytes exceeding and associated data will be flagged and narrated.	Correct problem, rerun check. If problem persists, repeat ICAL.	Analyst	EnviroFlux PFM SOP
GC (PFM-Alcohol Tracers)	CCV	Before sample analysis, after every 10 field samples and at the end of the analytical sequence.	70-130% for all target analytes. Analytes exceeding and associated data will be flagged and narrated.	Correct problem, rerun check. If problem persists, repeat ICAL.	Analyst	EnviroFlux PFM SOP
GC (PFM-Alcohol Tracers)	Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA	Analyst	EnviroFlux PFM SOP
GC (PFM-Alcohol Tracers)	Retention Time (RT) window width	At method set-up and after major maintenance (e.g. column change).	RT width is ± 3 times standard deviation for each analyte RT from the 72-hour study or 0.03 minutes, whichever is greater.	NA	Analyst	EnviroFlux PFM SOP

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

Tables 25.1 and **25.2** provides information on analytical instruments and equipment, maintenance, testing, and inspection. To ensure that the analytical instruments and equipment are available and in working order when needed, all laboratory analytical equipment will undergo maintenance and testing procedure in accordance with the laboratory SOPs (provided in **Appendix G**).

Table 25.1 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: VOCs

Analytical Method: 8260C

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	Parameter Set-up	Physical Check	Examples: Check that the autosampler is functioning as expected. Check that temperature program is set at the most recently determined optimum condition.	Initially; prior to each use	Autosampler must move to the expected position when activated. Refer to instrument optimize temperature program setup.	Reset to SOP set-up, if parameter checks reveal deviations. Notate all adjustments in Daily Maintenance Log. Examples: Reset autosampler, if problem persist perform autosampler troubleshooting prior to instrument use. Reset to optimized temperature setup.	Analyst	EMAX-8260

Table 25.1 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: VOCs

Analytical Method: 8260C

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC-MS	Replace hydrocarbon traps and oxygen traps on helium and hydrogen gas lines; Replace chemical traps; Replacing converter tube in gas purifier system	Check oxygen/ moisture indicator (OM-1) tube for a color change	Check GC system for high detector noise and reduced detector response.	As needed	N/A	N/A	Analyst or certified instrument technician	EMAX-8260
GC/MS	Traps	Instrument performance – failing CCV	Change trap	When responses start to drop; failing CCV	Lack of moisture; CCV pass	Replace and rebake traps; reanalyze CCV or recalibrate instrument	Analyst	EMAX-8260

Table 25.1 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: VOCs

Analytical Method: 8260C

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	Detector maintenance	Column change, failing tune	Change detector and/or pump oil	Oil level/ quality visually examined monthly; oil physically changed every 6 months	Tune passes; scan does not indicate presence of air/water	Refill or exchange the oil; clean parts; reanalyze tune	Analyst	EMAX-8260

Table 25.2 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: Geochemical Parameters

Analytical Methods: 6010C, RSK-175, 9056A, 9060A, and 2320B

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC ICP IC	Parameter Set-up	Physical Check	Various - Check Autosampler, settings, temperature programs, etc.	Initially, prior to each use.	Set-up in accordance to SOP guides.	Reset to SOP requirements. Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-RSK175 EMAX-6010 EMAX-9056
GC	Preventative maintenance	Physical check	Inspect and clean syringe. Check instrument parameters to ensure normal operating conditions. Change liner as necessary. Clean injection port as necessary. Check instrument performance (e.g., Daily calibration check, instrument blank	Daily, prior to analysis	No defects	Clean/ replace as needed. Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-RSK175

Table 25.2 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: Geochemical Parameters

Analytical Methods: 6010C, RSK-175, 9056A, 9060A, and 2320B

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	Preventative maintenance	Autosampler	Inspect and clean injection line. Check autosampler response.	Daily, prior to analysis.	No defects	Clean/ replace as needed. Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-6010
ICP	Preventative maintenance	System Cleaning	Remove dust from fan and vent	Every 6 months or as needed	No defects	Clean as needed Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-6010
IC	Parameter Set-up and daily check	Physical Check	Check pressure, effluent detector, flowrate are at proper settings. Check pump for leaks and spills. Check air lines for crimping and discoloration. Empty waste container if needed.	Daily, prior to each use.	Set-up in accordance to SOP guides. Performance checks within limits.	Reset to SOP requirements. Repair leaks as necessary. Relocate pinched lines and/or replace damaged lines. Document all adjustments in Daily	Analyst	EMAX-9056

Table 25.2 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: Geochemical Parameters

Analytical Methods: 6010C, RSK-175, 9056A, 9060A, and 2320B

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
			Detector maintenance-inspect flow cell for leaks.			Maintenance Log.		
TOC Analyzer	Daily Check	Physical check	Examples: Check Lamp stability, Photometric noise, ensure sufficient instrument warm-up (min 15 minutes), verify proper wavelength.	Daily, prior to each use	No physical defects and performance checks within limits.	Reset to SOP set-up, if parameter checks reveal deviations. Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-9060
Auto-titrator	Daily Check	Physical Check	Various - Check Autosampler, settings, programs, etc.	Daily, prior to each use.	Set-up in accordance to SOP guides.	Reset to SOP requirements. Document all adjustments in Daily Maintenance Log.	Analyst	EMAX-2320B

Table 25.3 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection: PFM- Volatiles and Alcohol Tracers

Analytical Method: 8260C and 8015C

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS (8260C)	Clean sources, maintain vacuum pumps	Tunning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Analyst	PFM SOP
GC/MS (8260C)	Mass selective detector ion source cleaning	ICAL and CCV	Instrument performance and sensitivity	When tune difficulties or fluctuating internal standard areas are encountered	System performance passes	Re-clean or replace source parts	Analyst	PFM SOP
GC (8015C))	Replace GC injector septa and glass insert	NA	Instrument performance and sensitivity	Maximum of 150 injections	System performance passes	Replace GC injector septa and glass insert	Analyst	PFM SOP

Worksheets #26 & 27: Sample Handling, Custody, and Disposal

26.1 SAMPLE NUMBERING

A sample numbering system will be implemented to identify each sample collected during the investigation. This numbering system will ensure that each sample is uniquely labeled and will provide a tracking procedure to allow retrieval of information about each sample collected. QC samples will be numbered using the same sequential system and notes will be made in the field notebook to record which samples are QC samples.

Groundwater and soil samples will be numbered using the following format:

Property-[location type][location number]_[upper depth]-[lower depth]_[time frame]_[QC]

where:

- Property = up to five character site name from which the sample was collected; "T1AMF" = Former Titan 1-A Missile Facility.
- Location type = "MW" for monitoring well groundwater, "PFM" for passive flux meter media, and "B" for boring.
- Location number = two-digit sequential sample number (including leading zeroes, as necessary) that identifies the monitoring well or soil boring location number.
- Upper Depth = two- or three-digit number that signifies the top of the depth interval the sample was collected from, if applicable.
- Lower Depth = two- or three-digit number that signifies the bottom of the depth bgs interval the sample was collected from, if applicable.
- Time Frame = month and year sampling occurred using a three-letter abbreviation for month, and two-digit year; e.g., MAR22.
- QC = Quality Control (QC) indicator can be used to indicate field duplicates ("_FD"), matrix spikes ("_MS"), matrix spike duplicate ("_MSD").
- If a sample is recollected, "_R" will be added to the end of the sample ID.

Using this system, the sample number "T1AMF-MW019_MAR23" would indicate a sample collected from monitoring well MW19 in March 2023, while the sample number "T1AMF-B01_01-02_MAR23" would indicate a soil sample collected from boring B-01 from a depth of 1 to 2 feet bgs in March 2023.

Trip blanks, equipment blanks, and other blanks not tied to specific locations, will be given unique names every event (e.g., TripBlank1 cannot be used more than once in a particular project). Blank samples will be numbered using the following format:

Sample type-[number]_[time frame]

- Sample type = "TB" for trip blank, "EB" = equipment blank, and "AB" for ambient blank.
- Sample number = sequential sample number unique to that day which identifies that specific sample, so the third TB collected would be listed as sample "003."

- Time Frame = month and year sampling occurred using a three-letter abbreviation for month, and two-digit year; e.g., MAR23.

26.2 SAMPLE HANDLING

To ensure sample authenticity and data defensibility, proper sample handing procedures will be followed from the time of sample collection to final sample disposal. Sample handling procedures are described in **Section 26.4**.

The Parsons field team will be responsible for completing the sample bottle label and Chain of Custody (CoC) forms, sample collection, on-site sample control, sample packing, and coordination of sample shipment with the laboratory. Samples will be sent to the appropriate laboratory via FedEx overnight.

The laboratory sample receipt staff and/or custodian will acknowledge the sample receipt upon arrival. The laboratory technicians will inspect the samples upon receipt and note any issues or discrepancies. All issues, discrepancies, or problems with the samples will be communicated to the Project Chemist within 24 hours of sample receipt. The laboratory staff will prepare and analyze the field samples in accordance with this UFP-QAPP and the applicable laboratory SOPs. The field samples and all extracts/digestates will be stored at the laboratory for 30 days after the final report has been submitted to Parsons Team. The laboratory hazardous waste manager will be responsible for the final sample disposal upon notice from the Parsons Team, Parsons' Project Chemist or designee. Sample disposal will be performed in accordance with all local, state, and federal laws and regulations.

Table 26.1 – Responsibilities for Sample Handling, Custody, and Disposal

Sample Collection, Packaging, and Shipment
Sample Collection (Personnel/Organization): Field Sampler/Parsons
Sample Packaging (Personnel/Organization): Field Sampler/Parsons
Coordination of Shipment (Personnel/Organization): Project Chemist/Parsons
Type of Shipment/Carrier: Overnight/FedEx[1]
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): Sample Receipt Staff/EMAX, Regenesis, and EnviroFlux
Sample Custody and Storage (Personnel/Organization): Laboratory Staff/EMAX, Regenesis, and EnviroFlux
Sample Preparation (Personnel/Organization): Laboratory Technician/EMAX, Regenesis, and EnviroFlux
Sample Determinative Analysis (Personnel/Organization): Laboratory Technician/EMAX, Regenesis, and EnviroFlux
Sample Archiving
Field Sample Storage (No. of days from sample collection): 60 days
Sample Extract / Digestate Storage (No. of days from extraction/digestion): 30 days

Table 26.1 – Responsibilities for Sample Handling, Custody, and Disposal

Sample Disposal
Personnel/Organization: Laboratory Hazardous Waste Manager/EMAX, Regenesis, and EnviroFlux
Number of Days from Analysis: 60 days

Notes:
1 FedEx will primarily be used to ship samples. However, other overnight carriers may also be used during the course of this project.

26.3 SAMPLE LABELING

Sample labels will include, at a minimum, project name, project number, sample identification, date/time collected, analysis group or method, preservative, and sampler's name. Labels will be taped to the sample container prior to sample collection, unless pre-tared, to ensure that they do not separate. For pre-tared containers the labels on the container will be completed but not taped and the containers will be placed inside sealable plastic bags. An additional sample label will be affixed to the plastic bag.

26.4 FIELD SAMPLE CUSTODY PROCEDURES (SAMPLE COLLECTION, PACKAGING, SHIPMENT, AND DELIVERY TO LABORATORY)

Upon collection, all samples will be placed on ice or refrigerated and will be kept cool (≤6 ° Celsius) until the sample has been packaged to ship to a laboratory facility. Once the samples have been collected, the following guidelines will be used to prepare the sample containers for shipment to the laboratory:

- When the sampling team returns from sample collection with completed samples stored on ice, the sample cooler will be submitted to the on-site sample coordinator for processing.
- The sample coordinator will verify that all sample documentation is correct. Each sample will be placed into a clean zip-top bag. Each sample bag will be individually labeled with the unique sample ID using a permanent marker and then placed in the cooler.
- Wet ice will be used to maintain sample temperature during shipping. All ice used should be double bagged in well-sealed zip-top bags. A temperature blank will be included in each cooler. Samples will be carefully packed to minimize breakage and leakage.
- Trip blanks (one set) should be included in each cooler that contains samples for volatile analysis.
- The sample coordinator will maintain custody of the samples until they are shipped to the commercial laboratory facility for analysis. Upon delivery, the laboratory will sign for receipt of the samples on the CoC, inspect each cooler and sample, and record the status of the samples, including any noncompliance issues or discrepancies.
- A custody seal or locks will be used on the sample coolers in order to control access and reduce the chances of sample tampering.
- Shipping labels will be strongly adhered to the sample cooler. The project coordinator will email the Project Chemist with the applicable CoCs and tracking number information each day samples are shipped.

The following addresses will be used for sample shipment:

- EMAX: EMAX Laboratories, 3051 Fujita St., Torrance, California 90505; telephone # 310-618-8889
- Regenesis: Regenesis, Chris Lee, 1011 Calle Sombra, San Clemente, CA 92673; telephone # 262-455-0928
- EnviroFlux: Jay Cho, 1140 NW. 8th Ave Suite 20, Gainesville, Florida 32601; telephone # 352-328-8759

26.5 LABORATORY SAMPLE CUSTODY PROCEDURES (RECEIPT OF SAMPLES, ARCHIVING, DISPOSAL)

All laboratory sample receipt, internal custody, sample archiving, and disposal procedures shall be completed in accordance with the laboratory specific SOPs. All documentation shall be available upon request or during a review of the laboratory for inspection.

Upon opening a cooler containing soil or groundwater samples at the analytical laboratory, the receiving clerk shall sign the CoC and take the temperature using the temperature blank (if absent, a representative sample container shall be used). The sample containers in the cooler shall be unpacked and checked against the client’s CoC. Any discrepancies between the samples received, sample labels, and/or CoC shall be noted on a sample receipt form. All cooler temperatures and the status of any broken or damaged sample containers shall be noted on the sample receipt form. The laboratory shall contact the Parsons’ Project Chemist or designee immediately upon discovery of non-compliant temperatures, broken or damaged sample containers, or any other issues that may possibly impact sample analysis and/or data quality.

Upon opening a package containing samples at the analytical laboratory, the receiving clerk shall sign the CoC. The sample containers shall be unpacked and checked against the client’s CoC. Any discrepancies between the samples received, sample labels, and/or CoC shall be noted on a sample receipt form. The status of any broken or damaged sample containers shall be noted on the sample receipt form. The laboratory shall contact the Parsons’ Project Chemist or designee immediately upon discovery of broken or damaged sample containers, or any other issues that may possibly impact sample analysis and/or data quality.

26.6 SAMPLE IDENTIFICATION PROCEDURES

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. This information will be communicated to the laboratory via the CoC.

The laboratory will assign each sample shipment to a unique sample delivery group (SDG) number. The laboratory shall log in the samples received and assign each field sample a laboratory sample identification based on the designated SDG and the information on the CoC. The laboratory shall send (via email) the sample login forms generated by the Laboratory Information Management System (LIMS) along with the signed CoCs and sample receipt checklist to the Parsons’ Project Chemist or designee as soon as possible after sample receipt.

The sample ID, collection date and time, SDG number, and laboratory receipt date will be uploaded to the FUDSChem database in accordance with the Sample Event Management section of the FUDSChem User Manual (Environmental Synectics 2023). Field data collected will be uploaded to FUDSChem in accordance with Section 6 of the FUDSChem User Manual.

26.7 CHAIN-OF-CUSTODY PROCEDURES

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

26.8 NON-CONFORMANCE

The laboratory PM or designee will contact the Project Chemist to resolve any issues encountered during sample receipt and login.

26.9 LABORATORY SAMPLE HANDLING PROCEDURES

All laboratories will obtain representative subsamples for soil samples using the California ELAP-approved techniques detailed in the associated laboratory SOPs. All laboratory SOPs are listed in **Worksheet #23** and included in **Appendix G** of this document.

Worksheet #28: Analytical Quality Control and Corrective Action

Tables 28.1 and **28.2** provide information on the QC samples, frequency, method or SOP QC acceptance limits, Corrective Actions, person responsible for the Corrective Actions, and measurement performance criteria.

Table 28.1 – Analytical Quality Control and Corrective Action: Soil and Water, Volatile Organic Compounds

Laboratory: EMAX
Matrix: Soil and Water
Analytical Group: Volatile Organic Compounds
Analytical Method/ SOP Reference: SW8260C / EMAX-8260

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Internal Standard	Every field sample, standard and QC sample.	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL;	Inspect mass spectrometer and GC for malfunctions and correct problem.	Analyst	Accuracy/ Sensitivity	DoD (2021) QSM V5.4 criteria
		EICP area within - 50% to +100% of ICAL midpoint standard. On days when ICAL is not performed, the daily initial CCV can be used.	Reanalysis of samples analyzed while system was malfunctioning is mandatory.			
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit,	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/ Sensitivity	DoD (2021) QSM V5.4 criteria

Table 28.1 – Analytical Quality Control and Corrective Action: Soil and Water, Volatile Organic Compounds

Laboratory: EMAX
Matrix: Soil and Water
Analytical Group: Volatile Organic Compounds
Analytical Method/ SOP Reference: SW8260C / EMAX-8260

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
		whichever is greater. Common contaminants must not be detected > LOQ.				
LCS	One per preparatory batch.	Criteria listed in **Table 28.1.1**	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/ Precision - Analytical	DoD (2021) QSM V5.4 criteria
MS/MSD	One per preparatory batch.	Criteria listed in **Table 28.1.1**	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Accuracy/ Precision - Analytical	DoD (2021) QSM V5.4 criteria
Surrogate Spike	All field and QC samples.	Criteria listed in **Table 28.1.1**	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory	Analyst	Accuracy	DoD (2021) QSM V5.4 criteria

Table 28.1 – Analytical Quality Control and Corrective Action: Soil and Water, Volatile Organic Compounds

Laboratory: EMAX
Matrix: Soil and Water
Analytical Group: Volatile Organic Compounds
Analytical Method/ SOP Reference: SW8260C / EMAX-8260

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.			

Table 28.1.1 – Analytical Quality Control and Corrective Action: Water, Volatile Organic Compounds (SW8260C)

Laboratory: EMAX

Matrix: Water

Analytical Group: Volatile Organic Compounds (SW8260C)

Analyte	CAS No.	MS/MSD and LCS/LCSD	
		%R	RPD
1,1-Dichloroethene	75-35-4	71-131	20
1,4-Dichlorobenzene	106-46-7	79-118	20
Benzene	71-43-2	79-120	20
cis-1,2-Dichloroethene	156-59-2	78-123	20
Ethylbenzene	100-41-4	79-121	20
m,p-Xylene	179601-23-1	80-121	20
o-Xylene	95-47-6	78-122	20
Toluene	108-88-3	80-121	20
trans-1,2-Dichloroethene	156-60-5	75-124	20
Trichloroethene	79-01-6	79-123	20
Vinyl chloride	75-01-4	58-137	20
1,2-Dichloroethane-d4 (S)	17060-07-0	81-118	N/A
4-Bromofluorobenzene (S)	460-00-4	85-114	N/A
Dibromofluoromethane (S)	1868-53-7	80-119	N/A
Toluene-d8 (S)	2037-26-5	89-112	N/A

Definitions:

(S) indicates a surrogate compound. RPD is not applicable for surrogate compounds.

Table 28.1.2 – Analytical Quality Control and Corrective Action: Soil, Volatile Organic Compounds (SW8260C)

Laboratory: EMAX

Matrix: Soil

Analytical Group: Volatile Organic Compounds (SW8260C)

Analyte	CAS No.	MS/MSD and LCS/LCSD	
		%R	RPD
1,1-Dichloroethene	75-35-4	70-131	20
1,4-Dichlorobenzene	106-46-7	75-120	20
Benzene	71-43-2	77-121	20
cis-1,2-Dichloroethene	156-59-2	77-123	20
Ethylbenzene	100-41-4	76-122	20
m,p-Xylene	179601-23-1	77-124	20
o-Xylene	95-47-6	77-123	20
Toluene	108-88-3	77-121	20
trans-1,2-Dichloroethene	156-60-5	74-125	20
Trichloroethene	79-01-6	77-123	20
Vinyl chloride	75-01-4	56-135	20
1,2-Dichloroethane-d4 (S)	17060-07-0	71-136	N/A
4-Bromofluorobenzene (S)	460-00-4	79-119	N/A
Dibromofluoromethane (S)	1868-53-7	78-119	N/A
Toluene-d8 (S)	2037-26-5	85-116	N/A

Definitions:

(S) indicates a surrogate compound. RPD is not applicable for surrogate compounds.

Table 28.2 – Analytical Quality Control and Corrective Action: Water, Dissolved Gases

Laboratory: EMAX
Matrix: Water
Analytical Group: Dissolved Gases
Analytical Method/SOP Reference: RSK-175 / EMAX-RSK175

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/ Bias - Contamination	DoD (2021) QSM V5.4 criteria
Laboratory Control Sample (LCS)	One per preparatory batch.	Criteria listed in **Table 28.2.1**	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/ Bias	DoD (2021) QSM V5.4 criteria
MS/MSD or MD	Project designated sample matrix QC.	Criteria listed in **Table 28.2.1**	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Interferences - Accuracy/ Bias - Precision	DoD (2021) QSM V5.4 criteria

Table 28.2.1 – Analytical Quality Control and Corrective Action: Water, Dissolved Gases

Laboratory: EMAX

Matrix: Water

Analytical Group: RSK-175

Analyte	CAS No.	LCS/LCSD MS/MSD	
		%R	RPD
Ethane	74-80-0	74-131	30
Ethene	74-85-1	72-133	30
Methane	74-82-8	73-125	30
Carbon Dioxide	124-38-9	80-122	30

Table 28.3 – Analytical Quality Control and Corrective Action: Water, Metals

Laboratory: EMAX
Matrix: Water
Analytical Group: Metals
Analytical Method/SOP Reference: SW6010C / EMAX-6010

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/Bias - Contamination	DoD (2021) QSM V5.4 criteria
Laboratory Control Sample (LCS)	One per preparatory batch.	Criteria listed in **Table 28.3.1**	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/Bias	DoD (2021) QSM V5.4 criteria
MS/MSD or MD	Project designated sample matrix QC.	Criteria listed in **Table 28.3.1**	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and	Analyst	Interferences - Accuracy/Bias - Precision	DoD (2021) QSM V5.4 criteria

Table 28.3 – Analytical Quality Control and Corrective Action: Water, Metals

Laboratory: EMAX
Matrix: Water
Analytical Group: Metals
Analytical Method/SOP Reference: SW6010C / EMAX-6010

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			extract / reanalyze the sample.			
Dilution Test	One per preparatory batch if MS or MSD fails (using the same sample as used for the MS/MSD if possible).	Five-fold dilution must agree within ± 10% of the original measurement. *Only applicable for samples with concentrations > 50 x LOQ (prior to dilution). Use along with MS/MSD and PDS data to confirm matrix effects*	Discuss in the case narrative	Analyst	Accuracy /Bias	DoD (2021) QSM V5.4 criteria
Post Digestion Spike (PDS)	One per preparatory batch if MS or MSD fails (using the same sample as used for the MS/MSD if possible).	Recovery within 80-120% *Criteria applies for samples with concentrations <50 X LOQ prior to dilution*	Discuss in the case narrative	Analyst	Interferences-Accuracy/Bias Precision	DoD (2021) QSM V5.4 criteria

Table 28.3.1 – Analytical Quality Control and Corrective Action: Water, Metals

Laboratory: EMAX

Matrix: Water

Analytical Group: Metals

Analyte	CAS No.	LCS/LCSD MS/MSD	
		%R	RPD
Aluminum	7429-90-5	86-115	20
Calcium	7440-70-2	87-113	20
Iron	7439-89-6	87-115	20
Magnesium	7439-95-4	85-113	20
Manganese	7439-96-5	90-114	20

Table 28.4 – Analytical Quality Control and Corrective Action: Water, Anions

Laboratory: EMAX
Matrix: Water
Analytical Group: Anions (Sulfate and Nitrate)
Analytical Method/SOP Reference: SW9056A / EMAX-9056

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/ Bias – Contamination	DoD (2021) QSM V5.4 criteria
Laboratory Control Sample (LCS)	One per preparatory batch.	% Recovery: Sulfate = 87-112% Nitrate = 88-111%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/ Bias	DoD (2021) QSM V5.4 criteria
MS/MSD or MD	Project designated sample matrix QC.	% Recovery: Sulfate = 87-112% Nitrate = 88-111% RPD ≤ 15%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Interferences - Accuracy/ Bias - Precision	DoD (2021) QSM V5.4 criteria

Table 28.5 – Analytical Quality Control and Corrective Action: Water, Total Organic Carbon (TOC)

Laboratory: EMAX
Matrix: Water
Analytical Group: TOC
Analytical Method/SOP Reference: SW9060A / EMAX-9060

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch.	No analytes detected > LOQ	Correct problem. Reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/ Bias - Contamination	Per SOP: All analytes <LOQ
Laboratory Control Sample (LCS)	One per preparatory batch.	% Recovery: 80-120%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/ Bias	Per SOP: %Rec: 80-120%
MS/MD	Project designated sample matrix QC.	% Recovery: 75-125% RPD ≤ 20%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Interferences - Accuracy/ Bias - Precision	Per SOP: % Rec: 75-125% RPD ≤ 20%

Table 28.6 – Analytical Quality Control and Corrective Action: Water, Alkalinity and Hardness

Laboratory: EMAX
Matrix: Water
Analytical Group: Alkalinity
Analytical Method/SOP Reference: SW2320B and SW2340C / EMAX-2320B and EMAX-2340C

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch.	No analytes detected > LOQ	Correct problem. Reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst	Accuracy/ Bias - Contamination	Per SOP: All analytes <LOQ
Laboratory Control Sample (LCS)	One per preparatory batch.	% Recovery: 80-120%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Accuracy/ Bias	Per SOP: %Rec: 80-120%
Sample Duplicate	Project designated sample matrix QC.	RPD ≤ 20%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract / reanalyze the sample.	Analyst	Interferences - Accuracy/ Bias - Precision	Per SOP: RPD ≤ 20%

Table 28.7 – Analytical Quality Control and Corrective Action: PFM Volatiles and Alcohol Tracers

Laboratory: EnviroFlux
Matrix: PFM
Analytical Group: Volatiles and Alcohol Tracers
Analytical Method/SOP Reference: SW8260C and SW8015C / PFM SOP

QC Sample	Frequency & Number	Analytical/Prep Method and SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per batch of 20 samples.	No analytes detected > method reporting limit (or LOQ)	Correct problem. If required, re-prep and reanalyze method blank and all QC samples and field samples processed with the contaminated blank.	Analyst	Accuracy/ Bias – Contamination	No analytes detected > method reporting limit
Laboratory Control Sample (LCS)	One per batch of 20 samples	QC acceptance criteria +/- 20 of true value for all QA/QC analytes and target analytes	1) Reanalyze 2) Identify and correct problem 3) Qualify data	Analyst	Accuracy/ Bias	QC acceptance criteria +/- 20 of true value for all QA/QC analytes and target analytes
Surrogate	All field and QC samples	70-130%	Identify and correct problem. If necessary, re-prepare and reanalyze associated samples. If matrix effect is verified, reanalysis is not needed. Discuss in narrative.	Analyst	Accuracy	70-130%

Worksheet #29: Project Documents and Records

29.1 PROJECT DOCUMENTS AND RECORDS FOR FIELD-RELATED TASKS

The table below lists the data quality-related documentation prepared to support the semi-annual sampling and reporting.

Table 29.1 – Project Documents and Records for Field-Related Tasks

Document/ Record	Purpose	Related Definable Feature of Work	Primary Generator	Completion/ Update Frequency
Site manager's logbook	Record all important events	ALL	Site Manager	Daily
Daily status reports	Report notable events to project team	ALL	Site Manager	Daily
Safety/quality compliance check list	Focus the process for and record the results of safety/quality compliance reviews	ALL	Site Safety and Health Officer (SSHO), Project QC Manager	During review
Sampling Logbook	Record important sampling information including equipment calibration	ALL Sampling Definable Features of Work	Sampler	When sampling activities occur
Soil boring log	Record boring/sampling methods, lithology, field observations/ screening results, and soil sample information.	Soil borings and soil sampling	Project Geologist	During soil boring/ sampling
Monitoring well completion log	Document monitoring well construction details.	Monitoring well construction	Project Geologist	During well installation
Monitoring well development log	Document groundwater monitoring well development activities.	Monitoring well development	Project Geologist	During well development activities

Table 29.1 – Project Documents and Records for Field-Related Tasks

Document/ Record	Purpose	Related Definable Feature of Work	Primary Generator	Completion/ Update Frequency
Groundwater sample log (low-flow)	Document groundwater sampling activities using low-flow sampling methods.	Low-flow groundwater sampling	Sampler	During low-flow groundwater sampling activities
Soil sample log	Document soil sampling activities	Soil sampling	Sampler	During soil sampling activities
PFM sampling	Document PFM sampling activities	PFM sampling	Sampler	During PFM sampling activities
Field change request form	Record non-critical (i.e., minor) deviations from the QAPP (*“non-critical” deviations are defined as those that will not impact project objectives*)	ALL	Site Manager	As needed
Root cause analysis	Document MPC failures and causes, as well as corrective actions taken, actions taken to prevent recurrence, and actions taken to monitor effectiveness of corrective action	ALL	Site Manager with support from Project QC Manager, and other discipline QC leads.	If MPC failures are noted
Waste tracking log	Track waste generated, drum numbers, whether the drum has been sampled, and its classification.	Waste characterization sampling and waste management	Site Manager	As needed
Waste transportation and disposal log	Track the shipment and disposal of drums containing waste.	Waste characterization sampling and waste management	Site Manager	As needed

29.2 PROJECT DOCUMENTS AND RECORDS FOR ANALYTICAL-RELATED TASKS

29.2.1 ANALYTICAL RECORDS

29.2.1.1 Hard Copy Analytical Data Deliverables

The laboratory data reports will contain information included in **Tables 29.2** and **29.3** below. All items applicable to the reported method will be provided in the Stage 4 data package. A portable document format (PDF) version of all data will be provided as part of the laboratory data deliverable. Supporting raw data information is required and will also be included in the PDF submittal. The analytical data deliverables will be stored by Parsons.

Table 29.2 – Analytical Data Deliverables

Case narrative – A detailed case narrative per analytical fraction is required and will include explanation of any non-compliance and/or exceptions and corrective action. Exceptions will be noted for receipt, holding times, methods, preparation, calibration, blanks, spikes, surrogates (if applicable), and sample exceptions.
Signed release statement
Sample identification cross reference sheet (laboratory assigned IDs and associated client IDs)
Completed CoC and any sample receipt information
Sample preparation (extraction/digestion) logs
Copies of non-conformance memos and Corrective Action Reports

IDW soil sample results will be reported in wet weight.

The data for this project will be collected and documented in such a manner that will allow the generation of data packages that can be used by an external data reviewer to reconstruct the analytical process. The data provided by the laboratory must be legible and properly labeled and must be compliant with requirements stated in the DoD (2021) QSM version 5.4.

Table 29.3 – Method-Specific Data

Sample Results
Surrogate recovery summary (w/ applicable control limits)
MS/MSD accuracy and precision summary [1]
LCS accuracy summary
Method blank summary
Initial and continuing calibration blanks
Instrument tuning summary (including tuning summary for applicable initial calibrations [ICALs])
Interference check standard summary
ICAL summary (including concentration levels of standards)
Secondary source verification summary

Table 29.3 – Method-Specific Data

Continuing calibration verification summary
IS summary (including applicable ICALs)
Sample preparation (extraction/digestion) logs
Analytical batch sequence / run log
Laboratory duplicate summary [1]
Compound identification summary / ion spectra
Performance check / Sensitivity Check
Instrument or method detection limit summary
ICP Interelement correction factors
High-level check standard
Low-level calibration check standard
Confirmation analyses (if required)
All supporting raw data associated with items listed above

Notes:

[1] RPD shall be calculated using concentration.

29.2.1.2 SEDD 2a Electronic Data Deliverables

The laboratory will provide a validated electronic deliverable in Staged Electronic Data Deliverable (SEDD) 2a format compatible with the FUDSChem database (USACE 2019, 2023). The laboratory shall load the SEDD into the FUDSChem database, check it for compliance to the electronic UFP-QAPP (eQAPP), and notify the contractor of SEDD certification by the FUDSChem database administrator. Data in the electronic submittal must agree completely with the data in the hard copy report.

29.2.1.3 Data Assessment Records

Data assessment records include, but are not limited to, the following:

Table 29.4 – Data Assessment Records

Document	Where Maintained
FUDSChem eQAPP	FUDSChem
Field notebooks	Electronic PDF copies in the project file. Hard copy (bound notebook) in the project file. Archived at project closeout.
CoC records	Electronic PDF copies in the project file. Hard copy in the project file. Archived at project closeout.
Air bills	Hard copy in the project file. Archived at project closeout.
Telephone logs	Hard copy in the project file. Archived at project closeout.

Table 29.4 – Data Assessment Records

Document	Where Maintained
Corrective action forms	Electronic PDF copies in the project file. Hard copy in the project file. Archived at project closeout.
Electronic field data deliverables	Loaded in the field database then transferred to the structured query language (SQL) data warehouse as the final repository.
Various field measurements	Recorded in field notebook and stored in SQL data warehouse.
All field equipment calibration information	Recorded in field logbook.
Pertinent telephone conversations	Recorded in field logbook.
Field equipment maintenance records	Reviewed by the Field Team Lead.
Sample receipt, custody, and tracking records	Electronic PDF copies in the project file.
Standard traceability logs	Included in data package PDF. Archived at project closeout.
Equipment calibration logs	Included in data package PDF. Archived at project closeout.
Sample prep logs	Included in data package PDF. Archived at project closeout.
Run logs	Included in data package PDF. Archived at project closeout.
Equipment maintenance, testing, and inspection logs	Maintained by the laboratory. Available upon request.
Reported field sample results	Included in data package PDF. Archived at project closeout.
Reported results for standards, QC checks, and QC samples	Included in data package PDF. Archived at project closeout.
Instrument printouts (raw data) for field samples, standards, QC checks, and QC samples	Included in data package PDF. Archived at project closeout.
Sample disposal records	Maintained by the laboratory.
Extraction/cleanup records	Included in data package PDF. Archived at project closeout.
Field sampling review checklists	Included in data package PDF. Archived at project closeout.
FUDSChem Electronic data deliverables (EDDs)	Validated EDDs will be uploaded to the FUDSChem system by the laboratory.
Data validation reports	Electronic PDF copies in the project file.
FUDSChem data validation	FUDSChem

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

31.1 PLANNED PROJECT ASSESSMENTS

This table provides information on the required periodic assessments that will be performed during the project to ensure the planned project activities are implemented in accordance with this UFP-QAPP. The type, frequency, and responsible parties of planned assessment activities to be performed for the project are summarized in the table below. Data will be reviewed internally by the contractor before being provided for external review.

Table 31.1 – Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Preparatory QC Meeting	Prior to beginning of each field mobilization.	Internal	Parsons	Parsons PM will organize and perform the meeting.	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Parson PM or designee.
Preparatory Meeting Inspection Report	With each Preparatory QC Meeting	Internal	Parsons	Site Manager or designee	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Site Manager or designee

Table 31.1 – Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Initial QC Meeting	Shortly after each field mobilization	Internal and External	Parsons, government personnel, and subcontractors, as warranted.	Site Manager	Site Manager, Field Team Manager or other QC Personnel as appropriate based on findings.	Site Manager, Field Team Managers or other QC Personnel as appropriate based on findings.	Parson PM or designee.
Initial Meeting Inspection Report	With each Initial QC Meeting	Internal	Parsons	Site Manager or designee	Field Team Manager or other QC Personnel as appropriate based on findings.	Field Team Managers or other QC Personnel as appropriate based on findings.	Site Manager or designee
Ongoing QC and Corrective Action Inspections	Periodically during field mobilization	Internal	Parsons	Site Manager or designee	Field Team Manager or other QC Personnel as appropriate based on findings.	Field Team Managers or other QC Personnel as appropriate based on findings.	Site Manager or designee

Table 31.1 – Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Ongoing QC and Corrective Action Report	With each Ongoing QC and Corrective Action Inspections	Internal	Parsons	Site Manager or designee	Field Team Manager or other QC Personnel as appropriate based on findings.	Field Team Managers or other QC Personnel as appropriate based on findings.	Site Manager or designee
Completion Inspection	At the end of each field mobilization.	Internal	Parsons	Parsons PM	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Parson PM or designee.
Completion Inspection Report	With each Completion Inspection	Internal	Parsons	Parsons PM or designee	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Site Manager, Other Field Management or other QC Personnel as appropriate based on findings.	Parsons PM or designee

Table 31.1 – Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Field Procedure Assessment and QAPP Compliance	Once per project during field activities	Internal	Parsons	Corporate QC Manager	Project QC Manager	Project QC Manager	Site Manager
Health & safety (H&S) Review	Once per project during field activities	Internal	Parsons	Project H&S Manager	SSHO	SSHO	Site Manager Project H&S Manager
Field Record Verification	Once per field mobilization	Internal	Parsons	Project QC Manager	Site Manager and/or appropriate discipline manager	Site Manager and/or appropriate discipline manager	Project QC Manager
Review Geospatial Data	For each GIS data submittal	External (see QASP)	USACE	Applicable USACE staff	Parsons' PM and GIS Manager	Parsons' GIS Manager	Parsons' PM
Field Activities	See Quality Assurance Surveillance Plan (QASP)	External (see QASP)	USACE	Applicable USACE staff	Parsons' PM and relevant personnel	Site Manager and other relevant personnel	Parsons' QC Manager
Sampling and Analysis	See QASP	External (see QASP)	USACE	USACE Project Chemist	Parsons' PM and Project Chemist or designee	Parsons' Project Chemist and Sampling Lead	Parsons' Project Chemist and Sampling Lead

Table 31.1 – Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Offsite Laboratory Technical Systems Review	All laboratories utilized over the duration of this project must have and maintain California and DoD ELAP accreditations throughout the life of the project. The laboratory must be re-evaluated and receive recertification prior to the expiration of the current accreditation period of performance.	External	Third-party DoD Accrediting Body	Third-party DoD Accrediting Body	Laboratory QA Manager	Laboratory QA Manager	Laboratory QA Manager, Project Chemist

31.2 ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Based on the findings of project assessments, corrective action may be required. A “corrective action” is defined as an action taken by a project to eliminate the cause(s) of nonconformity to prevent recurrence. For assessment findings that require corrective action, deficiencies will be documented and communicated to the appropriate project personnel. Corrective action will then be implemented, and a follow-up assessment will be performed to verify the results of the corrective action. Procedures for handling UFP-QAPP deviations during each type of assessment are summarized in the table below.

Table 31.2 – Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Field Procedure Assessment and QAPP Compliance	Internal memo	Project QC Manager	1 business day	Internal e-mail	Site Manager	1 business day
Field Documentation Reviews	Internal memo	Field Task Lead	3-5 business days	Internal e-mail	Site Manager	3–5 business days
H&S Compliance Inspection	Written compliance inspection report	Site Manager/ SSHO	3-5 business days	Letter or memo	PM H&S Manager	24 hours after notification
Preparatory QC Meeting	Preparatory Meeting Inspection Report	Parsons PM; Site Manager; other appropriate site management.	1-2 business days	Report Form and meeting minutes	Parsons PM; Parsons Site Manager, USACE PM	3–5 business days
Initial QC Meeting	Initial Meeting Inspection Report	Parsons PM; Site Manager; other appropriate site management.	1-2 business days	Report Form and meeting minutes	Parsons PM; Parsons Site Manager; USACE PM	3–5 business days

Table 31.2 – Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Ongoing QC and Corrective Action Inspections	Ongoing QC and Corrective Action Report	Parsons PM; Site Manager; other appropriate site management.	1-2 business days	Report Form and Internal e-mail	Parsons PM; Parsons Site Manager; Department of Toxic Substances Control (DTSC) and CVRWQCB will receive a copy as part of the weekly project updates	3–5 business days
Completion Inspection	Completion Inspection Report	Parsons PM; Site Manager; other appropriate site management.	1-2 business days	Report Form and Internal e-mail	Parsons PM; Parsons Site Manager	3–5 business days

31.3 QUALITY ASSURANCE MANAGEMENT REPORTS

In order to demonstrate that DQOs have been achieved, periodic QA management reports will be prepared to ensure that the project stakeholders are updated on project status and the results of all QA assessments. The frequency and type of planned QA management reports, the delivery date, the personnel responsible for report preparation, and the report recipients are identified in the table below.

Table 31.3 – Quality Assurance Management Reports

Type of Report	Frequency	Projected Delivery Date(s)	Primary Person(s) Responsible for Report Preparation	Report Recipient(s)
Daily Field Report	At the end of each sampling day	TBD	Field Team Lead or designee	Recipients listed in the Distribution Memo (see **Worksheet #3**)
Data Validation Report	Upon completion of data package review and validation	TBD	Third-party data validation company	Recipients listed in the Distribution Memo (see **Worksheet #3**)
Data Usability Report (DUR)	Once after all data are generated and validated	TBD	Parsons' Project Chemist or designee	Recipients listed in the Distribution Memo (see **Worksheet #3**)
Final Project Report	Once after all data are generated, validated, and evaluated	TBD	Parsons	Recipients listed in the Distribution Memo (see **Worksheet #3**)

Worksheet #34: Data Verification & Validation Inputs

This worksheet lists the inputs that will be used during data verification and validation (**Tables 34.1** and **34.2**). 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. Data validation includes evaluation of the data against the project specific MPCs (**Worksheet #12**). Data verification and validation procedures and responsibilities are described on **Worksheet #35** and **Worksheet #36**, respectively. Once verification and validation have been completed, a usability assessment is conducted to evaluate whether process execution and resulting data meet DQOs. Usability assessment procedures are described on **Worksheet #37**.

Table 34.1 – Verification and Validation Inputs for Field-Related Tasks

Description	Verification (completeness)	Validation (conformance to specifications)
Field Records		
Site manager logbook (content and legibility check)	X	
Daily status reports	X	
Team leader logbook(s) (content and legibility check)	X	
Field change request form	X	
Root cause analysis	X	
SOP checklists	X	X
Sample log	X	
Drilling log	X	
Equipment calibration log	X	

Table 34.2 – Verification and Validation Inputs for Analytical-Related Tasks

Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records		
Approved UFP-QAPP	X	
Laboratory subcontract	X	
Field SOPs	X	
Laboratory SOPs	X	
Field Records		
Field logbooks	X	
CoC forms	X	
Change orders/deviations, when applicable	X	
Field corrective action reports, when applicable	X	
Analytical Data Package (including but not limited to the following items)		
Cover sheet (laboratory identifying information)	X	X
Case narrative	X	X
CoC and shipping forms	X	X
Sample condition upon receipt records	X	X
Sample chronology (i.e., dates/times of receipt, preparation, and analysis)		X
Communication records	X	
LOD/LOQ verification	X	X
Detection and quantitation limits		X
Standards traceability		X
Instrument calibration records		X
Definition of laboratory qualifiers	X	X
Analytical sample results	X	X
QC sample results	X	X
Raw data, including manual integrations when applicable[1]		X
Electronic data deliverable[2]		X

Table 34.2 – Verification and Validation Inputs for Analytical-Related Tasks

Description	Verification (completeness)	Validation (conformance to specifications)
Corrective action reports, when applicable	X	X

Notes:

[1] When manual integrations are performed, raw data records shall include a complete inspection trail for those manipulations (i.e., the chromatograms obtained before and after the manual integration must be retained). This requirement applies to all analytical runs including calibration standards and QC samples. The person performing the manual integration must sign and date each manually integrated chromatogram and record the rationale for performing the manual integration.

[2] Electronic deliverables shall be submitted in SEDD 2A format compatible with the FUDSChem database (USACE 2019, 2023). The laboratory shall load the SEDD into the FUDSChem database, check it for compliance to the eQAPP, and notify the contractor of SEDD certification by the FUDSChem database administrator. In addition, a separate SEDD 2A EDD shall be submitted to the contractor via email. Data in the electronic copy must agree completely with the data in the hard copy report.

Worksheet #35: Data Verification Procedures

"Verification" is a completeness check that is performed before the data review process is conducted to determine whether the required information is available for validation. It involves a review of all data inputs to ensure that they are present. This step of the data review process answers whether or not the required data inputs are present. "Validation" is performed to identify and qualify data that do not meet the MPCs specified on **Worksheet #12.** Data requiring validation are summarized on **Worksheet #34.** The tables below show what data inputs are required for data validation as well as the processes used to conduct the validation.

Table 35.1 – Verification Procedures for Field-Related Tasks

Verification Input	Description of Verification Process	Internal/ External	Responsible for Verification
Site manager logbook	Confirm logbooks on file cover entire duration of field effort.	Internal	Site Manager
Daily status reports	Confirm Daily Status Reports on file cover entire duration of field effort.	Internal	Site Manager
Field notebooks	Field notebooks will be reviewed internally on a weekly basis initially, moving to a monthly review, and placed into the project file for archival at project closeout.	Internal	Site Manager
Team leader logbook(s)	Confirm logbooks on file cover entire duration of field effort.	Internal	Site Manager
Field change request form (when applicable)	Confirm that a Field Change Request on file for each QAPP change due to minor field-based QAPP revisions.	Internal	Site Manager
Root cause analyses (when applicable)	Confirm Root Cause Analyses on file for all applicable MPC failures.	Internal	Project QC Manager /Contractor
SOP checklists	Confirm all SOP checklists are on file and cover entire duration of field work.	Internal	Project QC Manager
Sample log	Verify that all sample logs are on file for all samples.	Internal	Project QC Manager
Drilling log	Verify that all drilling logs are on file for all soil borings (Direct Push).	Internal	Project QC Manager

Table 35.2 – Verification Procedures for Analytical Related Tasks

Verification Input	Description of Verification Process	Internal/ External	Primary Person(s) Responsible
Cover sheet	Confirm the cover sheet includes laboratory identifying information, contact information, assigned sample delivery group number, date issued, project name, and laboratory approval signature.	External and Internal	Laboratory PM or QA Manager Parsons Project Chemist
Case narrative	Confirm the case narrative documents all non-conformance issues related to the samples and analytical data contained in the report.	External and Internal	Laboratory PM Parsons Project Chemist
CoC and shipping forms	CoC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent A copy of the CoC retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Internal	Site Manager Parsons Project Chemist
Sample condition upon receipt	Any discrepancies, missing, or broken containers will be communicated to the Project Chemist or designee along with the laboratory login information.	External	Laboratory Sample Receipt Staff Parsons Project Chemist
Definition of laboratory qualifiers	Definitions of all laboratory applied data qualifiers must be included in the data package.	External and Internal	Laboratory PM, Parsons Project Chemist
Analytical sample results	Review analytical sample results for completeness against the requested parameters listed on the CoC.	External and Internal	Laboratory PM, Parsons Project Chemist or designee
QC sample results	Ensure all QC associated with sample analysis is included. (Laboratory should NOT include MS/MSD data associated with non-project samples.)	External and Internal	Laboratory PM, Parsons Project Chemist or designee
Corrective action reports	Corrective Action reports will be reviewed by the Project Chemist or PM and placed into the project file for archival at project closeout.	External	Laboratory PM or QA Manager Parsons' Project Chemist or designee

Worksheet #36: Data Validation Procedures

Data Validation is performed to identify and qualify data that do not meet the MPCs specified on **Worksheet #12**. Data requiring validation are summarized on **Worksheet #34**. The following tables show what data inputs are required for data validation as well as the processes used to conduct the validation. Data validation will be performed in accordance with the DoD's (2019) "General Data Validation Guidelines" and any published modules.

Table 36.1 – Validation Procedures for Field-Related Tasks

Validation Input	Description of Validation Process	Responsible for Validation
Daily Instrument Test Report	Ensure the results of all relevant MPCs are attained and correctly documented in the deliverable.	QC Manager
SOP checklists	Ensure the correct procedures have been followed in accordance with defined SOPs .	QC Manager

Table 36.2 – Validation Procedures for Analytical-Related Tasks

Validation Input	Description of Validation Process	Primary Person(s) Responsible
Instrument calibration records	Ensure instrumentation was properly calibrated prior to sample analysis.	Parsons Project Chemist
Standard traceability	Verify all chemicals, spikes, and solvents used in the analysis are traceable back to the associated American Society for Testing and Materials standard.	Third-party data validation company
Raw data (including manual integrations when applicable)	Verify the accuracy of instrument print-outs and spot check the calculations performed by the instrument software. Review all manual integrations to ensure they were performed properly and that all required documentation was provided.	Parsons Project Chemist
Sample chronology	Calculate preparation and analytical holding times and compare to method requirements.	Parsons Project Chemist
Detection / quantitation limits	Ensure that the reported sample detection limits, LODs, and LOQs met the project sensitivity requirements specified in the project QAPP.	Parsons Project Chemist
Electronic data deliverable	Verify the EDD is error free and agrees with the hard copy report.	Parsons Project Chemist

Notes:
Items listed in this table are in addition to those detailed in **Table 35.2**.

36.1 DATA VALIDATION

Stage 4 data validation will be performed by Parsons Project Chemist on a minimum of ten percent (10%) of the data, excluding IDW. Stage 4 DoD (2021) QSM compliant data packages are required for all data with the exception of that associated with IDW. IDW data will be reviewed at Stage 1. Stage 2b data verification will be performed on all remaining data. If significant issues are noted during the verification process, escalation to higher stages of data validation may be warranted. The decision to perform validation at a higher stage than the minimum required may be made by the Parsons' project chemist or designee, the Parsons' PMs, the USACE Project Chemist, or the USACE PM. The stages of data validation are defined by DoD (2019).

Data selected for Stage 4 validation will include each parameter and matrix.

In addition to the required data packages in PDF format, the laboratory shall submit data using the SEDD format in accordance with the FUDSChem requirements (USACE 2019, 2023). Parsons project chemist or designee will electronically validate the data using FUDSChem. The FUDSChem outputs will be reviewed against the laboratory PDF report, supplementing with manual review where necessary. Upon completion of data validation, Parsons' project chemist will generate a written report summarizing all findings.

Table 36.3 – Overview of Analytical Data Validation for All Analytes

Analytical Group/Method:	All Chemical Analyses
Data Deliverable Requirements:	Stage 4 validation package (including raw data and Contract Laboratory Program-like forms) and EDD
Analytical Specifications:	Per UFP-QAPP and DoD (2021) QSM version 5.4
Measurement Performance Criteria:	Per UFP-QAPP (**Worksheet #12**)
Validation Code[1] and Percent of Data Packages to be Validated:	100% Stage 2B (S2BVEM) + 10% Stage 4 (S4VEM) (IDW at 100% Stage 1 (S1VM))
Percent of Raw Data Reviewed:	100%
Percent of Results to be Recalculated:	10%
Validation Procedure:	Per UFP-QAPP and DoD General Data Validation Guidelines, Rev 1 (Nov 2019) Data Validation Guideline Modules 1, 2, and 4.
Data Qualifiers:	See **Table 36.4** below
Electronic Validation Program/Version:	SEDD 2A format using latest version of the Automated Data Review.net (ADR.net) software compatible with the FUDSChem database[2]
Record Retention for Data Validation Records	5 years

Note:

1 – S2BVEM = Stage 2b Validation Electronic and Manual; S4VEM = Stage 4 Validation Electronic and Manual; S1VM = Stage 1 Validation Manual.

2 - The laboratory shall load the SEDD into the FUDSChem database, check it for compliance to the eQAPP, and notify the contractor of SEDD certification by the FUDSChem database administrator.

Table 36.4 – Data Validation Codes and Definitions

Data Qualifiers	Definitions
U	The analyte was not detected and was reported as less than the LOD. 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.
UJ	The analyte was not detected and was reported as less than the LOD. 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 are recommended.

Note: Detected analytes shall be reported to the DL. All detections between the DL and LOQ shall be qualified "J" as estimated. All non-detect results will be reported as non-detect at the LOD, as per DoD (2021) QSM version 5.4. Stage 4 validation includes re-quantification and recalculation on 10% of the samples per Sample Delivery Group, per analytical suite. If the SDG is analyzed on multiple instruments, then each instrument should be included in the calculations. More specifically, a minimum of 10% of the laboratory standards (instrument QC), field QC samples, field samples (prioritizing project specific target analyte detects, diluted samples, manual integrations, and any samples requiring re-analysis), and batch QC samples.

Worksheet #37: Usability Assessment

The data usability assessment is an evaluation based on the results of data verification and validation in the context of the overall project decisions or objectives. The assessment determines whether the project execution and resulting data meet the project DQOs (see **Worksheet #11**) and MPCs (see **Worksheet #12**). All types of data will be considered with the goal of assessing whether the final, qualified results support the decisions to be made with the data.

The following sections summarize the processes to determine whether the collected data are of the right type, quality, and quantity to support the environmental decision-making for the project and describes how data quality issues will be addressed and how limitations of the use of the data will be handled.

37.1 USABILITY ASSESSMENT FOR FIELD-RELATED DATA

37.1.1 SUMMARY OF USABILITY ASSESSMENT PROCESSES

Field-related data gaps may be present if (1) data are not collected, (2) data are not evaluated with regard to the necessary parameters, or (3) data are determined to be unusable. The need for further investigation or corrective action will be determined on a case-by-case basis, depending on whether data can be recovered, extrapolated from other data, and/or whether the missing data are needed based on the results of other recorded data.

The data usability assessment for field-related data will follow the following process:

- Review the project objectives and sampling design:
  - Are the DQOs (**Worksheet #11**) and MPCs (**Worksheet #12**) still applicable?
  - If the DQOs or MPCs have been changed, have the changes been documented?
  - Is the sampling design consistent with project objectives?
- Review the data verification and validation outputs:
  - Have the data been verified as described on **Worksheet #35**?
  - Have the data been validated as described on **Worksheet #36**?
- Document data usability and draw conclusions:
  - Have the DQOs been achieved?
  - Can the data be used as intended?
  - Are there limitations on data use?
  - Have the data been collected in accordance with the underlying assumptions in the analytical methods and sample collection procedures in applicable USEPA and State guidance?

The Site Manager, Project QC Manager, and other technical personnel as necessary will review project data to ensure that the collected data achieve the DQOs and MPCs specified in this UFP-QAPP. During data validation (**Worksheet #36**), non-conformances will be documented, and data will be qualified accordingly. All data are usable as qualified, with the exception of rejected data. The data are considered usable if the relevant MPCs are achieved and both the verification and validation steps are considered to have yielded acceptable data. During verification and validation steps, data may be qualified due to QC issues. Qualifiers are typically intended to indicate minor QC deficiencies, which will not affect the usability of the data. When major QC deficiencies are encountered, the acceptance or rejection of the data should be decided by the project team (including the project chemist). If data are rejected it will not be considered usable for making project decisions. Deviations from the UFP-QAPP will be reviewed to assess whether corrective action is warranted and to assess impacts on achievement of DQOs.

If samples were not collected in accordance with the underlying assumptions in the analytical methods and sample collection procedures in applicable USEPA and State guidance, that will be stated in data usability assessment, along with potential impacts to the data quality.

37.1.2 USABILITY ASSESSMENT DOCUMENTATION FOR FIELD WORK

All results will be reported for an overall quality assessment in the Field Data Completion Checklist (see **Table 37.1**), which will be completed at the end of the field effort. The Field Data Completion Checklist will document the Usability Assessment based on the five-step process described above. The assessment will include whether each field-related data element has been verified according to **Worksheet #35** and validated according to **Worksheet #36**, whether the DQOs (**Worksheet #11**) have been attained, and whether the data can be used as intended.

37.2 USABILITY ASSESSMENT FOR ANALYTICAL DATA

37.2.1 SUMMARY OF USABILITY ASSESSMENT PROCESSES

Analytical data gaps may be present if (1) data are not collected, (2) data are not evaluated with regard to the necessary parameters, or (3) data are determined to be unusable. The need for further investigation or corrective action will be determined on a case-by-case basis, depending on whether data can be recovered, extrapolated from other data, and/or whether the missing data are needed based on the results of other recorded data.

The Parsons' Project Chemist or designee will evaluate the sensitivity of the data collected to determine whether the required DLs, LODs, and LOQs were met. Data will be further evaluated to determine whether the reported DL, LOD, and LOQ are sufficient to meet the associated PQLGs. Sensitivity of target compounds may be affected by matrix interference, high levels of target or non-target analytes, sample volume available for collection, etc. If the sensitivity requirements are not met for a particular analyte (i.e., LOD is greater than the PQLG), the Parsons Team will evaluate whether the data can still be used for project decisions. The following approach will be used to evaluate data usability when the LOD is greater than the PQLG. For analytes that are site-related, the LOD will become the de facto PQLG, and the Parsons team will use a "weight of evidence" approach to evaluate the likelihood of the chemical's presence. This approach will take a holistic approach to consider data that does meet sensitivity requirements to evaluate the likelihood that analytes that do not meet the sensitivity requirements may be present at concentrations greater than the PQLG. In the absence of any information that indicates the potential presence of the analyte, such as the presence of the compound in other media or the presence of breakdown products, the Parsons Team will conclude that the analyte was not present, and thus data are usable for decision making.

For both the water and soil matrices, the majority of the volatile laboratory limits meet the PQLGs. However, benzene, 1,4-dichlorobenzene, trichloroethene, and vinyl chloride have LODs greater than the applicable PQLGs. For benzene, 1,4-dichlorobenzene, and trichloroethene, however, the DL is below the Project Screening Level (PSL). Therefore, data usability will not be impacted. For these analytes, the approach listed above will be used to evaluate data usability.

The laboratory limits that exceed PQLGs are highlighted yellow in **Worksheet #15**.

Table 37.1 – Field Data Completion Checklist

STEP 1: PROJECT OBJECTIVES AND SAMPLING DESIGN

Evaluation	Yes/No	Reference 1	Comments 2
Are the DQOs and MPCs still applicable?			
If DQOs or MPCs have been changed, are the changes documented?			
Is the sampling design consistent with project objectives?			

STEP 2: REVIEW THE DATA VERIFICATION AND VALIDATION OUTPUTS

Data Input	Verified (Yes/No)	Validated (Yes/No)	Reference 1	Comments 2
Site Manager Logbook		N/A		
Daily Status Reports		N/A		
Field Change Request Form		N/A		
Root Cause Analysis		N/A		
Photograph Log		N/A		
Daily Instrument Test Report				
SOP Checklists				

STEP 3: DOCUMENT DATA USABILITY AND DRAW CONCLUSIONS

Evaluation	Yes/No	Reference 1	Comments 2
Have the DQOs been achieved?			
Can the data be used as intended?			
Are there limitations on data use?			

Notes:
N/A – Not applicable; data validation not required (see **Worksheet #34**).

1 - The reference field lists the primary location in the UFP-QAPP where related data are presented, along with any sections of the report where the validation of that data are discussed.

2 - The comments field presents a brief explanation of any data verification or validation issues. Note that any such issues will be further explained in reports.

The Parsons' Project Chemist or designee will evaluate data usability based on the validation reports and laboratory data to determine whether the data are usable for the purposes of this project based on the requirements of this UFP-QAPP and the project DQOs.

The Parsons' multi-disciplinary project team will ensure that the collected data meet the MPCs specified in this UFP-QAPP. During data validation (**Worksheet #35**), non-conformances will be documented, and data will be qualified accordingly. All data are usable as qualified, with the exception of rejected data. Estimated and/or biased results are usable. The data are considered usable if the relevant MPCs are achieved and both the verification and validation steps are considered to have yielded acceptable data. During verification and validation steps, data may be qualified using the qualifiers specified in **Table 36.4** of this document. Qualifiers are applied to data points impacted by deficiencies in the associated QC samples, systematic quality issues, or matrix-specific problems. All qualifiers added, removed, or changed will be documented in the data validation reports. When major QC deficiencies are encountered, the acceptance or rejection of the data should be decided by the project team (including the project chemist). If data are rejected it will not be considered usable for making project decisions. Deviations from the UFP-QAPP will be reviewed to assess whether corrective action is warranted and to assess impacts on achievement of PQOs.

37.2.2 PERSONNEL RESPONSIBLE FOR PERFORMING USABILITY ASSESSMENT

The following personnel are responsible for performing usability assessments:

- Parsons PM
- Parsons Site Manager
- Parsons Project Chemist or designee
- Multi-disciplinary Parsons Project Team
- Parsons risk assessors, statisticians, and other project personnel, as necessary

37.2.3 IMPACTS OF QUALIFIED DATA AND PLAN DEVIATIONS

Parsons will utilize all data not rejected during validation to implement and assess the effectiveness of ISCR and EAB. Parsons will work with USACE and project regulators if there is a concern about the statistical validity of the sample results or to determine if sample locations with rejected data need to be re-sampled.

37.2.4 USABILITY ASSESSMENT DOCUMENTATION

The DUA will be completed using the DUA tool and checklist in FUDSChem. The DUA will evaluate whether the data meets the overall goals of the project, as outlined in the DQOs. A DUA will be prepared to document the data validation findings for all data, excluding IDW, and will be documented in the semi-annual sampling reports.

References

ACHP (Advisory Council on Historic Preservation). 2023. Policy Statement on Burial Sites, Human Remains, and Funerary Objects. March

AEG (Applied Engineering and Geology). 2012. Report of Soil Vapor Survey, Crocker Knoll Property, Oak Tree Lane, Lincoln, Placer County, California. September.

AEG (Applied Engineering and Geology). 2015a. Report of Groundwater Investigation, Crocker Knoll Property, Oak Tree Lane, Lincoln, Placer County, California. October.

AEG (Applied Engineering and Geology). 2015b. Report of Soil Vapor Survey, Oak Tree Lane Property, 500 Oak Tree Lane, Lincoln California. January.

AEG (Applied Engineering and Geology). 2016. Report of Groundwater Investigation, Former Titan 1-A Missile Facility, Oak Tree Lane, Lincoln, Placer County, California. September.

Ahtna (Ahtna Environmental). 2020. Fourth Quarter 2019 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. October.

Ahtna (Ahtna Environmental). 2021a. Second Quarter 2020 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. March.

Ahtna (Ahtna Environmental). 2021b. Third Quarter 2020 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. March.

Ahtna (Ahtna Environmental). 2021c. Fourth Quarter 2020 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. September.

Ahtna (Ahtna Environmental). 2022a. First Quarter 2021 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. February.

Ahtna (Ahtna Environmental). 2022b. Second Quarter 2021 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. February.

Ahtna (Ahtna Environmental). 2022c. Third Quarter 2021 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. July.

Ahtna (Ahtna Environmental). 2022d. Fourth Quarter 2021 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. November.

Ahtna (Ahtna Environmental). 2023a. First Quarter 2022 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. March.

Ahtna (Ahtna Environmental). 2023b. Second Quarter 2022 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. March.

Ahtna (Ahtna Environmental). 2023c. Third Quarter 2022 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. April.

Ahtna (Ahtna Environmental). 2023d. Fourth Quarter 2022 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. May.

Ahtna (Ahtna Environmental). 2023e. First Quarter 2023 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB), Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California. FUDS Project J09CA1108-01. Final. June.

Ahtna (Ahtna Environmental). 2023f. Supplemental Remedial Investigation and Feasibility Study Report, Beale Air Force Base (AFB) Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California, FUDS Project J09CA1108-01. Draft. June.

Brown and Caldwell. 2003. Titan 1-A Missile Facility, 2002 Annual Groundwater Monitoring Report. November.

Brown and Caldwell. 2004a. Human Health and Ecological Risk Assessment.

Brown and Caldwell. 2004b. Continuing Remediation Investigation Report, , Titan 1-A Missile Facility, Lincoln, California. June.

Brown and Caldwell. 2004c. Titan 1-A Missile Facility, 2003 Annual Groundwater Monitoring Report. June.

Brown and Caldwell. 2005. Titan 1-A Missile Facility, Technical Memorandum for Underground Storage Tank Investigation.

Brown and Caldwell. 2006. Titan 1-A Missile Facility, 2006 Annual Groundwater Monitoring Report.

Brown and Caldwell. 2007. Feasibility Study Report, Former Titan 1-A Missile Facility, Lincoln, California, April.

CEBMCO (Corps of Engineers Ballistic Missile Construction Office). 1962. History of Corps of Engineers Activities at Beale Air Force Base, October 1959 to March 1962.

City of Lincoln. 2023. Zoning Map. April. Available online at: https://www.lincolnca.gov/en/business-and-development/resources/Documents/Zoning-Map-Update2022.pdf

CVRWQCB (Central Valley Regional Water Quality Control Board). 2019. *Water Quality Control Plan (basin Plan) for the California Regional Water Quality Control Board, Central Valley Region*. Fifth Edition. February.

DoD (Department of Defense). 2019. General Data Validation Guidelines, Environmental Data Qualification Workgroup. November.

DoD (Department of Defense). 2021. Quality Systems Manual (QSM) for Environmental Laboratories, Final, Version 5.4.

Dynamac (Dynamac Corporation). 1992. *Inventory Project Report, Defense Environmental Restoration Program, Formerly Used Defense Sites, Site No. J09110800*. September.

Environmental Synectics. 2023. Formerly Used Defense Sites Chemical Database (FUDSChem) User Manual, Version 6.1. October.

FA/BC (Forsgren Associates/Brown and Caldwell). 2002. Titan 1-A Missile Facility, 2001 Annual Groundwater Report. June.

FA/BC (Forsgren Associates/Brown and Caldwell). 2004. *Human Health and Ecological Risk Assessment, Titan 1-A Missile Facility, Lincoln, California*. April.

IDQTF (Intergovernmental Data Quality Task Force). 2005. Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs. EPA-505-B-04-900A. DTIC ADA 427785. March.

IDQTF (Intergovernmental Data Quality Task Force). 2012. Uniform Federal Policy for Quality Assurance Work Plans, Part 2A (revised): Optimized UFP-QAPP Worksheets. March.

IEM (Iowa Environmental Mesonet). 2023. Station data and metadata for station LHM at the Lincoln Regional Airport. Available online at: https://mesonet.agron.iastate.edu/sites/site.php?station=LHM&network=CA_ASOS

Parsons. 2024a. Draft Remedial Investigation Report for Former Titan 1-A Missile Facility, Lincoln, California, February.

Parsons. 2024b. Final Uniform Federal Policy for Quality Assurance Project Plans for Semi-Annual Groundwater and Soil Vapor Sampling at Former Titan 1-A Missile Facility, Lincoln, California, April.

Radian (Radian Corporation). 1991. Monitoring Well Installation and Ground Water Sampling at Ferrari Eastlake Ranch Site, May.

URS. 2001. Focused Remedial Investigation Report, Titan 1-A Missile Facility, Lincoln, California. Draft Final. December.

U.S. Air Force. 1962. Technical Manual. Corrosion Control and Treatment for Aerospace Equipment. T.O. 1-1-2. October.

USACE (U.S. Army Corps of Engineers). 2016. EM 200-1-2 Technical Project Planning Process.

USACE (U.S. Army Corps of Engineers). 2018. Beale Air Force Base Titan 1-A Biological Site Visit Report. April.

USACE (U.S. Army Corps of Engineers). 2019. Staged Electronic Data Deliverable (SEDD) Specification and Data Element Dictionary Version 5.2. March.

USACE (U.S. Army Corps of Engineers). 2023. SEDD Modifications and Clarifications for FUDSChem Submission. August.

USEPA (U.S. Environmental Protection Agency). 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. EPA/600/R-98/128. September.

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

Wallace-Kuhl (Wallace-Kuhl & Associates). 2015. Surface Soil and Soil Vapor Investigation Report, Hidden Hills Property, Lincoln, California. May.

Woodward-Clyde. 1996. Records Research Report, Titan 1-A Missile Facility, Lincoln, California. February.

Woodward-Clyde. 1997. Field Investigation Report, Passive Soil Vapor Survey, Titan 1-A Missile Complex, Lincoln, California. February.

FIGURES

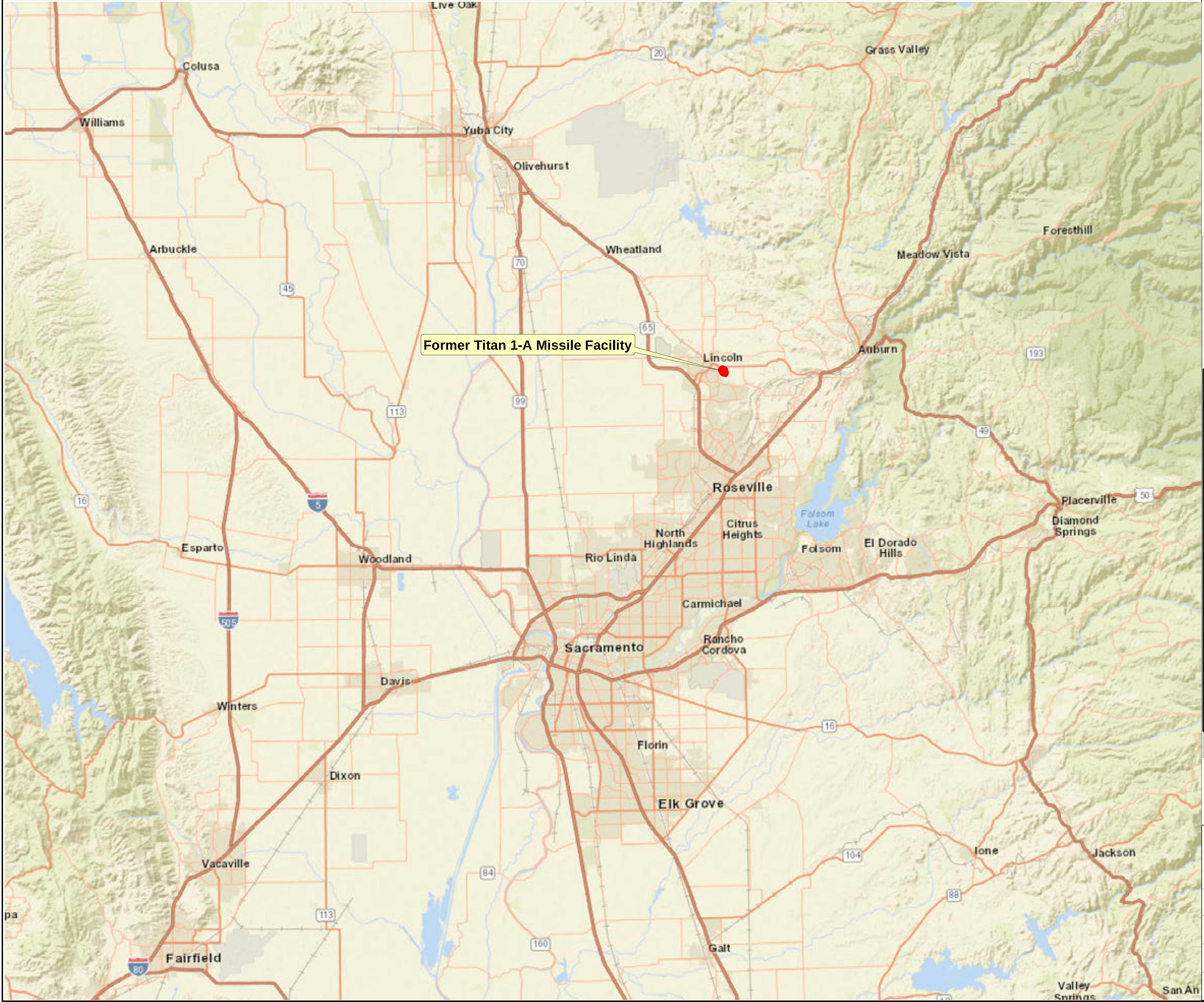

Figure Int.1

General Site Location
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

🟥 Former Titan 1-A Missile Facility / FUDS Boundary

Site Location in California

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT	General Site Location
DRAWN BY: BT	PROJECT TYPE: HTRW
CHECKED BY: MR	PROJECT: J09CA1108-01
SUBMITTED BY: CR	DATE: December 2023

PROJECT NUMBER: 100306.0044.110251.09000

PAGE NUMBER:

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Figure Int.2

Site Setting
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

🟥 Former Titan 1-A Missile Facility / FUDS Boundary

Site Location in California

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY:	BT
DRAWN BY:	BT
CHECKED BY:	MR
SUBMITTED BY:	CR

Site Setting

PROJECT TYPE: HTRW
PROJECT NUMBER: 100306.0044.110251.09000
PROJECT: J09CA1108-01
PAGE NUMBER:
DATE: March 2024

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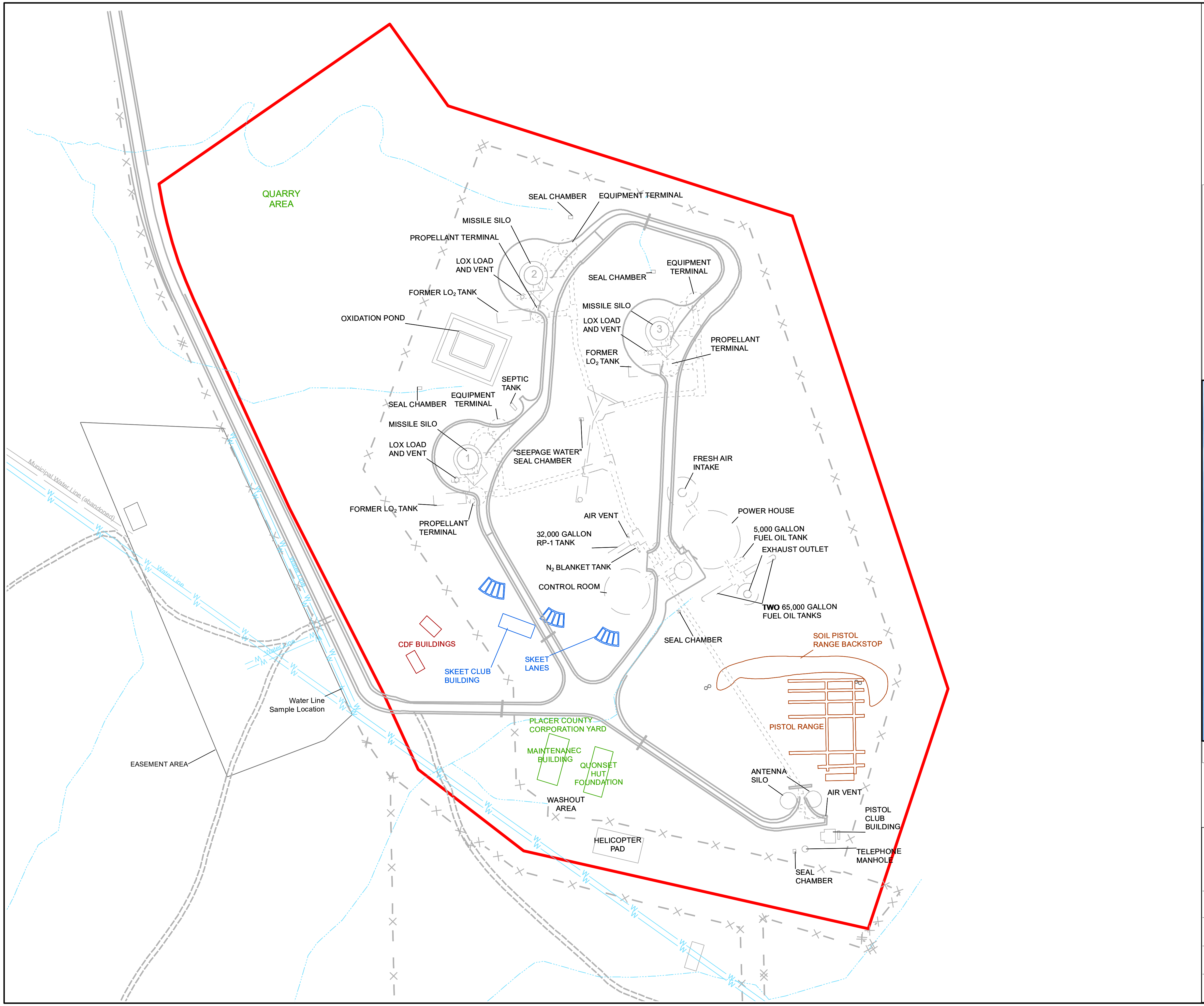

Figure Int.3

Historic Site Features
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

🟥	Former Titan 1-A Missile Facility / FUDS Boundary
🟩	Placer County Corporation Yard and Quarry
🟥	California Division of Forestry (CDF) Fire Station
🟦	Trap and Skeet Shooting Club
🟫	Pistol Range
‐ ‐ ‐	Drainage Path
—W—	Municipal Water Line

Site Location in California

200 100 0 200 Feet

N E S W

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT

DRAWN BY: BT

CHECKED BY: MR

SUBMITTED BY: CR

Historic Site Features

PROJECT TYPE: HTRW

PROJECT NUMBER: 100306.0044.110251.09000

PROJECT: J09CA1108-01

PAGE NUMBER:

DATE: February 2024

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Figure Int.4

Parcel Ownership
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

- 🟥 Former Titan 1-A Missile Facility / FUDS Boundary
- 🟨 Parcel Boundary

Site Location in California

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT	**Parcel Ownership**
DRAWN BY: BT	
CHECKED BY: MR	PROJECT TYPE: HTRW — PROJECT NUMBER: 100306.0044.110251.01000
SUBMITTED BY: CR	PROJECT: J09CA1108-01 — DATE: April 2024 — PAGE NUMBER:

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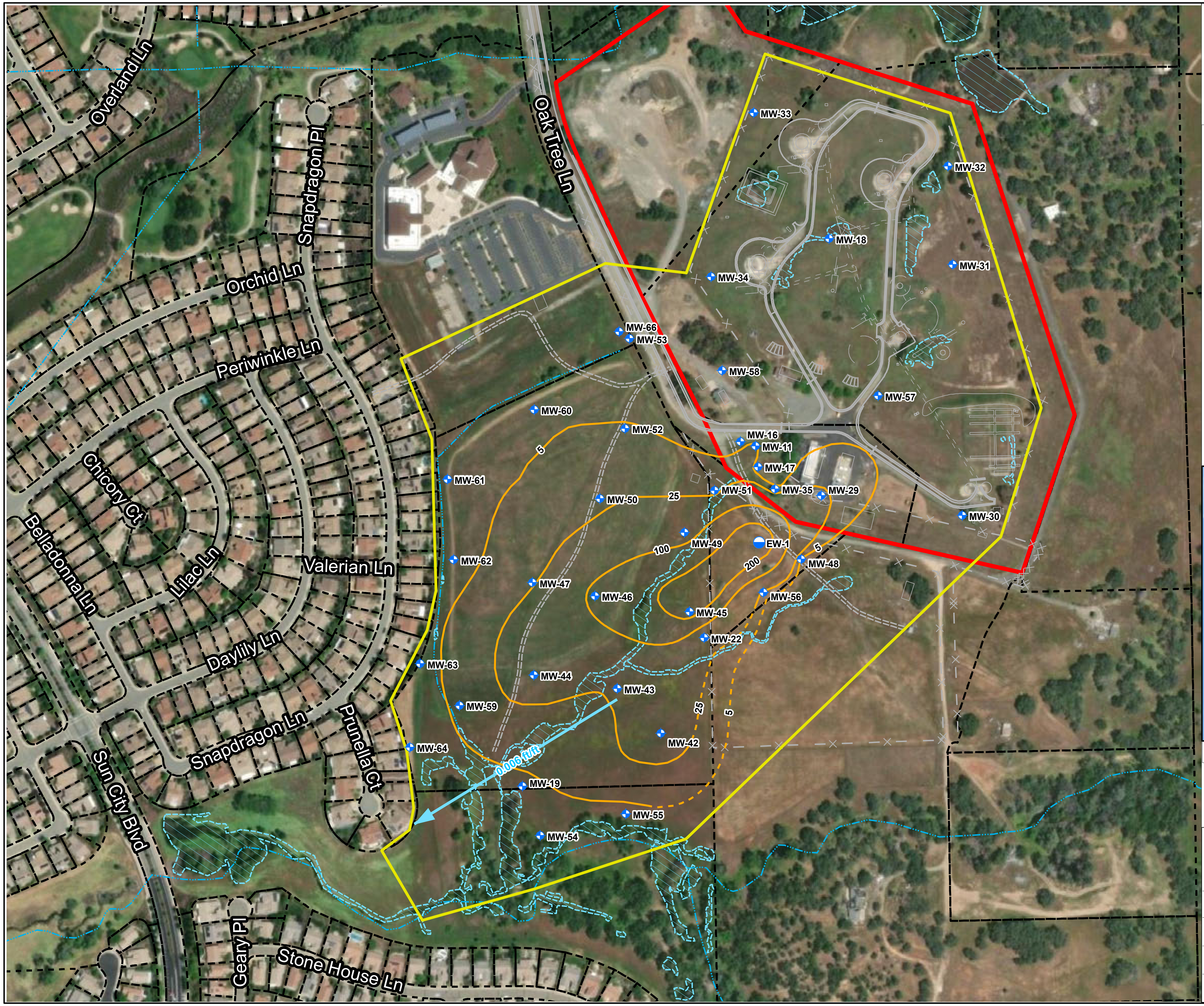

Figure Int.5

Groundwater Well Locations
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

◒	Extraction Well
⊕	Monitoring Well
→	Direction of Groundwater Flow
×—	Fence
—	TCE Isoconcentration (µg/L) Line, Dashed where Estimated
⬚	Parcel Boundary
▨	Ephemeral/Seasonal Streams and Surface Water Bodies
-·-	Ephemeral stream
🟥	Former Titan 1-A Missile Facility / FUDS Boundary
🟨	Study Area

Note:
The concentration contours are from the first semi-annual sampling event in 2024. Contours are dashed where inferred.
The concentrations provided as #/# are the normal sample result followed by the field duplicate result.
J = Estimated value
U = not detected at the indicated Limit of Detection

Site Location in California

PARSONS	U.S. Army Corps of Engineers Sacramento District

DESIGNED BY: BT	**Groundwater Well Locations**	
DRAWN BY: BT		
CHECKED BY: MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.09000
SUBMITTED BY: CR	PROJECT: J09CA1108-01 DATE: July 2024	PAGE NUMBER:

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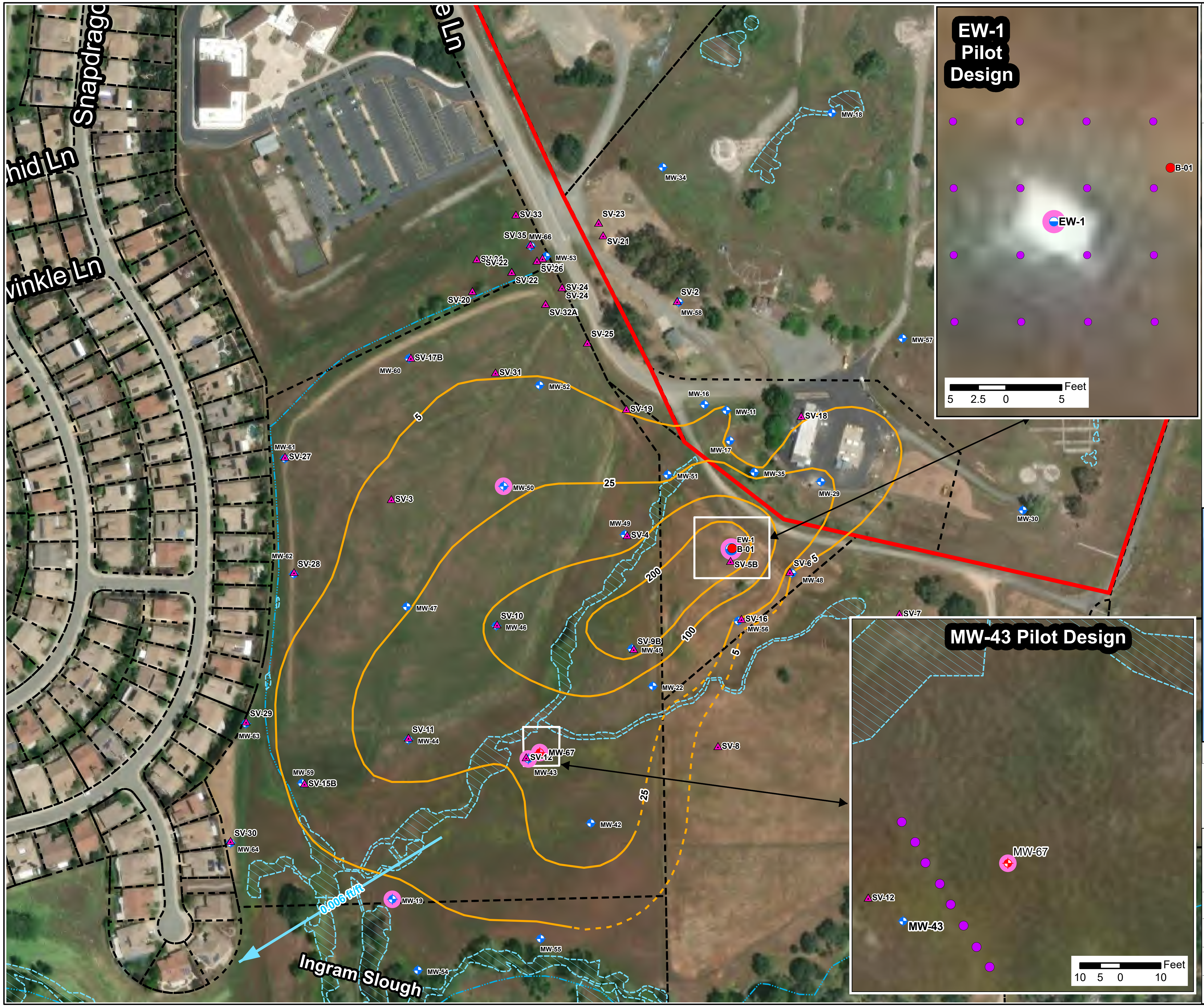


Figure Int.6

Injection Locations
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

- ◒ Extraction Well
- ⊕ Monitoring Well
- → Direction of Groundwater Flow
- — TCE Isoconcentration (µg/L) Line, Dashed where Estimated
- ▭ Parcel Boundary
- ▨ Ephemeral/Seasonal Streams and Surface Water Bodies
- -·- Ephemeral stream
- ▭ Former Titan 1-A Missile Facility / FUDS Boundary
- ● Proposed Boring
- ● Proposed Injection Location
- ⊕ Proposed Monitoring Well
- ▲ Soil Vapor Probe
- ⊕ Treatability Study Well

Note:
The concentration contours are from the first semi-annual sampling event in 2024. Contours are dashed where inferred.
The concentrations provided as #/# are the normal sample result followed by the field duplicate result.
J = Estimated value
U = not detected at the indicated Limit of Detection

Site Location in California

200 100 0 200 Feet

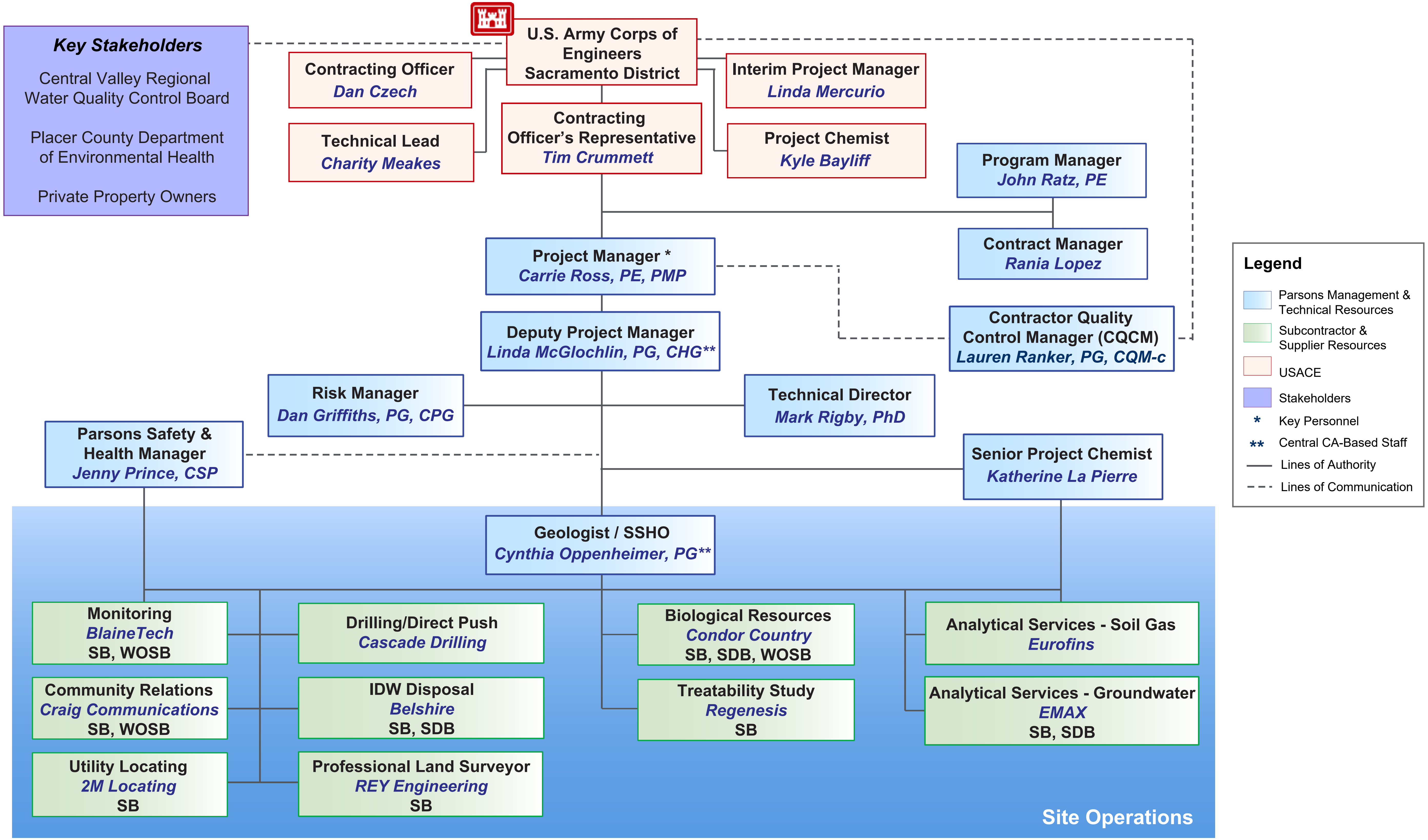
PARSONS

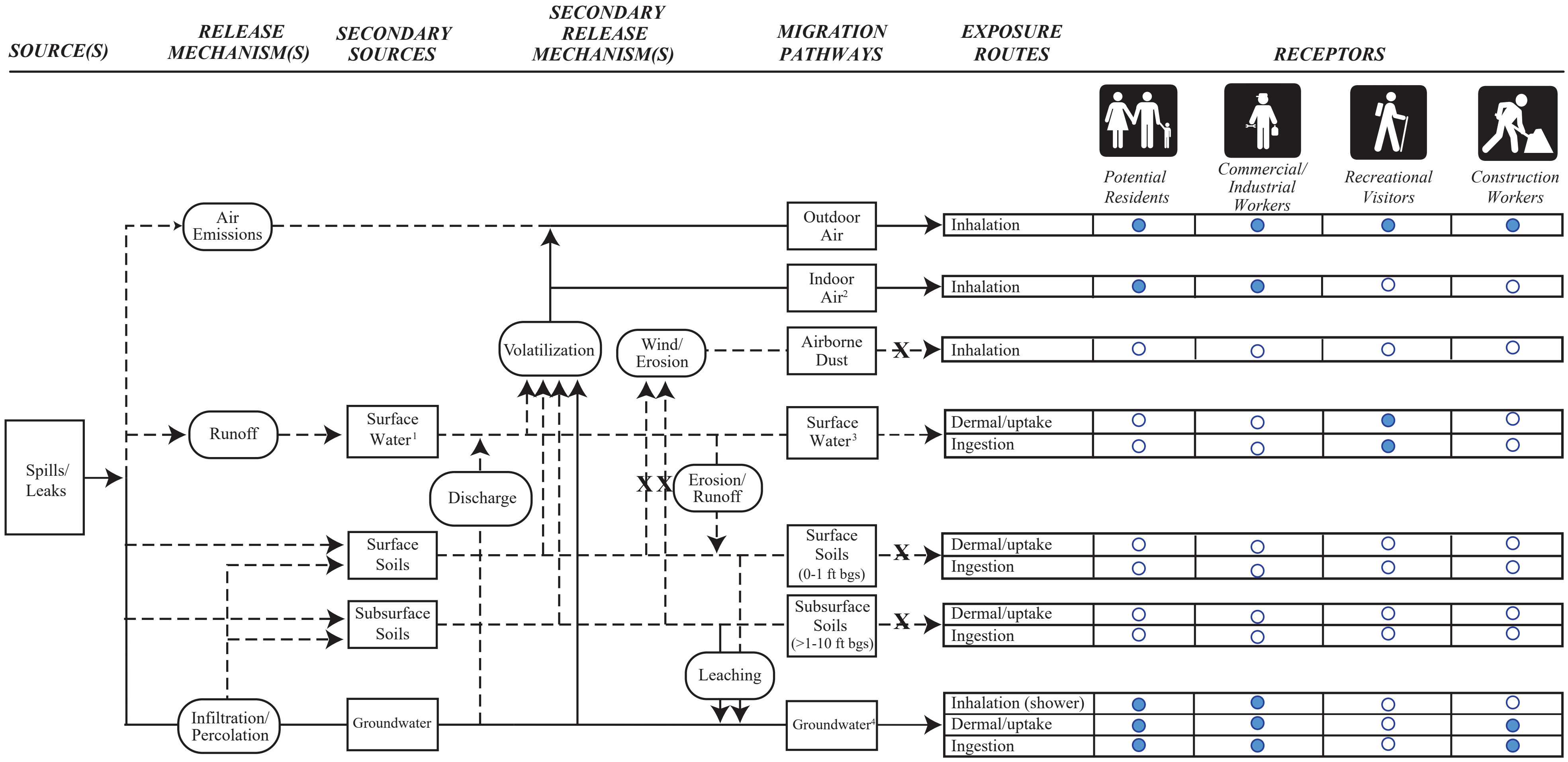
U.S. Army Corps of Engineers
Sacramento District

BT	**Injection Locations**
BT	
MR	PROJECT TYPE: HTRW
	PROJECT NUMBER: 100306.0044.110251.11000
	PROJECT: J09CA1108-01
	PAGE NUMBER:
CR	DATE: December 2024

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

Figure 3.1 - Project Organization Chart





Migration Pathways	Exposure Routes	Potential Residents	Commercial/ Industrial Workers	Recreational Visitors	Construction Workers
Outdoor Air	Inhalation	●	●	●	●
Indoor Air²	Inhalation	●	●	○	○
Airborne Dust	Inhalation	○	○	○	○
Surface Water³	Dermal/uptake	○	○	●	○
	Ingestion	○	○	●	○
Surface Soils (0-1 ft bgs)	Dermal/uptake	○	○	○	○
	Ingestion	○	○	○	○
Subsurface Soils (>1-10 ft bgs)	Dermal/uptake	○	○	○	○
	Ingestion	○	○	○	○
Groundwater⁴	Inhalation (shower)	●	●	○	○
	Dermal/uptake	●	●	○	●
	Ingestion	●	●	○	●

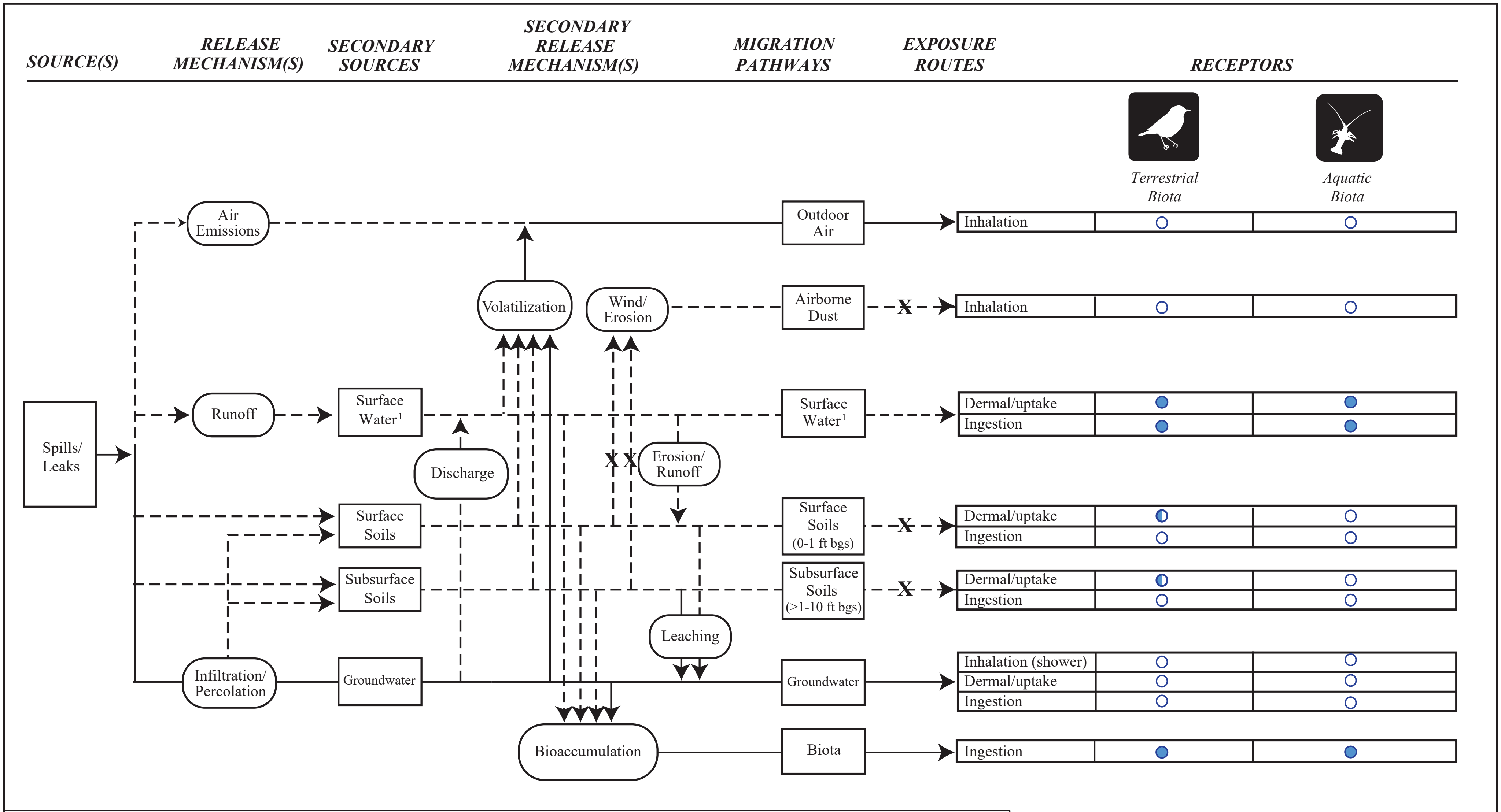
Legend

——→	Complete exposure pathway
- - - →	Potentially complete exposure pathway
- - X - →	Incomplete exposure pathway
●	Potentially complete exposure route (quantitatively evaluated, where applicable)
○	Incomplete exposure route
1	Currently, there are no residents at the Site.
2	For structures built over the groundwater plume without vapor intrusion mitigation measures
3	No perennial surface water is located on the site. Downgradient of the Site, there are ephemeral streams and ponds.
4	Shallow groundwater not currently used as a drinking water source.

Figure 10.1

Conceptual Site Exposure Model for Human Receptors

Former Titan 1-A Missile Facility
Lincoln, CA
FUDS Project No. J09CA1108-01



Migration Pathways	Exposure Routes	Terrestrial Biota	Aquatic Biota
Outdoor Air	Inhalation	○	○
Airborne Dust	Inhalation	○	○
Surface Water¹	Dermal/uptake	●	●
	Ingestion	●	●
Surface Soils (0-1 ft bgs)	Dermal/uptake	◐	○
	Ingestion	○	○
Subsurface Soils (>1-10 ft bgs)	Dermal/uptake	◐	○
	Ingestion	○	○
Groundwater	Inhalation (shower)	○	○
	Dermal/uptake	○	○
	Ingestion	○	○
Biota	Ingestion	●	●

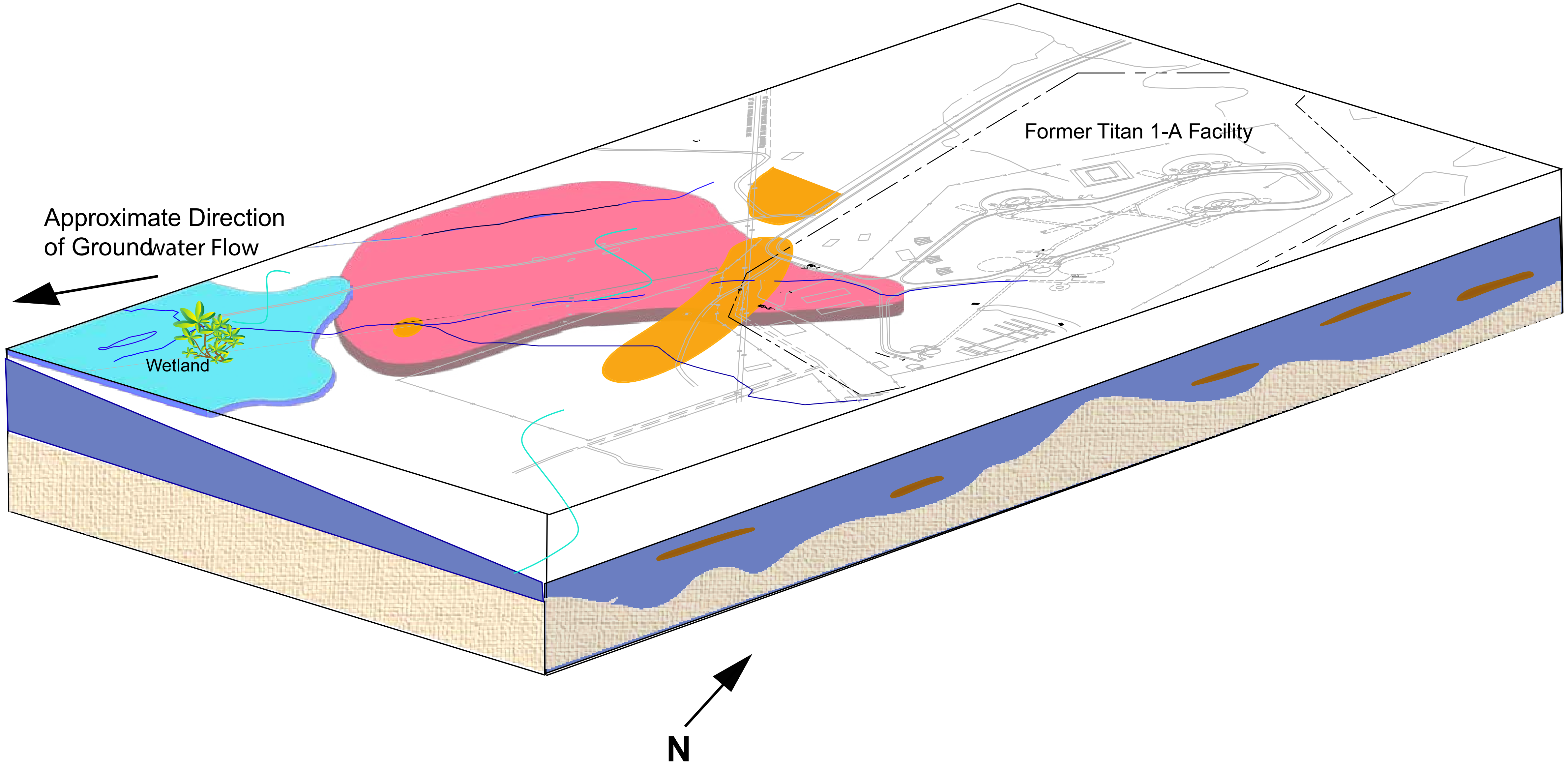
Legend

→ Complete exposure pathway
- - → Potentially complete exposure pathway
- - X - → Incomplete exposure pathway
● Potentially complete exposure route (quantitatively evaluated, were applicable)
◐ Potentially complete, but insignificant, exposure route (not evaluated)
○ Incomplete exposure route
1 No perennial surface water is located on the site. Downgradient of the trichloroethene groundwater plume, there are ephemeral streams (including Ingram Slough) and ponds with which groundwater may be in connection.

Figure 10.2

Conceptual Site Exposure Model for Ecological Receptors

Former Titan 1-A Missile Facility
Lincoln, CA
FUDS Project No. J09CA1108-01



Drawing Not To Scale

Figure 10.3

Conceptual Site Model

Legend:

🟥	Surface Representation of Groundwater Plume (TCE and daughter products)
🟧	Surface Representation of Soil Vapor Plume (TCE and daughter products)
🟦	Representation of Groundwater (thickness: 5 to 15 ft)
▨	Representation of Bedrock Topography
🟫	Representation of localized low-permeability layer

Figure source: *Ahtna. 2023g. Supplemental Remedial Investigation and Feasibility Study Report, Beale Air Force Base (AFB) Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California, FUDS Project J09CA1108-01. Draft. June.*

Site Location in California

Feet
300 150 0 300

N
W E
S

PARSONS

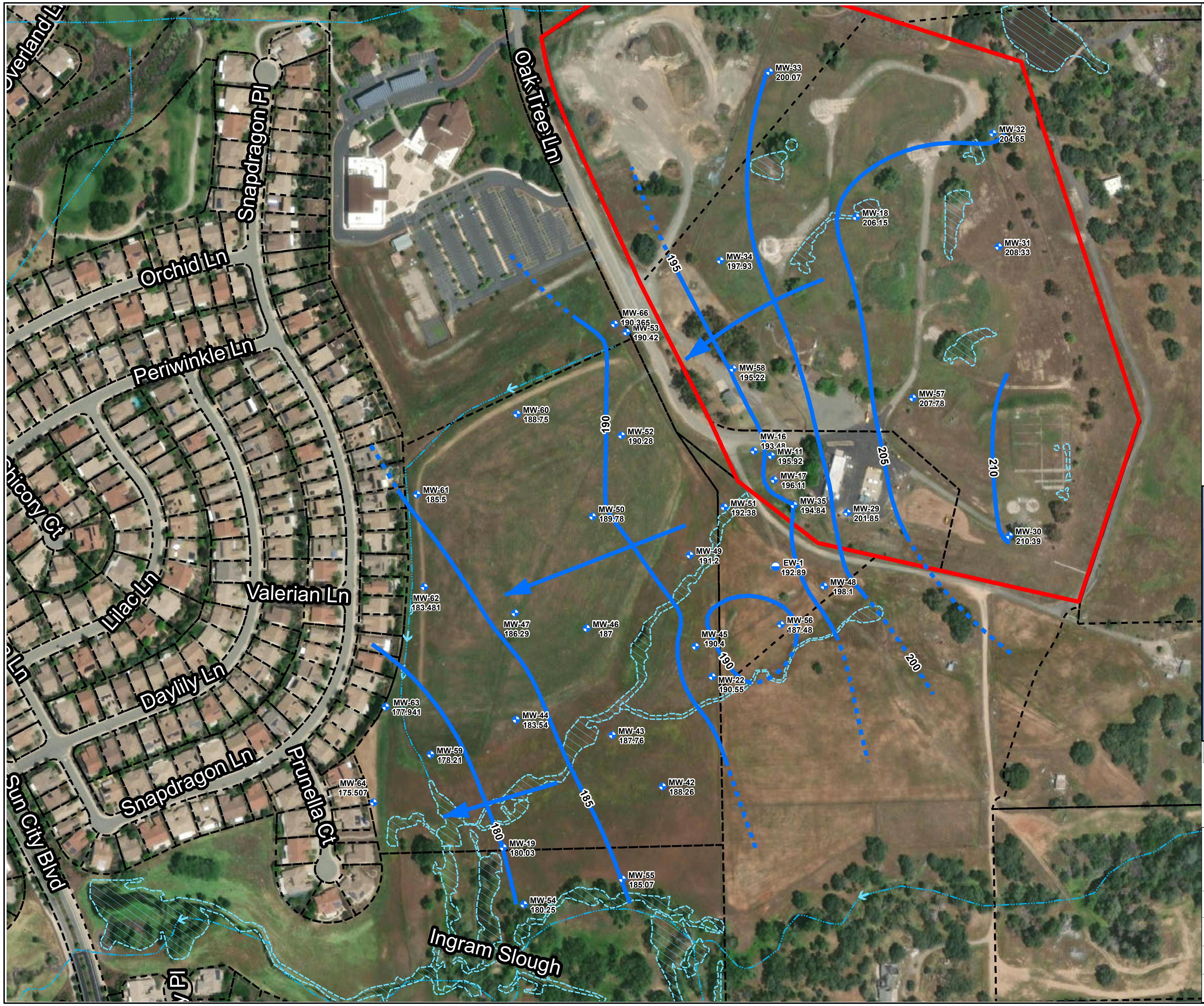
U.S. Army
Corps of Engineers
Sacramento District

Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

PROJECT TYPE: HTRW
PROJECT: J09CA1108-01
DATE: May 2024

Figure 10.4

Groundwater Elevations and Contours
1st Semi-Annual Sampling Event 2024
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108



Legend

- ◒ Extraction Well
- ⊕ Monitoring Well
- ━ Ground water Elevation Contour (feet above mean sea level), dashed where estimated
- ➔ Direction of Groundwater Flow
- ▭ Parcel Boundary
- ▨ Ephemeral/Seasonal Streams and Surface Water Bodies
- ‐·‐ Ephemeral stream
- 🟥 Former Titan 1-A Missile Facility / FUDS Boundary

Note:
Groundwater Elevations are in feet above mean sea level.
The groundwater elevation contours and groundwater flow directions are from:
1st Semi-Annual Sampling Event 2024.
Beale Air Force Base (AFB) Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California
FUDS Project J09CA1108-01.

Site Location in California

Feet
300 150 0 300

N
W E
S

PARSONS

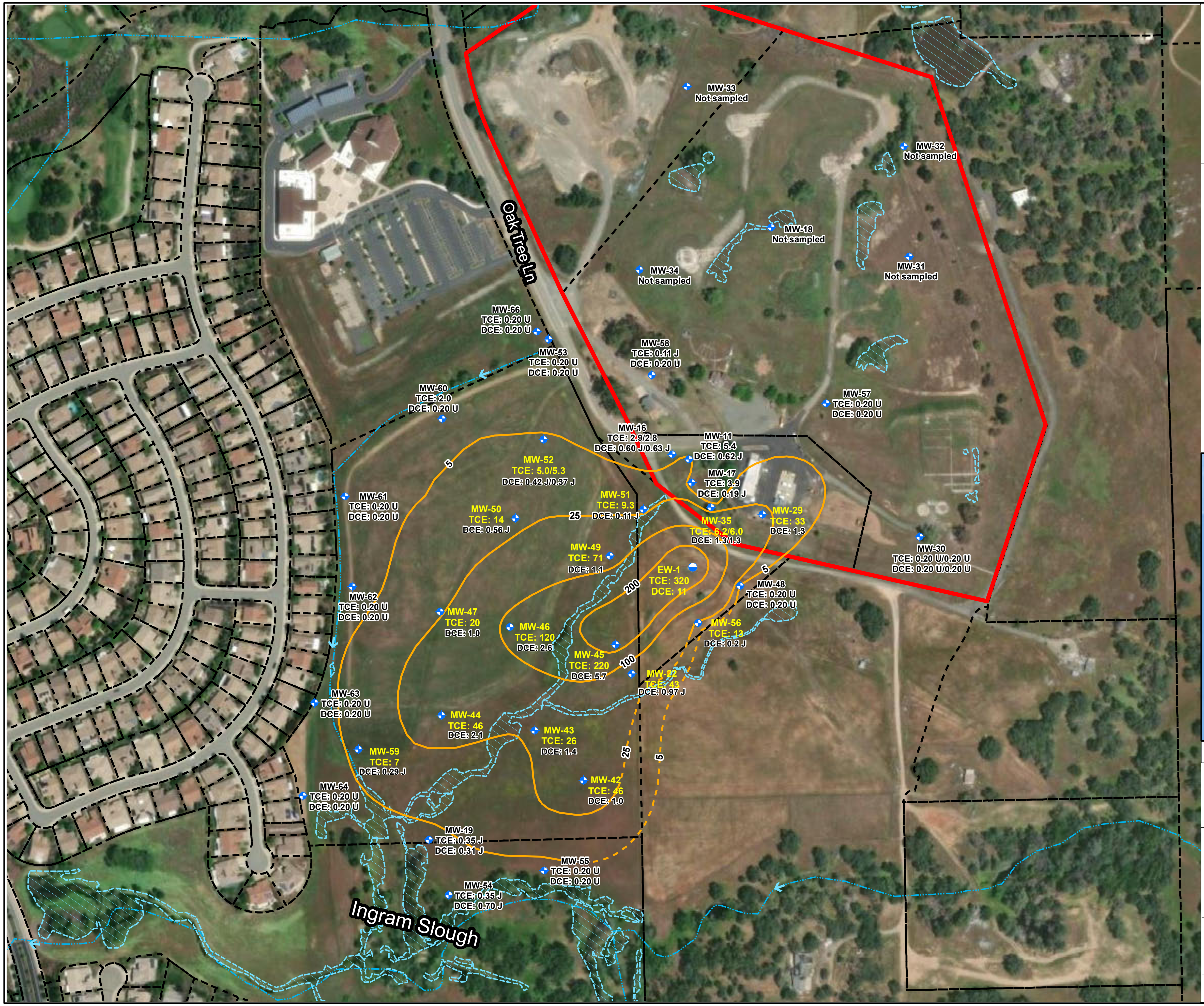
U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT	**Groundwater Elevations and Contours 1st Semi-Annual Sampling Event 2024**		
DRAWN BY: BT			
CHECKED BY: MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.01000	
SUBMITTED BY: CR	PROJECT: J09CA1108-01	PAGE NUMBER:	
	DATE: July 2024		

FILE: X:\gis\Other_sites\Maps\Titan1A\RI

Figure 10.5

Trichloroethene and cis-1,2-Dichloroethene in Groundwater, 1st Semi-Annual Sampling Event 2024
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108



Legend

- ◓ Extraction well
- ⌖ Monitoring Well
- Trichloroethene (TCE) and cis-1,2-dichloroethene (DCE) concentrations shown below the extraction/monitoring well in µg/L. Results greater than the California Maximum Contaminant Level for TCE (5 ug/L) or cis-1-2-DCE (6 ug/L) are shown in yellow.
- ━ TCE Isoconcentration line (µg/L), dashed where inferred
- ⬚ Parcel Boundary
- ▨ Ephemeral/Seasonal Streams and Surface Water Bodies
- -·-·- Ephemeral stream

Note:
Contours are dashed where inferred.
The concentrations provided as #/# are the normal sample result followed by the field duplicate result.
J = Estimated value
U = not detected at the indicated Limit of Detection

Site Location in California

PARSONS

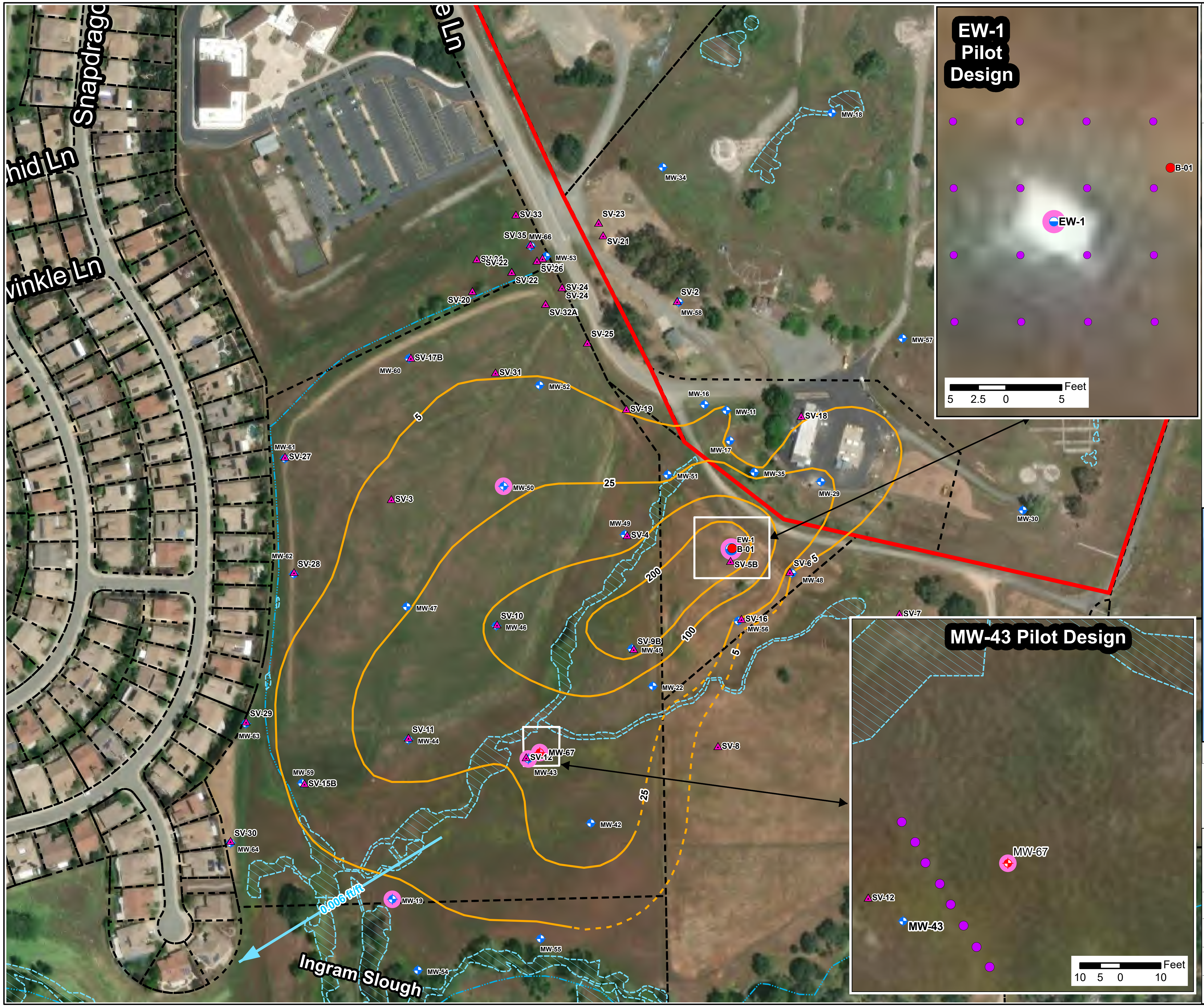
U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT	Trichloroethene and cis-1,2-Dichloroethene in Groundwater, 1st Semi-Annual Sampling Event 2024		
DRAWN BY: BT			
CHECKED BY: MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.09000	
SUBMITTED BY: CR	PROJECT: J09CA1108-01	PAGE NUMBER:	
	DATE: July 2024		

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

Figure 11.1

Injection Locations
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108



Legend

- ◒ Extraction Well
- ⊕ Monitoring Well
- → Direction of Groundwater Flow
- — TCE Isoconcentration (µg/L) Line, Dashed where Estimated
- ▭ Parcel Boundary
- ▨ Ephemeral/Seasonal Streams and Surface Water Bodies
- ┄ Ephemeral stream
- ▭ Former Titan 1-A Missile Facility / FUDS Boundary
- ● Proposed Boring
- ● Proposed Injection Location
- ⊕ Proposed Monitoring Well
- ▲ Soil Vapor Probe
- ⊕ Treatability Study Well

Note:

The concentration contours are from the first semi-annual sampling event in 2024. Contours are dashed where inferred.

The concentrations provided as #/# are the normal sample result followed by the field duplicate result.

J = Estimated value

U = not detected at the indicated Limit of Detection

Site Location in California

PARSONS	U.S. Army Corps of Engineers Sacramento District

BT	**Injection Locations**	
BT		
MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.11000
	PROJECT: J09CA1108-01	PAGE NUMBER:
CR	DATE: December 2024	

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

Figure 18.1

Sampling Route Map
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

◒	Extraction Well
◆	Monitoring Well, Existing
◆	Monitoring Well, Proposed
●	Boring, Proposed
—	Sampling Route, Dashed where Walking (no vehicles allowed)
×—	Fence
⬚	Parcel Boundary
▨	Ephemeral/Seasonal Streams and Surface Water Bodies
-·-	Ephemeral stream
×	Vehicles will use high-density polyethylene mats to cross streams/wetlands
☐	Former Titan 1-A Missile Facility / FUDS Boundary
☐	Investigation Derived Waste Storage Area

Note: *The concentration contours and groundwater flow directions are from: Ahtna. 2023. First Quarter 2023 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB) Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California, FUDS Project J09CA1108-01.*

Site Location in California

PARSONS

U.S. Army Corps of Engineers
Sacramento District

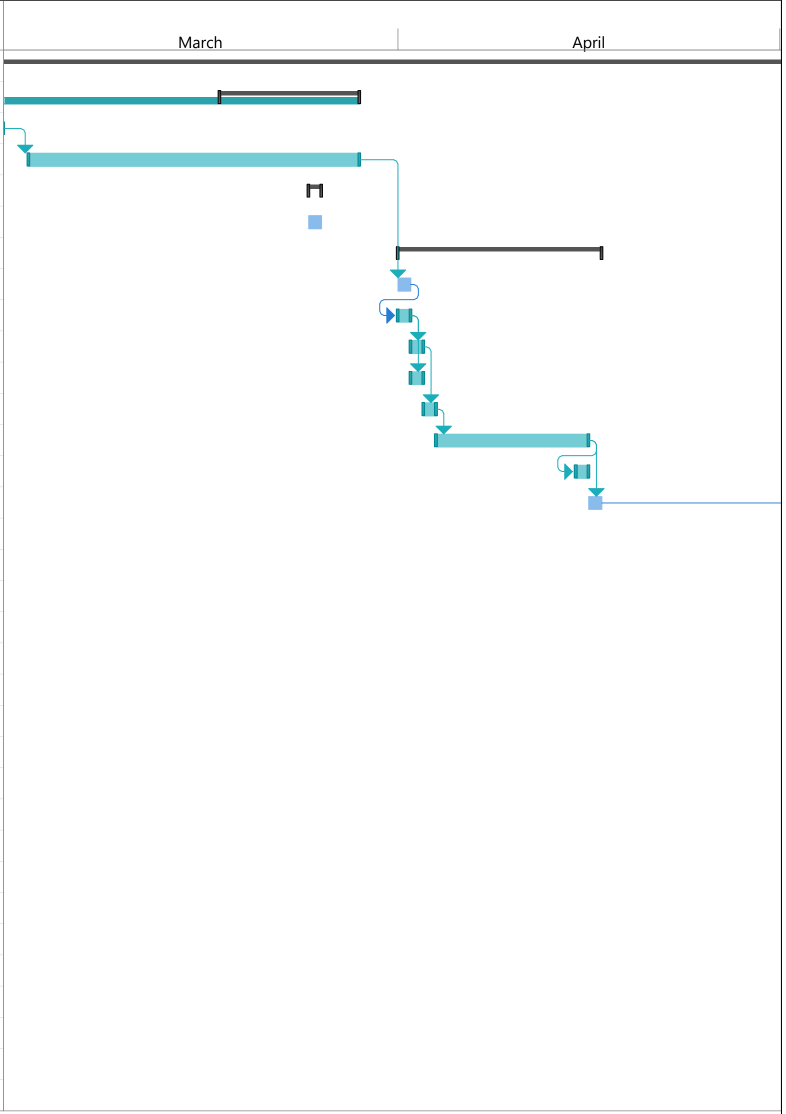
DESIGNED BY: BT	**Sampling Route Map**		
DRAWN BY: BT			
CHECKED BY: MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.09000	
SUBMITTED BY: CR	PROJECT: J09CA1108-01	PAGE NUMBER:	
	DATE: July 2024		

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

APPENDIX A – Project Schedule

Field Schedule
Titan Treatability Study

ID	Task Name	Duration	Start	Finish
1	**Titan 1A Treatability Study**	**254 days**	**Fri 2/28/25**	**Wed 2/18/26**
2	**Baseline Groundwater Sampling (EW-1, MW-43, & MW-50)**	**9 days**	**Tue 3/18/25**	**Fri 3/28/25**
3	Groundwater Sampling / Deploy PFMs	1 day	Fri 2/28/25	Fri 2/28/25
4	4wk - Deployment of PFMs	20 days	Mon 3/3/25	Fri 3/28/25
5	**Biological Nesting Bird Survey**	**1 day**	**Tue 3/25/25**	**Tue 3/25/25**
6	Biological Nesting Bird Survey	1 day	Tue 3/25/25	Tue 3/25/25
7	**Treatability Study Field Work**	**12 days**	**Tue 4/1/25**	**Wed 4/16/25**
8	Mobilize and Recover / Sample PFMs	1 day	Tue 4/1/25	Tue 4/1/25
9	Utility Clearance / Vegetation Clearance	1 day	Tue 4/1/25	Tue 4/1/25
10	Groundwater Monitoring Well Installation (MW-67)	1 day	Wed 4/2/25	Wed 4/2/25
11	Soil Boring and sampling (B-01)	1 day	Wed 4/2/25	Wed 4/2/25
12	Develop and Sample Monitoring Well (MW-67)	1 day	Thu 4/3/25	Thu 4/3/25
13	Amendment Injections	8 days	Fri 4/4/25	Tue 4/15/25
14	Survey	1 day	Tue 4/15/25	Tue 4/15/25
15	Demobilize	1 day	Wed 4/16/25	Wed 4/16/25
16	**Performance Groundwater Monitoring**	**200 days**	**Thu 5/15/25**	**Wed 2/18/26**
17	1st Quarterly GW Sampling	5 days	Thu 5/15/25	Wed 5/21/25
18	2nd Quarterly GW Sampling	5 days	Thu 8/14/25	Wed 8/20/25
19	3rd Quarterly GW Sampling	5 days	Thu 11/13/25	Wed 11/19/25
20	4th Quarterly GW Sampling	5 days	Thu 2/12/26	Wed 2/18/26
21	**Treatability Study Report**	**179 days**	**Tue 6/10/25**	**Fri 2/13/26**
22	Draft Treatability Study Report	22 days	Thu 6/26/25	Fri 7/25/25
23	PDT Review	15 days	Tue 7/29/25	Mon 8/18/25
24	Resolution of PDT Comments	10 days	Wed 8/20/25	Tue 9/2/25
25	PDT Backcheck Review	10 days	Thu 9/4/25	Wed 9/17/25
26	Draft 2 Treatability Study Report	5 days	Fri 9/19/25	Thu 9/25/25
27	EM-CX Review	15 days	Mon 9/29/25	Fri 10/17/25
28	Resolution of EM-CX Comments	10 days	Tue 10/21/25	Mon 11/3/25
29	EM-CX Backcheck Review	10 days	Wed 11/5/25	Tue 11/18/25
30	Draft Final Treatability Study Report	5 days	Thu 11/20/25	Wed 11/26/25
31	Government and Regulator/Property Owner Review	22 days	Fri 11/28/25	Mon 12/29/25
32	Resolution of Government and Regulator/Property Owner Comments	10 days	Wed 12/31/25	Tue 1/13/26
33	Government and Regulator/Property Owner Backcheck	15 days	Thu 1/15/26	Wed 2/4/26
34	Final Treatability Study Report	6 days	Fri 2/6/26	Fri 2/13/26



Project: Titan Treatability Study
Date: Thu 2/20/25

Task		Inactive Task		Manual Summary Rollup		External Milestone	◇
Split		Inactive Milestone	◇	Manual Summary		Deadline	⬇
Milestone	◆	Inactive Summary		Start-only	[	Progress	
Summary		Manual Task		Finish-only	]	Manual Progress	
Project Summary		Duration-only		External Tasks			

APPENDIX B – Waste Management Plan

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B.3 Waste Soil ... B-2
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Figure B.1 Investigation Derived Waste Storage Area ... B-7

ATTACHMENT B.1 UFP-QAPP Worksheets 15, 19, and 20
ATTACHMENT B.2 Waste Tracking Log
ATTACHMENT B.3 Waste Transportation and Disposal Log

B.1 INTRODUCTION

This Waste Management Plan (WMP) has been developed for the management of wastes generated during semi-annual groundwater and soil vapor sampling at the Former Titan 1-A Missile Facility Used Defense Site (FUDS) property located in Lincoln, California. Expected waste streams requiring disposal generated during this project could potentially include, but are not limited to, the following:

- Waste Soil;
- Purge Water;
- Personal Protective Equipment (PPE), Used Sampling Equipment, and Related Waste;
- Decontamination Water.

The waste streams listed above are all considered investigation-derived waste (IDW), and waste disposal operations will be conducted in accordance with this WMP.

B.2 APPLICABLE FEDERAL AND STATE OF CALIFORNIA WASTE CODES

Hazardous waste regulations are specified in the 40 Code of Federal Regulations (CFR) Part 261. Hazardous waste is any solid waste that either exhibits any of the characteristics of hazardous waste or is a listed United States Environmental Protection Agency (USEPA) waste. D-listed wastes are wastes that exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity (D001 through D043). F-listed wastes are hazardous wastes from non-specific sources (F001 through F039). K-listed wastes are hazardous wastes from specific sources (K001 through K151). P-listed wastes are acute hazardous wastes (P001 through P123) and U-listed wastes are toxic wastes (U001 through U359).

The California hazardous waste laws, regulations, and policies can be found at the California Department of Toxic Substances Control website at: https://dtsc.ca.gov/dtsc-laws-regulations/.

Prior to shipping HTRW waste, the USEPA Region 9 Off-Site Contact will be consulted to ensure that a waste disposal facility is selected that complies with the CERCLA off-site rule; i.e., 40 CFR 300.440(b)(1) and ER 200-3-1 Section 4-9.3. The current USEPA Region 9 Off-Site Contact is Jennifer MacArthur (macarthur.jennifer@epa.gov); 415-972-3994).

B.3 WASTE SOIL

Waste soil will consist of soil cuttings from soil borings, which will be staged onsite in United States Department of Transportation (DOT)-approved 55-gallon drums until the results of waste profiling analysis have been received and evaluated. IDW soils may be combined in a single drum when they originate from nearby areas. Soil cuttings will be segregated and managed as suspect hazardous waste if obvious signs of contamination are observed during field activities such as visible staining, odors, or if photoionization detector (PID) volatile organic compound (VOC) readings are greater than 500 parts per million (ppm). All IDW soil drums will be labeled and managed in designated staging areas until waste profiling has been completed. Waste profiling of IDW soil will be performed in accordance with the sampling protocols detailed in worksheets #17, 18, and 20, and as follows. Each

IDW drum generated will be sampled. For drums containing soil, a composite will be made in the field that includes soil from multiple layers of the drum. The soil will be combined in a plastic ziploc-style baggie and homogenized in the field before being distributed amongst the appropriate sample containers. Soil IDW samples will be analyzed for

- total metals via USEPA Method 6010/7471
- VOCs via USEPA Method 8260

If concentrations exceed the 10 times Soluble Threshold Limit Concentration (STLC) listed in 22 California Code of Regulations (CCR) 66261.24, the sample will also be analyzed using STLC. If concentrations exceed 20 times the Toxicity Characteristic Leaching Procedure (TCLP) criterion listed in 22 CCR 66261.24, the sample will also be analyzed using TCLP.

B.4 PERSONAL PROTECTIVE EQUIPMENT, USED SAMPLING EQUIPMENT, AND RELATED SOLID WASTE

Used PPE, disposable sampling equipment and materials, and other miscellaneous solid wastes will be generated during environmental sampling activities. The solid waste will be considered as non-hazardous solid waste, packaged in clear plastic bags, and disposed of as solid waste (trash) in a municipal trash receptacle.

B.5 LIQUID WASTE

Liquid waste will consist of decontamination/rinse water and purged groundwater. Decontamination water is expected to be generated from the rinsing of soil sampling equipment. Decontamination water will be stored in USDOT-approved 55-gallon drums separate from the groundwater IDW. Waste profiling for decontamination/rinse water will be performed in accordance with the sampling protocols detailed in worksheets #17, 18, and 20 and as follows. Each IDW drum generated will be sampled. For drums containing liquid, a bailer will be used to obtain a grab sample from approximately mid-drum. The liquid from the bailer will then be decanted into appropriate sample containers. Liquid IDW samples will be analyzed for the following:

- total metals via USEPA Method 6010/7471
- VOCs via USEPA Method 8260

Groundwater IDW is expected to be generated during the purging and sampling of groundwater monitoring wells. Groundwater IDW will be stored in USDOT-approved 55-gallon drums. Containerized groundwater IDW will be held in designated staging areas at the site until waste profiling has been completed.

B.6 TRACKING OF WASTE CONTAINERS

The following tracking system will be used for each waste stream encountered. The tracking system will be administered by the site manager (SM) (or designee) and reviewed by the Site Safety and Health Officer (SSHO). Each container will be tracked from point of recovery to disposal as follows:

1. Drums will initially receive a temporary number that will change to a permanent number according to monitoring results or laboratory analysis. This system allows for a more streamlined approach to waste characterization and potential consolidation of waste into larger containers for disposal. Temporary drum numbers will be designated as "T-001," "T-002," etc. and will be tracked via an electronic spreadsheet as well as the container log shown found in **Attachment C.2** and **C.3** of this Appendix. After it is deemed necessary for a drum and/or other container to receive a permanent number, the drum will be marked accordingly. The original temporary "T-###" number will be changed to "P-###," signifying that the waste has been profiled and the drum is ready for disposal. The number will also be noted on the waste tracking log for consistency.
2. All waste will be given permanent tracking numbers. However, if a drum is profiled as non-hazardous and can be combined with another drum of similar waste stream (also non-hazardous), the final drum would use the initial drum's permanent number and the second drum's number would be deleted (and not reused).
3. Each container will be marked directly on the top and side with a unique container number. The container number will be in an alphanumeric sequence that identifies both the site waste stream and container number. Waste stream designations for the project consist of the following:
    a. Waste Soil: WS
    b. Decontamination Water: H2O Decon
    c. Purge Water: H20 Purge
    d. Other debris: OD

An example container number follows: WS-001. This designation identifies the container as containing waste soil and identified as container number 1. Containers will be sequentially numbered with no numbers reused (e.g., WS-001, H2ODECON-002, H2OPURGE-003, PPE/SW-004, OD-005, etc.).

All containers will be labeled in accordance with DOT and USEPA regulations and restrictions. Initially, all drums will be labelled with a "non-hazardous waste" label and the contents will be listed as "contents pending analysis." When the analytical results are available, a new label (as appropriate) will be affixed to the drum with the updated contents and generator information in accordance with the analytical results.

Additionally, the outside of each container will be marked on the top and sides with the following information:

1. Generation date
2. Generator name and address
3. Waste approval code
4. USEPA identification number
5. Hazardous waste label
6. Unique drum number
7. Waste profile sheet number

B.7 STORAGE

Labeled drums will be transferred from their point of generation to the on-site designated holding area located in the Skeet Club Building parking area off of Placer County Road Construction Yard (**Figure B.1**). Labeled bins/drums containing soil cuttings may be stored and secured at off-site locations (point of origin) if the property owner has approved the storage location. The bins/drums should be transported as soon as disposal has been approved by the landfill. Hazardous waste may not be stored on-site for longer than 90 days.

B.8 TRANSPORTATION

Upon receipt of analytical data and the waste approval code from the disposal facility, transport of the containers to the appropriate facility will be arranged. An approved disposal contractor will be used as a transporter, and the waste will be disposed of at an appropriate approved disposal facility. Shipments will be coordinated and scheduled when a sufficient number of containers have accrued or when a specific waste stream is exhausted. The scheduling will also account for any state mandated storage periods.

Ultimately, waste will be labeled and shipped as profiled: hazardous waste will ship via a hazardous waste manifest and non-hazardous waste will ship via a bill-of-lading or non-hazardous waste manifest. Solid waste will be disposed of as specified in Section B.4.

B.9 DISPOSAL DOCUMENTATION

All disposal documentation will be in full compliance with applicable rules and regulations, including USEPA requirements, and DOT Hazardous Material Regulations (49 CFR 100-199). “DOD (DERP/FUDS)” will be will be listed as the generator of all waste streams and will provide a person responsible for signing required paperwork. The former Titan 1-A Missile Facility address will be used as the location of waste generation. Copies of all disposal documentation paperwork will be maintained in the site filing system by the SM. Disposal documentation will be included in the final report.

B.10 WASTE PROFILE SHEET

Prior to shipment from the worksite, samples will be forwarded to a Department of Defense and California accredited analytical laboratory for the appropriate chemical analyses. A waste profile sheet will then be produced for each of the waste streams based on the resulting analytical data.

B.11 MANIFESTING

Parsons, as the shipping agent, is responsible for manifesting the waste in compliance with existing rules and regulations. Hazardous waste will be properly manifested and sent to disposal facilities using a Hazardous Waste Manifest. Non-hazardous waste will be shipped via a bill of lading and/or a non-hazardous waste manifest. These forms will be provided by the waste shipment and disposal contractor. Draft and/or digital copies of waste documentation will be provided at least 48 hours before waste pick-up to allow Parsons to review for accuracy and compliance with regulations. Parsons will forward the final document, ready for signature, to the appropriate representative for signature. All waste documents, manifests or bills-of-lading will be signed by a representative from U.S. Army Corps of Engineers, Sacramento District (CESPK).

If waste is determined to be hazardous during profiling, an EPA identification (ID) number specific to this site, will be obtained. The EPA ID number is only necessary if waste is shipped as hazardous waste. Non-hazardous waste does not require an EPA ID number for disposal.

B.12 WEIGHT SLIPS

A signed weight slip will be furnished to the CESPK indicating the actual weight of the waste that has been shipped to the approved disposal facility.

B.13 NOTIFICATION OF WASTE SHIPPED

A notification of waste shipped form, required under the Land Ban Disposal restrictions, will be completed by the waste management subcontractor. This form will identify treatment standards required in 40 CFR 268. This form will be prepared as an addendum to the manifest.

B.14 CERTIFICATE OF DISPOSAL

A certificate of disposal indicating acceptance of materials by the disposal facility will be signed by the disposal facility representative and furnished to the CESPK within 90 working days after the disposal action has been completed. The completion of this form will be coordinated by Parsons.

Figure B.1

Investigation Derived Waste Storage Area Former Titan 1-A Missile Facility Lincoln, California FUDS Property No. J09CA1108

Legend

- 🟥 Former Titan 1-A Missile Facility / FUDS Boundary
- ▭ Investigation Derived Waste Storage Area

Site Location in California

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT

DRAWN BY: BT

CHECKED BY: MR

SUBMITTED BY: CR

Investigation Derived Waste Storage Area

PROJECT TYPE: HTRW

PROJECT NUMBER: 100306.0044.110251.09000

PROJECT: J09CA1108-01

PAGE No.

DATE: December 2023

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

ATTACHMENT B.1
UFP-QAPP Worksheets 15, 19, and 20

Table 15.1 - Reference Levels and Evaluation Table: Soil, Metals (SW6010C)

Laboratory: EMAX
Matrix: Soil
Analytical Group: Metals (SW6010C)

Analyte	Chemical Abstracts Service (CAS) Number	Units	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Antimony	7440-36-0	mg/kg	500	22 CCR 66261.24	167	10.00	3.00	1.00
Arsenic	7440-38-2	mg/kg	500	22 CCR 66261.24	167	2.00	1.00	0.50
Barium	7440-39-3	mg/kg	10,000	22 CCR 66261.24	3,333	1.00	0.50	0.20
Beryllium	7440-41-7	mg/kg	75	22 CCR 66261.24	25	0.50	0.20	0.10
Cadmium	7440-43-9	mg/kg	100	22 CCR 66261.24	33	0.50	0.20	0.10
Chromium, total	7440-47-3	mg/kg	2,500	22 CCR 66261.24	833	1.00	0.50	0.25
Cobalt	7440-48-4	mg/kg	8,000	22 CCR 66261.24	2,667	1.00	0.20	0.10
Copper	7440-50-8	mg/kg	2,500	22 CCR 66261.24	833	1.00	0.50	0.25
Lead	7439-92-1	mg/kg	1,000	22 CCR 66261.24	333	2.00	1.00	0.50
Molybdenum	7439-98-7	mg/kg	3,500	22 CCR 66261.24	1,167	1.00	0.50	0.25
Nickel	7440-02-0	mg/kg	2,000	22 CCR 66261.24	667	1.00	0.50	0.25
Selenium	7782-49-2	mg/kg	100	22 CCR 66261.24	33	2.00	1.00	0.50
Silver	7440-22-4	mg/kg	500	22 CCR 66261.24	167	1.00	0.20	0.10
Thallium	7440-28-0	mg/kg	700	22 CCR 66261.24	233	1.00	0.50	0.25
Vanadium	7440-62-2	mg/kg	2,400	22 CCR 66261.24	800	0.50	0.20	0.10
Zinc	7440-66-6	mg/kg	5,000	22 CCR 66261.24	1,667	10.00	5.00	2.00

Notes:

1 - the PSL is the California Total Threshold Limit Concentration from 22 CCR 66261.24.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

CCR - California Code of Regulations
PSL - Project Screening Level

Table 15.2 - Reference Levels and Evaluation Table: IDW, TCLP Metals (SW1311/SW6010C) and STLC Metals (STLC/SW6010C)

Laboratory: EMAX
Matrix: IDW
Analytical Group: TCLP Metals (SW1311 / SW6010C)

Analyte	CAS Number	Units	PSL	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Arsenic (As)	7440-36-0	mg/L	5.0	40 CFR 261.24	1.7	4.0	2.0	1.0
Barium (Ba)	7440-39-3	mg/L	100	40 CFR 261.24	33	1.0	0.20	0.10
Cadmium (Cd)	7440-43-9	mg/L	1.0	40 CFR 261.24	0.33	1.0	0.50	0.25
Chromium (Cr)	7440-47-3	mg/L	5.0	40 CFR 261.24	1.67	1.0	0.50	0.20
Lead (Pb)	7439-92-1	mg/L	5.0	40 CFR 261.24	1.67	1.0	0.50	0.25
Selenium (Se)	7782-49-2	mg/L	1.0	40 CFR 261.24	0.33	2.0	1.0	0.5
Silver (Ag)	7440-22-4	mg/L	5.0	40 CFR 261.24	1.67	1.0	0.5	0.20

Laboratory: EMAX
Matrix: IDW
Analytical Group: STLC Metals (STLC[1] / SW6010C)

Analyte	CAS Number	Units	PSL	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Antimony	7440-36-0	mg/L	15	22 CCR 66261.24	5.0	10.0	3.0	1.5
Arsenic	7440-38-2	mg/L	5.0	22 CCR 66261.24	1.7	4.0	2.0	1.0
Barium	7440-39-3	mg/L	100	22 CCR 66261.24	33	1.0	0.20	0.10
Beryllium	7440-41-7	mg/L	0.75	22 CCR 66261.24	0.25	1.0	0.20	0.10
Cadmium	7440-43-9	mg/L	1.0	22 CCR 66261.24	0.33	1.0	0.50	0.25
Chromium	7440-47-3	mg/L	5.0	22 CCR 66261.24	1.7	1.0	0.50	0.20
Cobalt	7440-48-4	mg/L	80	22 CCR 66261.24	27	1.0	0.20	0.10
Copper	7440-50-8	mg/L	25	22 CCR 66261.24	8.3	1.0	0.50	0.25
Lead	7439-92-1	mg/L	5.0	22 CCR 66261.24	1.7	1.0	0.50	0.25
Molybdenum	7439-98-7	mg/L	350	22 CCR 66261.24	117	1.0	0.50	0.20
Nickel	7440-02-0	mg/L	20	22 CCR 66261.24	6.7	1.0	0.50	0.20
Selenium	7782-49-2	mg/L	1.0	22 CCR 66261.24	0.33	2.0	1.0	0.50
Silver	7440-22-4	mg/L	5.0	22 CCR 66261.24	1.7	1.0	0.50	0.20
Thallium	7440-28-0	mg/L	7.0	22 CCR 66261.24	2.3	2.0	1.0	0.5
Vanadium	7440-62-2	mg/L	24	22 CCR 66261.24	8.0	1.0	0.20	0.10
Zinc	7440-66-6	mg/L	250	22 CCR 66261.24	83	5.0	2.0	1.0

Notes:

1 - Soluble Threshold Limit Concentration (STLC) method reference: California Title 22 Guidelines (STLC) Chapter 11, Article 5, Appendix II. December 9, 2005.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

CCR - California Code of Regulations

PSL - Project Screening Level

Table 15.3 - Reference Levels and Evaluation Table: Soil, Mercury (SW7471B)

Laboratory: EMAX

Matrix: Soil

Analytical Group: Mercury (SW7471B)

Analyte	CAS Number	Units	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Mercury (Hg)	7439-97-6	mg/kg	20	22 CCR 66261.24	6.7	0.10	0.067	0.033

Notes:

1 - the PSL is the California Total Threshold Limit Concentration from 22 CCR 66261.24.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

CCR - California Code of Regulations

PSL - Project Screening Level

Table 15.4 - Reference Levels and Evaluation Table: IDW, TCLP Mercury (SW1311/SW7470A) and STLC Mercury (STLC/SW7470A)

Laboratory: EMAX
Matrix: Water
Analytical Group: TCLP Mercury (SW1311/SW7470A)

Analyte	CAS Number	Units	PSL	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Mercury (Hg)	7439-97-6	mg/L	0.2	40 CFR 261.24	0.067	0.050	0.020	0.010

Laboratory: EMAX
Matrix: IDW
Analytical Group: STLC Metals (STLC[1] / SW7470A)

Analyte	CAS Number	Units	PSL	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
Mercury (Hg)	7439-97-6	mg/L	0.2	22 CCR 66261.24	0.067	0.050	0.020	0.010

Notes:

1 - Soluble Threshold Limit Concentration (STLC) method reference: California Title 22 Guidelines (STLC) Chapter 11, Article 5, Appendix II. December 9, 2005.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects will be reported to the LOD; detections will be reported to the DL.

Definitions:

PSL - Project Screening Level

Table 15.5 - Reference Levels and Evaluation Table: Soil, Low-level VOCs (SW8260C)

Laboratory: EMAX

Matrix: Soil

Analytical Group: Low-level (Sodium Bisulfate) Volatile Organic Compounds (SW8260C)

Analyte	CAS Number	Units	PSL[1]	PSL Reference	Project Quantitation Limit Goal[2]	Laboratory-Specific[3]		
						LOQ	LOD	DL
1,1-Dichloroethene	75-35-4	mg/kg	14	40 CFR 261.24	4.7	1.0	0.2	0.1
1,2-Dichloroethane	107-06-2	mg/kg	10	40 CFR 261.24	3.3	1.0	0.2	0.1
1,4-Dichlorobenzene	106-46-7	mg/kg	150	40 CFR 261.24	50	1.0	0.2	0.1
Benzene	71-43-2	mg/kg	10	40 CFR 261.24	3.3	1.0	0.2	0.1
Carbon tetrachloride	56-23-5	mg/kg	10	40 CFR 261.24	3.3	1.0	0.2	0.1
Chlorobenzene	108-90-7	mg/kg	2,000	40 CFR 261.24	667	1.0	0.2	0.1
Chloroform	67-66-3	mg/kg	120	40 CFR 261.24	40	1.0	0.2	0.1
2-Butanone (MEK)	78-93-3	mg/kg	4,000	40 CFR 261.24	1,333	20	10	5
Tetrachloroethene	127-18-4	mg/kg	14	40 CFR 261.24	4.7	1.0	0.3	0.15
Trichloroethene	79-01-6	mg/kg	2,040	22 CCR 66261.24	680	0.0050	0.0010	0.0005
Vinyl chloride	75-01-4	mg/kg	4.0	40 CFR 261.24	1.3	1.0	0.3	0.11

Notes:

1 - the PSL is the California Total Threshold Limit Concentration from 22 CCR 66261.24 or the Toxicity Characteristic Leaching Procedure in 40 CFR 261.24 multiplied by a dilution factor of 20 if there is no Total Threshold Limity Concentration.

2 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

3 - Non-detects (< DL) will be reported to the LOD.

Definitions:

CCR - California Code of Regulations
PSL - Project Screening Level
CFR - Code of Federal Regulations

Table 15.6 - Reference Levels and Evaluation Table: IDW, TCLP VOCs (SW1311/SW8260C) and STLC VOCs (STLC/SW8260C)

Laboratory: EMAX

Matrix: IDW

Analytical Group: TCLP Volatile Organic Compounds (SW1311 / SW8260C)

Analyte	CAS Number	Units	PSL	PSL Reference	Project Quantitation Limit Goal[1]	Laboratory-Specific[2]		
						LOQ	LOD	DL
1,1-Dichloroethene	75-35-4	µg/L	700	40 CFR 261.24	233	1.0	0.2	0.1
1,2-Dichloroethane	107-06-2	µg/L	500	40 CFR 261.24	167	1.0	0.2	0.1
1,4-Dichlorobenzene	106-46-7	µg/L	7,500	40 CFR 261.24	2,500	1.0	0.2	0.1
Benzene	71-43-2	µg/L	500	40 CFR 261.24	167	1.0	0.2	0.1
Carbon tetrachloride	56-23-5	µg/L	500	40 CFR 261.24	167	1.0	0.2	0.1
Chlorobenzene	108-90-7	µg/L	100,000	40 CFR 261.24	33,333	1.0	0.2	0.1
Chloroform	67-66-3	µg/L	6,000	40 CFR 261.24	2,000	1.0	0.2	0.1
2-Butanone (MEK)	78-93-3	µg/L	200,000	40 CFR 261.24	66,667	20	10	5
Tetrachloroethene	127-18-4	µg/L	700	40 CFR 261.24	233	1.0	0.3	0.15
Trichloroethene	79-01-6	µg/L	500	40 CFR 261.24	167	1.0	0.2	0.1
Vinyl chloride	75-01-4	µg/L	200	40 CFR 261.24	67	1.0	0.3	0.11

Notes:

1 - The Project Quantitation Limit Goal is 1/3 of the PSL. If the resulting value is below the laboratory LOD, the LOD will be used as the de facto Project Quantitation Limit Goal.

2 - Non-detects will be reported to the LOD; detections will be reported to the DL.

Definitions:

CFR - Code of Federal Regulations

PSL - Project Screening Level

Worksheets #19: Sample Containers, Preservation, and Hold Times

Tables 19.1 - Sample Containers, Preservation, and Hold Times: SW6010C, SW6020A

Laboratory: EMAX

Analytical Method: SW6010C, SW7470A, SW7471B

Matrix	Analytical Group	Analytical Method	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
IDW Soil	TTLC Metals	Preparation Method: SW3050 Analysis Method: SW6010C	2 x 8oz wide-mouth jar with Teflon lined screw cap	200 g	None	180 days
IDW Soil	TCLP Metals	Preparation Method: SW1311, SW3010A Analysis Method: SW6010C	Use TTLC IDW soil container	200 g	None	180 days
IDW Soil	STLC Metals	Preparation Method: STLC, SW3010A Analysis Method: SW6010C	Use TTLC IDW soil container	200 g	None	180 days
IDW Water	Metals	Preparation Method: SW3010A Analysis Method: SW6010C	500mL plastic	100 mL	None	180 days
IDW Soil	TTLC Mercury	Analysis Method: SW7471B	2 x 8oz wide-mouth jar with Teflon lined screw cap	100 g	Cool to ≤ 6°C	28 days
IDW Soil	TCLP Mercury	Preparation Method: SW1311 Analysis Method: SW7470A	Use TTLC IDW soil container	100 g	Cool to ≤ 6°C	28 days
IDW Soil	STLC Mercury	Preparation Method: STLC Analysis Method: SW7470A	Use TTLC IDW soil container	200 g	Cool to ≤ 6°C	28 days

Tables 19.1 - Sample Containers, Preservation, and Hold Times: SW6010C, SW6020A

Laboratory: EMAX

Analytical Method: SW6010C, SW7470A, SW7471B

Matrix	Analytical Group	Analytical Method	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
IDW Water	Mercury	Analysis Method/SOP: SW7470A	500mL plastic	50 mL	Cool to ≤ 6°C	28 days

Definitions:

IDW – Investigation-derived waste

STLC – Soluble threshold limit concentration

STLC Method reference: California Title 22 Guidelines (STLC) Chapter 11, Article 5, Appendix II. December 9, 2005.

TCLP – Toxicity characteristic leaching procedure

TTLC - Total threshold limit concentration

Tables 19.2 - Sample Containers, Preservation, and Hold Times: SW8260C

Laboratory: EMAX

Analytical Method: SW8260C

Matrix	Analytical Group	Analytical Method/ SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
IDW Soil	VOCs	Preparation Method: SW5035 Analysis Method: SW8260C	1 x 8oz wide-mouth jar with Teflon-lined screw cap	50g	Cool to ≤ 6°C	14 days /14 days
IDW Soil	TCLP VOCs	Preparation Method: SW1311, SW5030C Analysis Method: SW8260C	Use VOC IDW soil container	50g	Cool to ≤ 6°C	14 days /14 days
IDW Water	VOCs	Preparation Method: SW5030C Analysis Method: SW8260C	3 x 40mL VOA vials with septa	40mL	Cool to ≤ 6°C (NO HCl)	14 days

Definitions:

IDW – Investigation-derived waste
TCLP – Toxicity characteristic leaching procedure
VOCs – Volatile organic compounds

Worksheet #20: Field Quality Control

This worksheet summarizes the field QC samples to be collected and analyzed for the project. The table below shows the relationship between the number of field samples and associated QC samples for each combination of analyte/analytical group and matrix. Note that if additional samples are collected over the estimated number shown, additional QC samples will be collected at the rate shown below.

Table 20.1 - Field Quality Control Sampling

Matrix	Analytical Group	Method	Estimated No. of Field Samples	Field Duplicates	MS/MSD	Source Blanks[1]	Equipment Blanks[1]	Trip Blanks	Total No. of Samples to Lab
IDW Soil and Water	Metals (CAM 17)	SW6010C, SW7471B/ SW7470A	TBD	NA[2]	NA[2]	NA[2]	NA[2]	NA[2]	TBD
IDW Soil and Water	Volatiles	SW8260C	TBD						TBD
IDW Soil and Water	TCLP/STLC Metals	SW1311 / SW6010C, SW7470A	TBD						TBD
IDW Soil and Water	TCLP VOCs	SW1311 / SW8260C	TBD						TBD

Notes:

1 - Field blanks will only be collected if decontaminated equipment comes into contact with the sample matrix.

2 - No field QC samples will be collected for waste characterization samples.

CAM 17 – Antimony, arsenic, barium, beryllium, cadmium, chromium (total), cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc

Definitions:

NA – Not applicable
IDW – Investigation-derived waste
MS/MSD – Matrix spike/matrix spike duplicate
STLC – Soluble threshold limit concentration

TBD – To be determined
TCLP – Toxicity characteristic leaching procedure

STLC Method reference: California Title 22 Guidelines (STLC) Chapter 11, Article 5, Appendix II. December 9, 2005.

ATTACHMENT B.2
Waste Tracking Log

WASTE TRACKING LOG
Former Titan 1-A Missile Facility, Lincoln, CA

Waste Tracking Table Number	Number of Containers	Container Location	Temporary Container Number	Permanent Container Number	Accumulation Start Date	Close Date	Waste Description	Initial Waste Characterization				Sample Date	Sample ID	Waste Code(s)	Final Waste Characterization				Clean Harbors Waste Profile Number	90 Days from accumulation closure
								Nonhaz	Haz	Unknown	TSCA				Nonhaz	Haz	Unknown	TSCA		
Solid Waste																				

WASTE TRACKING LOG

Former Titan 1-A Missile Facility, Lincoln, CA

Waste Tracking Table Number	Number of Containers	Container Location	Temporary Container Number	Permanent Container Number	Accumulation Start Date	Close Date	Waste Description	Initial Waste Characterization				Sample Date	Sample ID	Waste Code(s)	Final Waste Characterization				Clean Harbors Waste Profile Number	90 Days from accumulation closure
								Nonhaz	Haz	Unknown	TSCA				Nonhaz	Haz	Unknown	TSCA		
Liquid Waste																				

ATTACHMENT B.3
Waste Transportation and Disposal Log

WASTE TRANSPORT AND DISPOSAL LOG

Former Titan 1-A Missile Facility, Lincoln, CA

Waste Tracking Table Number	Accumulation Start Date	Permanent Container Number	Final Waste Characterization				Waste Description	Manifest/BOL Number	Shipment Date	Waste Hauler	Disposal Facility
			Nonhaz	Haz	Unknown	TSCA					

APPENDIX C – Meeting Minutes

Former Titan 1-A Missile Facility
RI/FS/PP/ROD
Placer County, California

MONTHLY STATUS CALL MEETING MINUTES
FEBRUARY 27, 2024

Text in bold italics indicates discussion had during the meeting.

ATTENDANCE

Name	Organization	Name	Organization
Tim Crummett	USACE	Tom McManus	Parsons
Matt Marlatt	USACE	Cynthia Oppenheimer	Parsons
Kyle Bayliff	USACE	Abby Bazin	Parsons
Carrie Ross	Parsons	Tracy Craig	Craig Communications
Mark Rigby	Parsons		

REVIEW OF COMPLETED TASKS IN THE PAST MONTH

- Participated in Public Meeting #1 on January 31, 2024
- Submitted Draft Final Sampling UFP-QAPP for regulatory/property owner review on February 14, 2024
- Submitted Draft Remedial Investigation Report on February 15, 2024

ITEMS TO BE COMPLETED THIS MONTH

- Participate in Prunella Court Resident Meeting
- Prepare for RAB Meeting #1
- Receive USACE comments on Draft Remedial Investigation Report
- Prepare Treatability Study UFP-QAPP

REVIEW OF UPCOMING IMPORTANT DATES & OTHER ITEMS

Matt Marlatt mentioned that he provided comments on the RAB agenda last week. Tracy will review his comments and provide a formal response. Carrie asked whether a date was selected for the 1st RAB meeting; no date as been selected.

- Treatability Study

Abby Bazin presented an overview of the Treatability Study. She explained that the proposed approach includes source area treatment at EW-1 and perimeter barrier treatment at MW-43.

Mark Rigby asked if the barrier treatment for MW-43 will consist of a flow through or flow around barrier. Abby confirmed that a flow through barrier is proposed.

Tim Crummett explained that the treatability study should support the selection of a remedy to achieve remedy in place by 2029. Reducing the cleanup duration is a secondary goal.

Abby confirms that injections across the site would be very expensive, and that the derived alternatives for the FS will look at all technologies and costs.

Matt Marlatt noted that a perimeter remedy would need to be compatible with residential as a future land use. For example, if a PRB was installed that would need media refresh before response complete that may need to be considered in the FS, since USACE can't control land development.

Mark Rigby stated that low elevation pathways on the site maybe potential natural barriers that could help during the study.

Matt would like to discuss the approach with a biologist to confirm if mitigation measures would need to be implemented to protect wetlands near MW-43.

Mark presented a google earth map to show the area surrounding MW-43, it appears that boundary fencing has been installed near MW-43.

Mark asked if USACE GIS personnel were able to verify parcel boundaries for the site. Matt confirmed that the results were inconclusive.

Carrie explained that Parsons FED employees were migrating to .US system on Wednesday (2/29). She will be sending out a new meeting invite following the migration via Microsoft Teams.

Call ended at 11:30 PST

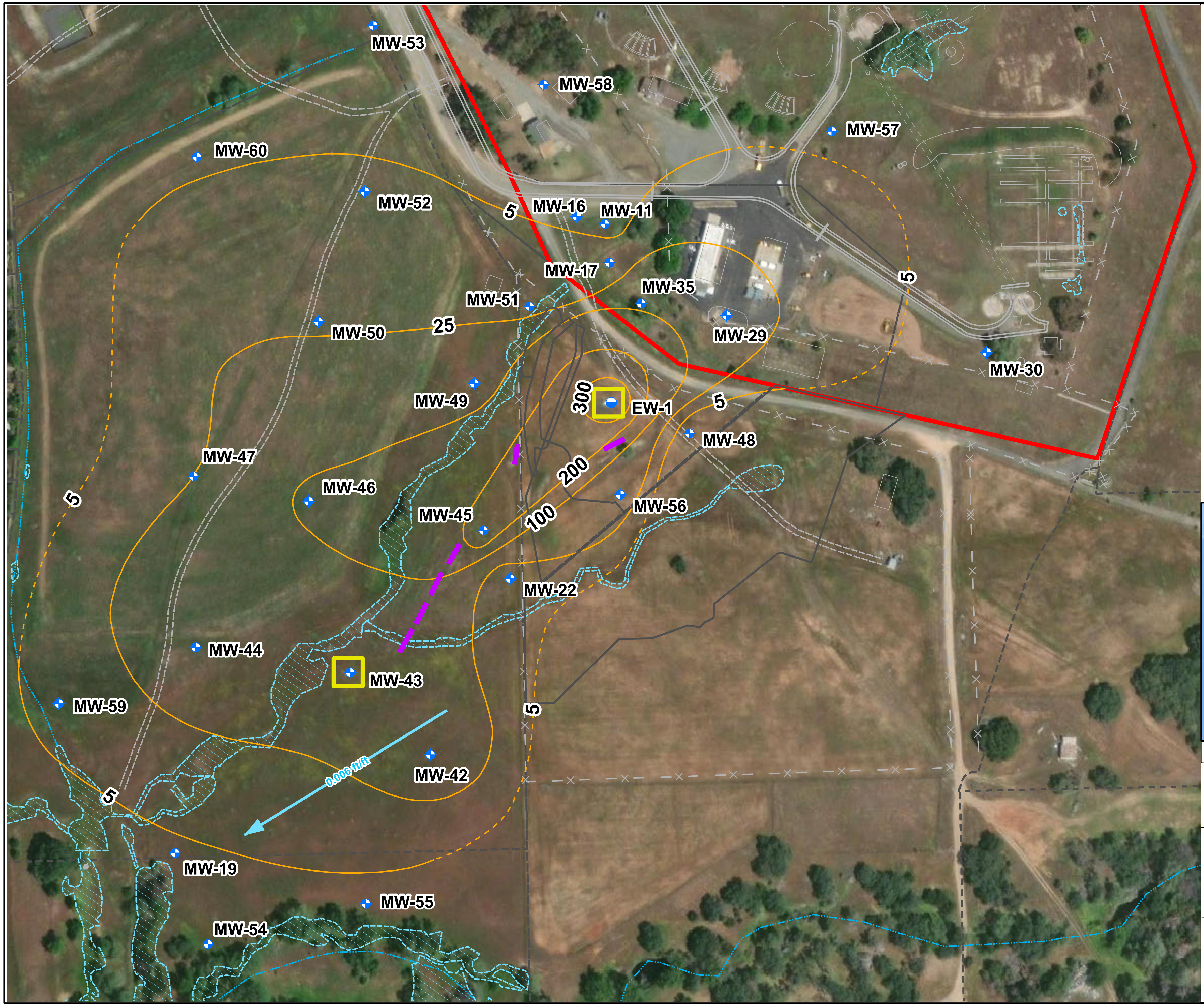

Figure x

Treatability Study
Former Titan 1-A Missile Facility
Lincoln, California
FUDS Property No. J09CA1108

Legend

- ◒ Extraction well (trichloroethene concentration shown below well in µg/L)
- ◈ Monitoring Well (trichloroethene concentration shown below well in µg/L)
- ☐ Proposed Treatability Study Areas
- → Direction of Groundwater Flow
- × — · Fence
- — TCE Isoconcentration (µg/L) Line, Dashed where Estimated
- — Groundwater Extraction Pilot Test System (Trenches)
- ☐ Planned Future Development Features
- ⬚ Parcel Boundary
- ▨ Ephemeral/Seasonal Streams and Surface Water Bodies
- -·-· Ephemeral stream

***Note**: The concentrations, concentration contours, and groundwater flow directions are from: Ahtna. 2023. First Quarter 2023 Groundwater and Soil Vapor Monitoring Report, Beale Air Force Base (AFB) Former Titan 1-A Missile Facility, Formerly Used Defense Site (FUDS), Placer County, Lincoln, California, FUDS Project J09CA1108-01.*

Site Location in California

Feet
200 100 0 200

N
W E
S

PARSONS

U.S. Army Corps of Engineers
Sacramento District

DESIGNED BY: BT	**Treatability Study**	
DRAWN BY: BT		
CHECKED BY: MR	PROJECT TYPE: HTRW	PROJECT NUMBER: 100306.0044.110251.09000
SUBMITTED BY: CR	PROJECT: J09CA1108-01 DATE: February 2024	PAGE NUMBER:

FILE: X:\gis\Other_sites\Maps\Titan1A\UFP-QAPP

APPENDIX D – Field SOPs

STANDARD OPERATING PROCEDURE

SOP-01

PERSONAL PROTECTIVE EQUIPMENT

Revision: 0

Date Effective: April 2019

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 INTRODUCTION

This personal protective equipment (PPE) SOP specifies procedures to protect personnel from safety and health hazards when performing field operations. This plan addresses U.S. Army Corps of Engineers PPE requirements contained in Section 5 of the USACE Safety and Health Requirements Manual (EM 385-1-1) and the Occupational Safety and Health Administration (OSHA) requirements as specified in 29 CFR 1910.132 (Personal Protective Equipment).

The purpose of PPE is to shield, isolate, or secure individuals from hazards that may be encountered when administrative or engineering controls are not feasible or cannot provide adequate protection.

The selection of the appropriate PPE is a complex process that takes into consideration a variety of factors. Key factors involved in this process are the identification of suspected hazards; their routes of exposure (inhalation, skin absorption, ingestion, and eye or skin contact); and the performance of the PPE materials in providing a barrier to these hazards. The anticipated levels of protection are outlined below. Compliance with the PPE selection requirements will be enforced by the SSHO.

2.0 PROTECTIVE ENSEMBLES

Descriptions of the PPE ensembles and project-specific applications are provided in the Work Plan.

3.0 DONNING AND DOFFING OF PPE

Donning of PPE will be accomplished in accordance with the manufacturer's instructions and only after an inspection of the item to ensure its operability, continuity and to be certain there are no “critters” making a home of the item. This inspection should include peering into and the shaking and slapping together of leather gloves prior to putting them on. The same procedure goes for the work boots and head protection. Be certain to conduct a visual inspection and then shake and bang the items against a hard object to dislodge any would be intruders.

Doffing of PPE is accomplished in accordance with the manufacturer's instructions and includes a complete inspection to ensure the item is free of dirt or anything else that may be clinging to it as well as an inspection for operability and continuity. Any item found to be torn, or inoperable must be replaced and the defective item either properly disposed of or repaired.

4.0 MAINTENANCE AND STORAGE OF PPE

Maintenance of PPE will only be conducted in accordance with the manufacturer's instructions and, in the instance of Level A and B, PPE, only by personnel that have received proper instruction in the maintenance of the PPE. Replacement items or parts will be those provided by the manufacturer and at no time will pieces from different brands of PPE be used to “fix” a defective piece of PPE. Any PPE used inside an Exclusion Zone (EZ), which is contaminated with HTRW or CWM shall be cleaned in accordance with the documented decontamination procedures. This cleaning will involve the use of one or more decontamination solutions and a freshwater rinse, and all re- usable PPE should be dried, or hung to dry, and stored in a clean environment, free from exposure to chemicals, dust, moisture, sunlight or extreme temperatures. Level D PPE, such as leather gloves, hard hats and safety glasses will be cleaned of dirt or anything clinging to the items that should not be there after every use.

PPE must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Many equipment failures can be directly attributed to improper storage. Storage of PPE will include storing in such a way that the natural shape of the PPE is not compromised. All PPE must be stored in such as manner as to prevent “critters” from crawling into the item and presenting a possible injury from a bite or sting. Establish a location and procedure for the proper storage of PPE. The bed of the pick-up truck or floor of the SUV are not acceptable locations for the storage of PPE.

Different types of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake. Protective clothing should be folded or hung in accordance with manufacturer's recommendations.

Reusable clothing (outer gloves, boots) must be thoroughly decontaminated before being reused if they were used on an HTRW environment.

5.0 TRAINING AND PROPER FITTING

The SSHO or other qualified person will train Parsons Employees and subcontractors in the proper use of protective equipment prior to field operations. At a minimum, the training should explain the user's responsibilities and should address the following issues, using a combination of classroom lecture and field simulation:

- OSHA and USACE PPE requirements;
- Proper use and maintenance of the selected PPE, including capabilities and limitations;
- Nature of the hazards and the consequences of not using the PPE;

- Instruction inspection, donning, doffing, decontaminating, checking, fitting, and using the selected PPE;
- User's responsibility (if any) for decontamination, cleaning, maintenance, and repair of PPE; and
- Emergency procedures and self-rescue in the event of PPE failure.

6.0 PPE PROGRAM EVALUATION

At a minimum, the PPE program should be reviewed monthly by the SSHO to evaluate the effectiveness of the following factors:

- Number of personnel-hours that are spent in various PPE ensembles;
- Degree to which the program complies with OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) and USACE requirements on PPE use, inspection, maintenance, and recordkeeping;
- Accident, injury, and illness statistics, and recorded levels of exposure;
- Adequacy of operating procedures to guide the selection of PPE; and
- Recommendations for and results of program improvement and modification.

STANDARD OPERATING PROCEDURE

SOP-02

LOW FLOW GROUNDWATER SAMPLING

Revision: 0

Date Effective: January 2022

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to define requirements for the collection of groundwater samples using low flow sampling techniques. This method dictates that pre-sample purging (the removal of standing water from a well and filter pack immediately prior to sample collection) be done at very low flow rates. This sampling method is designed to ensure that a representative sample is collected while minimizing the volume of purge water generated.

2.0 BACKGROUND

Low flow purging and sampling involves the use of a submerged pump that can be adjusted to deliver ground water to the surface at rates from less than 100 ml per minute to a maximum of 1 liter per minute. The purpose of this technique is the recovery of representative samples of the water from the soil formation adjacent to the well screen. Stagnant water above the screen and below will not usually be purged or sampled. The technique eliminates the need for collection and costly disposal of several well volumes of groundwater as investigative derived waste (IDW) from wells containing contaminated water. Typically, by using a low flow purging and sampling technique, the volume of water removed from a well will be a few liters, compared to more than 10 times this amount using the older, multiple well volume purging technique. The method looks to stabilized water quality parameters being achieved during purging rather than number of well volumes of groundwater removed.

During low flow purging and sampling the pump intake is placed within the lower depths of the screened interval and the water pumped from the well is monitored for a number of water quality parameters using a flow through cell and field instrumentation. The water level will also be monitored to ensure that draw down is kept to a minimum. Sampling commences when the measured parameters have stabilized and turbidity is at an acceptable and constant level.

3.0 RESPONSIBILITIES

The *Field Team Leader* is responsible for ensuring that the work is performed in conformance with this procedure and that the field personnel understand and perform activities in accordance with this SOP.

The *Field Geologist or Environmental Scientist* is responsible for continuous monitoring of purging and sampling activities, collecting water quality data and determining that the sampling is complete.

4.0 REQUIRED EQUIPMENT

- Submersible pump and related equipment
- Appropriate sample containers with labels and preservatives

- Cooler with ice for samples
- Water quality meters (temperature, pH, conductivity, turbidity, dissolved oxygen (DO), and oxygen reduction potential (ORP) as required by the Field Investigation Plan)
- Equipment calibration standards
- Electronic water level indicator
- Photo-ionization detector (PID), as required
- Plastic sheeting
- 5-gallon and 55-gallon drums for purge water with labels as required
- Decontamination supplies, as required
- Personal protective equipment (PPE) as specified in the Accident Prevention Plan (APP) and the associated Site Safety and Health Plan (SSHP)
- Monitoring well purge and sample log (**Appendix F**) and the field logbook

5.0 PROCEDURE

5.1 Preparation

The following steps must be followed when preparing for sample collection:

- Implement air monitoring as specified in the Field Investigation Plan and APP/SSHP.
- Don appropriate PPE as specified in the APP and the associated SSHP
- Calibrate all necessary equipment and document on an equipment calibration form.
- Arrange the required sampling equipment for convenient use. If on-site decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the wellhead. All equipment entering the well will be decontaminated prior to use.

5.2 Groundwater Sampling

The following steps should be followed when sampling groundwater with a submersible pump using low flow methods:

- Open the well and note the condition of the casing and cap. Using an electronic water level meter, determine the static water level and depth to well bottom. Top-of-casing (TOC) will be the reference point. Depth will be recorded to within ±0.01 feet. Record this information on the monitoring well purge and sample log.
- Lower the pump and piping into the well to a depth a few feet above the bottom of the well screen. Let the water column equilibrate and measure and record the static water level. This level should be used to ensure maintenance of the water level in the well as close to the static level as possible during purging and sampling. The highest discharge flow rate will be established such that the well will maintain a static water level and drawdown will be limited to 0.33 ft (< 100 to 300 ml per minute is a good target - a graduated measuring device will be used to calculate flow rate.)

- If a well is pumped dry at the lowest consistent flow rate the sampler can establish, then the well is considered properly purged, and groundwater samples will be collected when 80% of the initial well water volume is recharged.
- Plumb the flow through cell and a sampling port (ahead of the flow through cell) into the pump piping or tubing discharge line. Care should be taken to protect the discharge line and flow through cell from temperature extremes and excessive sunlight during the monitoring process. Water quality measurements will be recorded when the first water reaches the flow cell and then at regular intervals during purging (3 to 5 minutes apart). Once an initial volume of water has been removed from the well (the static water in the pump and delivery tubing and at least one flow cell volume), a consistent flow rate and static water level are achieved, and water quality measurements have stabilized groundwater samples can be collected. ASTM Practice D 6771 suggests the following criteria to define stabilization:

  pH: ± 0.2 pH units

  Conductivity: ± 3% of reading

  Dissolved Oxygen: ± 10% or reading or ± 0.2 mg/l, whichever is greater

  Eh or ORP: ± 20 mV

  Turbidity: ± 10% prior reading or ± 1.0 NTU

- Temperature, pH, conductivity, turbidity, DO, and ORP measurements will be recorded just prior to sampling. The pump will be adjusted to prevent aeration of the well water during sample collection. The flow should be no greater than 100 milliliters per minute for the VOC samples and then can be increased 1 liter per minute (if the well can yield this volume) to fill all other sample containers.
- Arrange the sample containers in the order of use and complete labels. Volatile organic compounds (VOCs) samples, if required, will be obtained first, followed in order by semi-volatile organic compounds (SVOCs) samples, and then all other samples. Sample collection will be conducted to prevent aeration. Samples collected for total dissolved solids and dissolved metals analysis will be field filtered.
- Immediately place the filled containers in the coolers(s) on ice.
- Record sample types, amounts collected, time, and date of collection in the field logbook and on the monitoring well purge and sample log (**Appendix F**). Prepare chain-of-custody and analytical request documents as required.
- One trip blank will be included in each ice chest that contains groundwater samples which are to be analyzed for VOCs. Trip blanks will be supplied by laboratory and will be analyzed only for VOCs. Other QC samples will be included as per the Field Investigation Plan.

6.0 EQUIPMENT DECONTAMINATION

Equipment decontamination will be performed following the procedures outlined in the SSHP and SOP-04.

7.0 RESTRICTIONS / LIMITATIONS

Situations that may affect the collection of representative groundwater samples include:

1. Wells that produce consistently turbid samples (i.e., greater than 50 NTU), or equivalent units depending on the method used, and
2. Wells designed improperly with little or no documentation available on well design and installation. The technical reviewer must decide whether the well ‘as built’ allows the sampler to collect representative groundwater samples.

STANDARD OPERATING PROCEDURE

SOP-03

GROUNDWATER LEVEL MEASUREMENT

Date Effective: January 2022

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 PURPOSE

The objective of this standard operating procedure (SOP) is to define the procedures and requirements used to measure water levels or total depth in a groundwater monitoring well, production well, or piezometer.

2.0 BACKGROUND

Groundwater level data can be used for several purposes during site investigations, including the following:

- To determine the magnitude of horizontal and vertical hydraulic gradients in an aquifer system
- To measure changes in groundwater levels over time
- To estimate the magnitude of surface water/groundwater interaction that occurs during various flow conditions
- To estimate aquifer properties after aquifer testing
- To calculate the purge volume of standing water in the well
- To establish whether wells have fully recharged after purging and aquifer testing

A water level meter will typically be used to measure the groundwater level and total depth in wells.

Water level meters use a battery-powered probe assembly attached to a cable marked in 0.01-foot increments. When the probe contacts the water surface, a circuit is closed, and electricity is transmitted through the cable to sound an audible and/or visual alarm. The equipment has a sensitivity adjustment switch that enables the operator to distinguish between actual and false readings caused by the presence of conductive, immiscible components (such as LNAPL floating on the groundwater) or condensation inside the well casing. Consult the manufacturer's operating manual for instructions on adjusting sensitivity.

Static groundwater level (depth to water [DTW]), depth to product (DTP), and total depth (TD) are measured relative to an established measurement reference point. The measurement reference point is generally the top of the casing (TOC), and may be marked with a surveyor's reference mark. The reference mark should be permanent, such as a small notch cut into the TOC or a permanent ink mark at the TOC. If a reference mark is not present at the time of water level measurement, use and mark the north side of the casing. Decontaminate all equipment before and after introducing it to the well as outlined in SOP-04.

3.0 RESPONSIBILITIES

The *Field Team Leader* (FTL) is responsible for determining that staff measuring water levels know the procedures in this SOP and that this SOP is implemented effectively and accurately.

4.0 REQUIRED MATERIAL/EQUIPMENT

- Power source (e.g., generator), if required
- Electronic water level indicator

5.0 PROCEDURES

5.1 Depth to Water Measurement

If the well is sealed with an airtight cap, allow time for pressure to equilibrate after the cap is removed before measuring water levels. Take measurements until consecutive readings are within 0.01 foot.

Measure DTW and DTP as follows:

1. With the water level indicator switched on, wet the tip of the probe in potable water to test whether the meter is working properly. If no audible alarm is observed, the meter is not working properly.
2. Slowly lower the water level meter or oil-water indicator probe down the monitoring well until the probe contacts the groundwater or LNAPL surface, as indicated by the audible alarm. Do not let the probe tip and tape free-fall down the well. Always hold onto the meter's reel handle.
3. Raise the probe out of the water or LNAPL until the audible alarm stops. Continue raising and lowering the probe until a precise level is determined within 0.01 foot.
4. If LNAPL is present in the well, measure and record the depth from the TOC reference point to the top surface of the LNAPL layer (that is, DTP). The oil-water indicator probe alarm will sound a continuous tone when LNAPL is detected.
5. Continue to lower the probe until the meter indicates the presence of groundwater. The alarm will typically emit a beep when water is detected. Measure the first static groundwater level and record the measurement (DTW) from the reference point to the top of the static groundwater level.
6. Record the measurements in the field logbook and groundwater sampling datasheet.

5.2 Total Depth Measurement

Use the following procedures to measure the TD of a groundwater monitoring well:

1. Slowly lower the water level meter until the cable goes slack. Do not let the probe tip and tape free-fall down the well. Always hold onto the meter’s reel handle.
2. Gently raise and lower the water level meter probe to tap the bottom of the well.
3. Record the reading on the cable at the established reference point to the nearest 0.01 foot. If there is an offset between the bottom of the probe and the water level sensor, adjust the measurement accordingly. Record the TD measurement in the field logbook or groundwater purge and sample log (**Appendix F**).

6.0 RECORDS

Document all measurements in the field notebook and/or on a groundwater sampling datasheet.

7.0 EQUIPMENT DECONTAMINATION

Equipment decontamination will be performed following the procedures outlined in the SSHP and SOP-04.

STANDARD OPERATING PROCEDURE

SOP-04

FIELD EQUIPMENT DECONTAMINATION

Revision: 0

Date Effective: January 2022

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 PURPOSE

The objective of this standard operating procedure (SOP) is to describe the requirements for decontamination of field environmental sampling equipment.

2.0 BACKGROUND

Decontamination of field equipment is necessary to ensure the quality of samples by preventing cross-contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off-site.

3.0 RESPONSIBILITY

The *Field Team Leader* is responsible for ensuring that the work is performed in conformance with this procedure and is responsible for ensuring that field personnel understand and perform activities in accordance with this SOP.

The *Field Geologist or Environmental Scientist* is responsible for oversight of decontamination activities, containerizing investigation derived waste (IDW) in accordance with the Waste Management Plan, and collecting equipment rinsate blank quality control samples if required for the project, and ensuring their preservation prior to receipt by laboratory.

4.0 EQUIPMENT

4.1 Large Equipment (e.g., Drill rigs, backhoes, drill rods and tooling, etc.)

The following equipment may be needed for cleaning/decontaminating large equipment:

- High-pressure or steam-spray unit
- 2- to 5-gallon manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Scrub brushes
- Gloves, goggles, and other PPE as specified in the Site Safety and Health Plan
- Plastic sheeting
- Metal troughs or water collection equipment

4.2 Field Sampling Equipment (reusable sampling tools, etc.)

- Plastic sheeting

- 5-gallon plastic buckets
- Phosphate-free detergent (e.g., Alconox, or Liquinox)
- Stiff-bristle brushes
- Sprayers or wash bottles, or 2- to 5-gallon manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Disposable wipes, paper towels, or clean rags
- Potable water
- Distilled water
- Disposable wipes, paper towels, or clean rags
- Gloves, goggles, and other PPE

5.0 PROCEDURES

5.1 Heavy Equipment Decontamination

Heavy equipment includes drill rigs and excavation equipment, such as backhoes. The following steps must be followed when decontaminating this equipment:

1. Set up a decontamination pad that is large enough to fully contain the equipment or parts of the equipment to be cleaned. Use one or more layers of heavy plastic sheeting to cover the ground surface. Raise the edges of the pad using wood, PVC pipes, or other material such that a berm is created to contain rinse water. Slope the pad towards one corner which will act as a sump to facilitate collection of liquids generated during decontamination.
2. Don gloves, boots, goggles, face shield, and any other personal protective equipment.
3. With heavy equipment in place, spray areas and surfaces (e.g., rear of rig, backhoe bucket, etc.) exposed to contaminated soil using a steam unit or high-pressure sprayer.
4. If phosphate-free detergent was used for the washdown step, rinse the equipment with potable water.
5. Remove equipment from the decontamination pad and allow to air dry before returning it to the work site.
6. Record equipment type, date, time, and method of decontamination in the appropriate logbook.
7. Collect rinse water as investigation derived waste (IDW) and manage in accordance with the Waste Management Plan (**Appendix C**).

5.2 Downhole Equipment Decontamination

Downhole equipment includes, drill bits, rods, casing, core barrels, etc. The following steps must be followed when decontaminating this equipment:

1. If possible, use heavy equipment decontamination pad or create a centralized decontamination area set up or metal trough to contain contaminated rinse water and minimize the spread of airborne spray.
2. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed.
3. Don gloves, boots, goggles, face shield and any other personal protective equipment.
4. Place object to be cleaned on tender truck, metal or wooden sawhorses or other supports.
5. Using a high-pressure sprayer or steam unit, spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray between and inside the drill string components. Use a brush, if necessary, to dislodge soil.
6. If using phosphate-free detergent, rinse the equipment using clean water.
7. Remove the equipment from the decontamination area and place in the clean area to air-dry.
8. If necessary, wrap clean downhole equipment in plastic or use other protective material, as feasible, to ensure that it does not become contaminated prior to next use.
9. Record the equipment type, date, time, and method of decontamination in the appropriate logbook.
10. Collect rinse water and manage as IDW in accordance with the Waste Management Plan (**Appendix C**).

5.3 Sampling Equipment Decontamination

Sampling equipment includes split spoons or other samplers, spatulas, spoons, trowels, compositing bowls, filtration equipment, and other reusable utensils or items that directly contact samples. The following steps must be followed when decontaminating this equipment:

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from contaminated to clean and end with an area for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed.
2. Don gloves, boots, goggles, and any other PPE.
3. Wash the item thoroughly in a 5-gallon bucket of phosphate-free detergent. Use a stiff-bristle brush or other cleaning tool to dislodge any soil adhered to the equipment. If

possible, disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete.

4. Rinse the item in a 5-gallon bucket of potable water. Rinse water should be replaced as needed, generally when cloudy.
5. Rinse with distilled/ deionized water.
6. If necessary, wrap clean sampling equipment in plastic or use other protective material, as feasible, to ensure that it does not become contaminated prior to next use.
7. Record the decontamination protocol and the date and time of decontamination in the field logbook.

6.0 WASTE DISPOSAL

After decontamination activities are completed, all contaminated waters, sludge, plastic sheeting (unless it will be reused at the decontamination pad), and disposable gloves, boots, and clothing will be disposed of in accordance with the Waste Management Plan (**Appendix C**).

7.0 RESTRICTIONS/LIMITATIONS

The following restrictions/limitations apply to these field equipment decontamination procedures:

- When feasible, use of disposable equipment is recommended to minimize the extent of decontamination required.
- Sensitive, non-waterproof, or other equipment that cannot be extensively decontaminated should be used in a manner that prevents contamination to the greatest possible extent (e.g., wrapping delicate instruments in plastic bags during use on-site). If decontamination is necessary despite these efforts, a damp cloth should be used to wipe any potential contaminated portions of such equipment.
- Equipment rinsate blank quality control samples will be collected in accordance with the UFP-QAPP to determine the effectiveness of field equipment decontamination. Equipment rinsate blanks will be obtained by pouring distilled/deionized water over decontaminated sampling equipment and collecting it in appropriate sampling containers for analysis, to determine if residual contamination is present. These samples will be handled, packaged, and shipped in a manner identical to that used for environmental samples.

STANDARD OPERATING PROCEDURE

SOP-05

DIRECT PUSH SOIL SAMPLING

Revision: 0

Date Effective: March 2024

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 PURPOSE

The objective of this standard operating procedure (SOP) is to describe the methods to be used for attaining and logging soil cores using direct push drilling equipment and techniques. Also outlined are the procedures for borehole abandonment, and the collection of soil samples from the borings.

2.0 BACKGROUND

The direct push method is used to acquire soil samples in formations where a standard 2-inch diameter split spoon sampler can be driven (e.g., unconsolidated clays, silts, sands, and fine gravels) at lower costs than other types of drilling. The direct push drilling method produces continuous cores that can provide lithologic detail of the subsurface strata and allow soil sampling for classification and chemical testing. In addition, soil strata profiling in shallow depths may be accomplished over large areas in less time than conventional drilling methods because of the rapid sample gathering potential of the direct push method. Direct push soil sampling has the benefits of smaller size tooling, smaller diameter boreholes, and minimal waste generation. Additionally, larger diameter direct push probes and rods allow for the installation of small diameter groundwater monitoring wells. These small diameter groundwater monitoring wells can be used as temporary wells or completed as permanent wells if appropriate. Some models of direct push drill rigs have the capability to perform hollow stem auger (HSA) drilling in addition to direct push. The soil sampling procedures described in this SOP apply equally to the direct push or direct push HSA methods.

3.0 RESPONSIBILITIES

The *Drilling Contractor* is responsible for ensuring that the drill crew is properly trained in direct push drilling techniques and soil sampling.

The *Field Team Leader* is responsible for ensuring that the work is performed in conformance with this procedure and that the field personnel understand and perform activities in accordance with this SOP.

The *Field Geologist or Environmental Scientist* is responsible for continuous monitoring of drilling activities and temporary well construction activities (if performed), logging soil encountered during advancement of the direct push probe, collecting soil samples in the manner described below, and ensuring samples are properly prepared and shipped for laboratory analysis.

4.0 EQUIPMENT

- Photo ionization detector (PID) or flame ionization detector (FID) for screening of volatiles and methane (if using an FID) in the boring,
- Sample containers, with labels and preservatives (provided by laboratory),
- Cooler and ice,
- Appropriate forms and field notebook,
- Waterproof pen and markers,
- Digital camera and Global Positioning System (GPS) unit
- American Society for Testing Materials (ASTM) Standard D 2488-00 (Modified United Soil Classification [USCS] scheme) for logging and Munsell color chart,
- Measuring tape,
- Acid bottle,
- Hand lens,
- Site map,
- Decontamination supplies, as required, and
- Personal protective equipment (PPE).

The drilling contractor is responsible for providing the required drilling equipment and related materials appropriate to site conditions, drilling depth, and other project requirements.

5.0 PROCEDURES

5.1 Preparation

The following steps must be followed when preparing for sample collection:

- Obtain the required excavation permit.
- Assemble decontamination equipment and supplies, sampling equipment, sampling containers, etc in the sampling area.
- Calibrate the PID or FID, as appropriate.
- Don appropriate PPE.

5.2 Direct Push Coring Process

- The top 6 inches of soil and/or vegetation will be set aside for replacement later.

- Soil samples will be collected continuously or at specific intervals, from the ground surface to the bottom of the boring using a Geoprobe® or similar drill rig operated by a California-licensed driller. The driller will employ a soil core sampling system of the appropriate outer diameter (OD) to collect soil samples for the specified soil boring diameter.
- The sampler will be placed directly under the hammer with the cutting shoe centered between the toes of the probe foot. Static weight and hammer percussion will be applied to advance the sampler until the drive head reaches the ground surface. This action will produce a core four to five feet long depending on the type of direct-push machine used.
- The sampler will then be pulled completely out of the ground and the sample liner will be removed from the sampler. Undisturbed soil samples can be obtained from the liner by splitting the liner either longitudinally or by segmenting the liner by cutting around its outside circumference.
- To sample consecutive soil cores, a clean sample liner will be advanced down the previously opened hole to the top of the next sampling interval. Another rod will be attached to the sampler and static weight and hammer percussion applied to advance the sampler to the desired depth. Again, the sampler will be pulled completely out of the ground and the sampler liner will be removed from the sampler.

5.2.1 Hole Abandonment

In accordance with Marin County requirements, borehole abandonment will consist of tremie grouting the borehole with a neat cement (with no more than 5% powdered bentonite) grout slurry. Depending upon the location of the boring, it will be backfilled as follows:

- Tremie grouted with neat cement from the bottom of the bore hole to within 6 inches of the ground surface.
- From the ground surface to 6 inches below ground surface, the soil core will be put back into the borehole. This will be done to preserve and any plant seed base.
- If the boring was made through asphalt or concrete, the asphalt/concrete will be patched, as appropriate.

5.3 Characterization of Soil Core

5.3.1 Measuring and Labeling Borehole Depths

Once the extraction of the plastic liners is completed, the geologist will verify with the driller the depth of the boring. The geologist will mark the bottom depth on the appropriate end of the plastic liner.

5.3.2 PID/FID Screening for VOCs

Where petroleum hydrocarbon contamination is suspected, an FID may be used in place of an PID. An FID can quantify volatile organic compounds (VOCs) just like a PID, but can also quantify methane, which may be produced by the degradation of petroleum hydrocarbons.

The onsite geologist will perform field screening of the core with a PID or FID by cutting open the disposable plastic liner to access the interior of the core. The tip of the PID or FID probe will then be slowly run the length of the partially opened liner. Additional PID or FID screening shall also be performed at any zone marked by visible discoloration or organic matter, noticeable odor, caliche cementation, and/or an abundance of silt/clay-sized particles that may control the distribution of VOCs. If readings vary considerably over the length of the core just recovered the geologist should take one or more additional measurements to further refine the distribution of organic soil vapors. These readings will be taken expeditiously and will be recorded immediately on the boring log.

5.3.3 Geologic Logging

Following VOC field screening, geologic logging will be conducted. The depths and thicknesses of distinguishable sediment/soil types (e.g., sand, silt, clay, gravel) will be recorded, as well as any other geologic features that may influence the distribution of contaminants, such as zones of caliche cementation or visible organic matter, will be described. Details concerning other parameters, including mineralogy, grain size, roundness, moisture content, stiffness or density, bedding, lamination, the Munsell color designation, etc., should also be described on the boring log.

5.3.4 Soil Sampling

Soil sampling will occur at the predetermined intervals or conditions described in the Field Investigation Plan. Sampling parameters are also outlined in the Field Investigation Plan for each planned sampling location and interval.

Samples planned for VOC analysis will be collected first. VOCs will be collected using a Terra Core™ sampler. Use of the Terra Core^{TM} sampler minimizes disturbance of the drill core and volatilization of VOCs. Three Terra Core^{TM} samples of approximately 5 grams each will be collected at discrete depths over an interval not to exceed one foot. The Terra Core^{TM} sampler consists of a capped plastic sleeve and a separate T-handle. To collect the sample, the cap is removed from the sleeve and the T-handle attached to the other end. The sleeve is then rotated or pressed into the drill core using the handle until it is completely filled with soil. It is then retracted from the drill core and capped. All three Terra Core^{TM} samplers (for one sample interval) are placed in a zip-lock bag and sealed for shipment to the laboratory.

Other sampling parameters will be sampled after the volatiles using a dedicated sampling spoon and appropriate sampling container provided by the laboratory. Sampling containers that are to be provided by the laboratory for each parameter are outlined in the UFP-QAPP.

Sampling labels will be filled out with all pertinent data for each sample location. All samples collected from the same interval should have identical information recorded. The chain of custody (COC) will be completed concurrently. Samples will be stored in a cooler with ice.

6.0 EQUIPMENT DECONTAMINATION

Drilling equipment decontamination will be performed by the drilling subcontractor following the procedures outlined in SOP-04. Field sampling equipment will also be decontaminated as outlined in SOP-04.

7.0 RESTRICTIONS/LIMITATIONS

As a general rule, the direct push method can be used in formations where a standard 2-inch diameter split spoon sampler can be driven. Suitable geologic materials include unconsolidated clays, silts, sands, and fine gravels. Care should be taken when pushing the sampling device or rod from the surface into the soil with the entire barrel unsupported. If the applied force to the unit is not in a vertical plane or an obstruction is encountered while driving the unit, the sampling device may be damaged by bending or breaking.

8.0 DOCUMENTATION

The drilling log form is intended for use in the field during drilling, sampling, and logging process for soil borings that will be drilled using the direct push technology described above.

All paperwork, including the field notebook, will be neatly and legibly recorded to clearly document the events and findings of the drilling activity. Parsons has the option to resubmit logs or a modified form in a deliverable as completely redrafted, typed, or computer-generated, and representing a combination of information applied in the field and office. The original field log or document will be retained in the permanent file. Alterations or changes between the office copy and the field original will be justified.

STANDARD OPERATING PROCEDURE

SOP-06

ORGANIC VAPOR SCREENING USING A PHOTOIONIZATION DETECTOR / FLAME IONIZATION DETECTOR

Revision: 0

Date Effective: January 2022

PARSONS

Former Titan 1-A Missile Facility,

Lincoln, California

1.0 PURPOSE

The objective of this standard operating procedure (SOP) is to describe the procedures for operating a photoionization detector (PID) or flame ionization detector (FID) for the field screening of soils containing volatile organic compounds. This SOP describes how to safely operate an PID/FID instrument and outlines the proper procedures for record keeping and use of the data generated.

2.0 RESPONSIBILITIES

The *Field Team Leader* is responsible for ensuring that the work is performed in conformance with this procedure and that the field personnel understand and perform activities in accordance with this SOP.

Field Personnel are responsible for the safe operation of the PID/FID, and for ensuring that operation conforms to this procedure.

3.0 EQUIPMENT

- Indelible black ink pens,
- Logbooks,
- PID/FID equipped with a proper lamp size (10.6 or an 11.8 eV lamp),
- PID/FID calibration equipment
- Spare batteries,
- PID/FID manual, and
- Sampling equipment, if necessary.

4.0 PROCEDURES

1. Select a PID/FID equipped with the proper lamp size the afternoon before the field work is scheduled and charge the battery overnight by plugging in the adapter. As the PIDs/FIDs have no battery gauge, failure to recharge the battery may leave you with a discharged battery and an unusable PID/FID.

2. Calibrate the PID/FID upon arrival at the site or prior to leaving the office. Record all pertinent information on the calibration record located in the case of each PID/FID and record the calibration on the Field Report form.

3. With a gloved hand, fill a dedicated sealable bag or soil jar approximately half full of soil to be screened. Refer to the site-specific sampling and analysis plan or work plan for appropriate sample container. Manually break up the soil clumps within the bag. Seal the bag or cover the opening of the soil jar with aluminum foil and screw on a lid. Use a marker to write the sample identifier and depth on the bag or jar lid.

4. Shake the sealed bag or soil jar for approximately 15 seconds, then allow the soil to volatilize for at least 10 minutes in an atmosphere of at least 70°F. On cold days it may be necessary place the bag or soil jar inside a heated room or vehicle.

5. After headspace development, shake the sample for another 15 seconds.

6. Complete organic vapor screening within approximately 20 minutes of sample collection. If using soil jars, remove the lid. Pierce the aluminum foil or plastic bag with the probe of the PID/FID. Record the highest meter response within a time period of two to five seconds.

7. Discard the soil samples on-site and dispose of used bags, soil jars, foil, and lids as trash.

5.0 RECORD KEEPING

A record of each analysis will be maintained in the field log book, and a rationale for the decision to collect the subsample from the core shall also be maintained. At a minimum, the following information needs to be recorded:

- Operator name
- Date
- Calibration check results
- Sample location
- Results
- Observations (soil moist or dry, rocky or sandy, color, etc)
- Battery charge

6.0 SAFETY EQUIPMENT

- Wear nitrile gloves to reduce the incidence of skin contact with potentially contaminated soil and to reduce the risk of cross-contamination.
- Refer to the Site Safety and Health Plan (SSHP) for other safety concerns and applicable personal protective equipment.

7.0 REFERENCES

The operating manual for the PID/FID instrument must be available to the instrument operators.

This document is intended for use with an approved work plan.

STANDARD OPERATING PROCEDURE

SOP-07

SOIL DESCRIPTION AND CLASSIFICATION SYSTEM

Revision: 1

Date Effective: April 2023

PARSONS

Former Titan 1-A Missile Facility,
Lincoln, California

Designation: D2488 – 17$^{\varepsilon 1}$

Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)[1]

This standard is issued under the fixed designation D2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

ε^1 NOTE—Editorially corrected Fig. 2 in March 2018.

1. Scope*

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D2487. The identification is based on visual examination and manual tests. It shall be clearly stated in reporting, the soil identification is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures outlined in Test Method D2487 shall be used.

1.2.2 In this practice, the identification procedures assigning a group symbol and name are limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils. Specimens used for identification may be either intact or disturbed.

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are rationalized conversions to SI units that are provided for information only and are not considered standard. The sieve designations are identified using the "alternative" system in accordance with Practice E11.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1452 Practice for Soil Exploration and Sampling by Auger Borings
D1586 Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
D1587 Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Exploration

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[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved July 15, 2017. Published August 2017. Originally approved in 1966. Last previous edition approved in 2009 as D2488 – 09a. DOI: 10.1520/D2488-17E01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)
D4427 Classification of Peat Samples by Laboratory Testing
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

3.1.2 *cobbles*—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve.

3.1.3 *boulders*—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.4 *clay*—soil passing a No. 200 (75-µm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dried. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 4 of Test Method D2487).

3.1.5 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

3.1.5.1 *coarse*—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

3.1.5.2 *fine*—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.6 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.7 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.8 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.9 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

3.1.9.1 *coarse*—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

3.1.9.2 *medium*—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

3.1.9.3 *fine*—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.10 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 4 of Test Method D2487).

3.1.11 *fine-grained soils*—soils that are made up of 50 % or more particles that will pass a No. 200 (75 µm) sieve.

3.1.12 *coarse-grained soils*—soils that are made up of more than 50 % particles that will be retained on a No. 200 (75 µm) sieve.

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D2487.

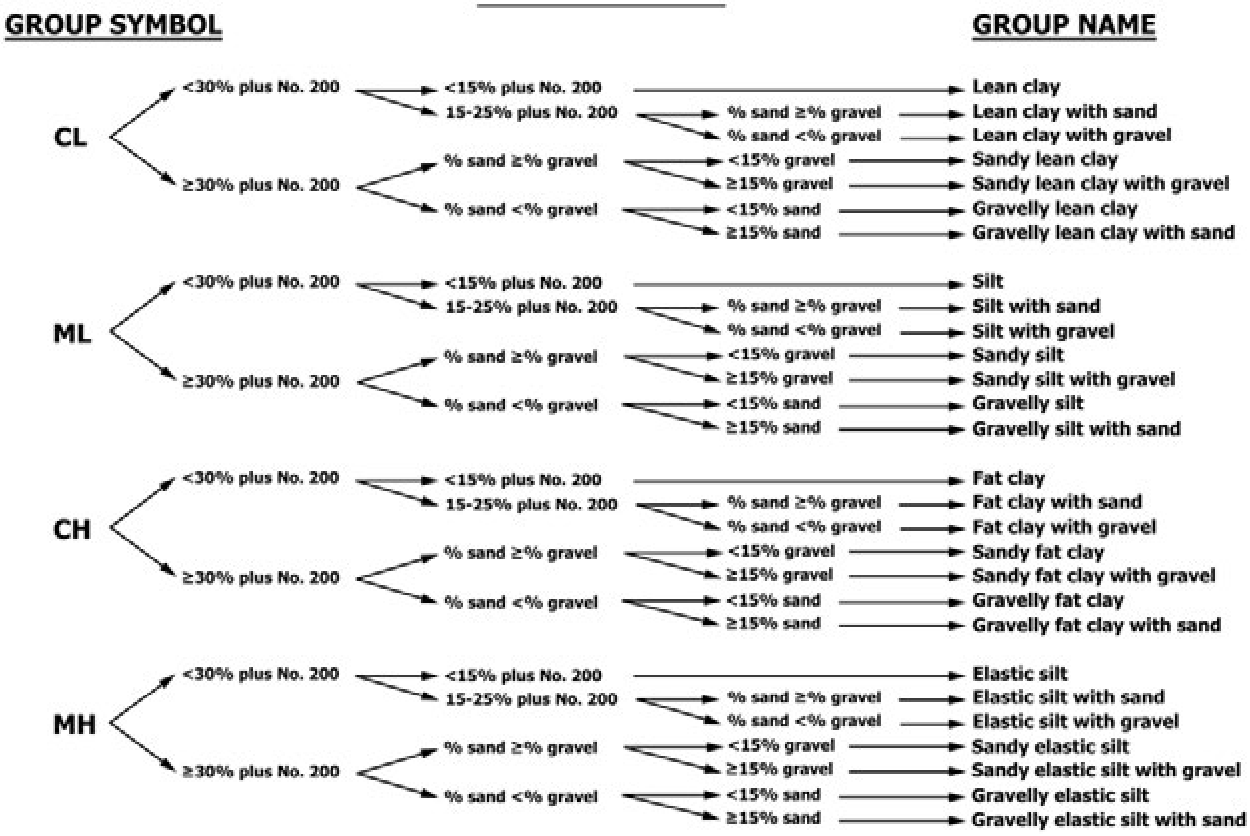
5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used for identification of soils in the field, laboratory, or any other location where soil samples are inspected and described.

5.5 This practice may be used to group similar soil samples to reduce the number of laboratory tests necessary for positive soil classification.

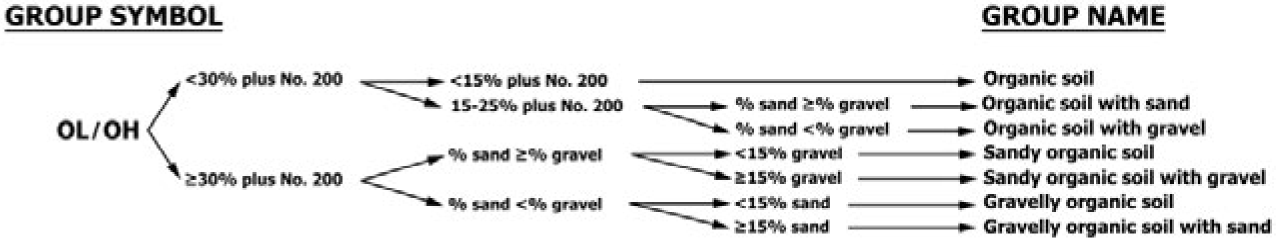
NOTE 2—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 Soil samples from a given boring, test pit or location which appear to have similar characteristics are not required to follow all of the procedures in this practice, providing at least one sample is completely described and identified. These samples may follow only the necessary procedures to determine they are "similar" and shall be labeled as such.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the closest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the closest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

5.7 This practice may be used in combination with Practice D4083 when working with frozen soils.

NOTE 3—The quality of the result produced by this standard is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Small Knife or Spatula*

6.2 *Test Tube and Stopper (optional)*

6.3 *Jar with Lid (optional)*

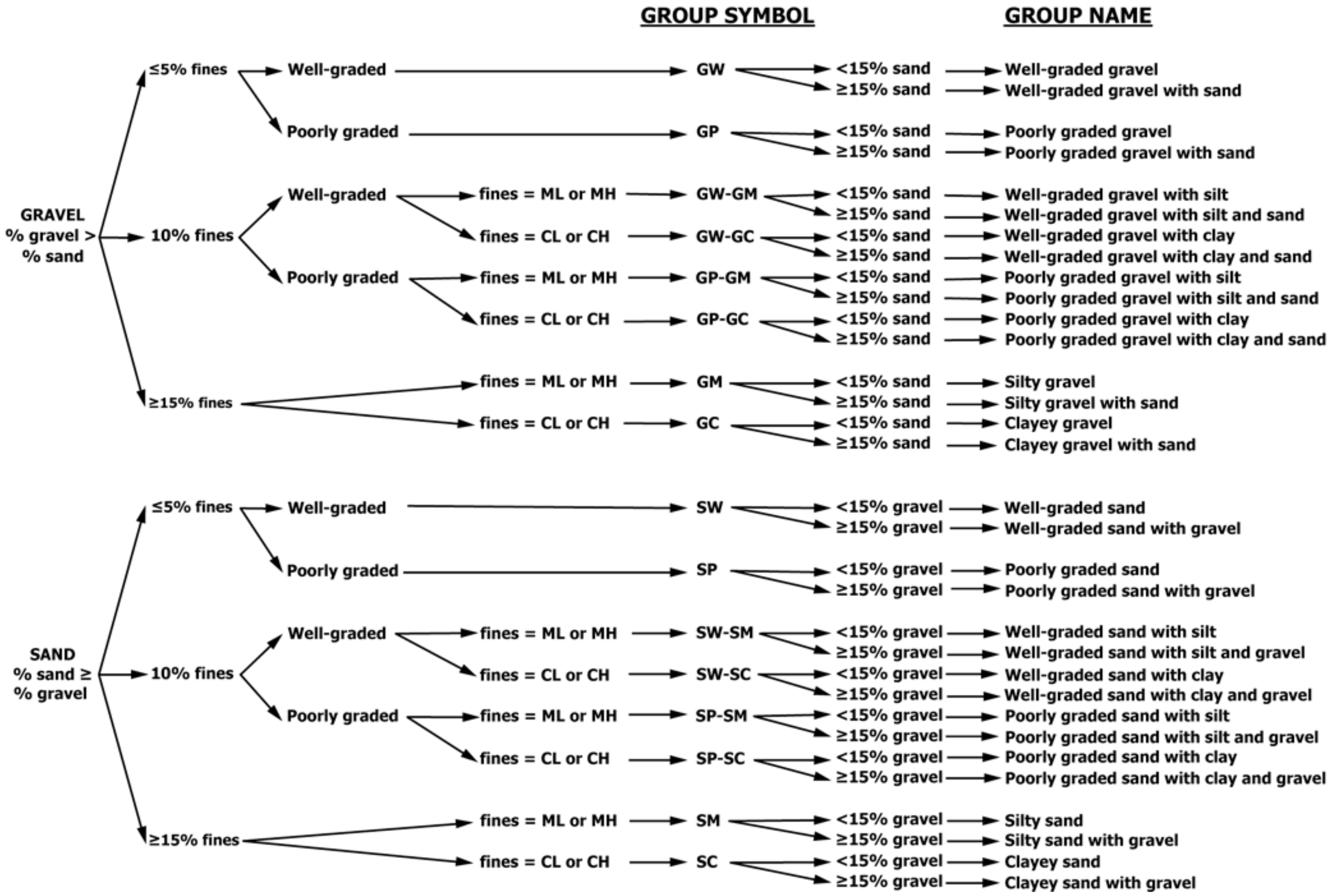
6.4 *Hand Lens (optional)*

6.5 *Shallow Pan (optional)*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid (HCl) one part HCl (10 *N*) to three parts distilled water (This reagent is optional for use with this practice). See Section 8.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the closest 5 %.

NOTE—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution, utilize personal protective equipment and store safely. If solution comes into contact with the skin or eyes, rinse thoroughly with water.

8.2 **Caution**—Acid shall be added to the water. Do not add water to the acid as this may cause an adverse reaction.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 4—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D1452, D1587, or D2113, or Test Method D1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 5—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a project number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with Table 1.

NOTE 6—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceding table.

9.4 If the sample or specimen being examined is smaller than the minimum recommended specimen size, the report shall include a remark stating as such.

TABLE 1 Minimum Specimen Dry Mass Requirements

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, by Dry Mass
No. 4 (4.75 mm)	0.25 lb (110 g)
⅜ in. (9.5 mm)	0.5 lb (220 g)
¾ in. (19.0 mm)	2.2 lb (1.0 kg)
1½ in. (38.1 mm)	18 lb (8.0 kg)
3 in. (75.0 mm)	132 lb (60.0 kg)

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 2 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 3 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual.

10.4.1 Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples.

10.4.2 If the samples are dried, the odor may often be revived by moistening the sample and slightly heating it.

10.4.3 Odors from petroleum products, chemicals or other substances shall be described.

10.4.4 Some fumes emitting from soil samples, especially of a chemical nature, may pose a health risk. Proper safety protocols which may include the use of personal protective equipment must be followed in these instances. It is the responsibility of the user to determine the extent of the health risk and the correct protocols to follow.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 4.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the criteria in Table 5. Since calcium carbonate is a common cementing agent, a comment of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 6. This observation is inappropriate for soils with significant amounts of gravel.

TABLE 2 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 7.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 8.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.5 and 3.1.9. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.9. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. will pass a 1½-in. (square opening) but not a ¾-in. (square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering the hole, caving of the trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetative tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as highly organic and shall be identified as peat, PT. Peat samples shall not be subjected to the identification procedures described hereafter. Refer to D4427 for procedures on classifying peat.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually for a loose sample, or ignored for an intact sample before classifying the soil.

(a) Rounded (b) Angular

(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

TABLE 3 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Visual estimates will be based on the percentage by volume.

NOTE 7—Since the percentages of the particle-size distribution in Test Method D2487 are by dry mass, and the estimates of percentages for gravel, sand, and fines in this practice are by dry mass, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry mass, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 8—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry mass. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*,

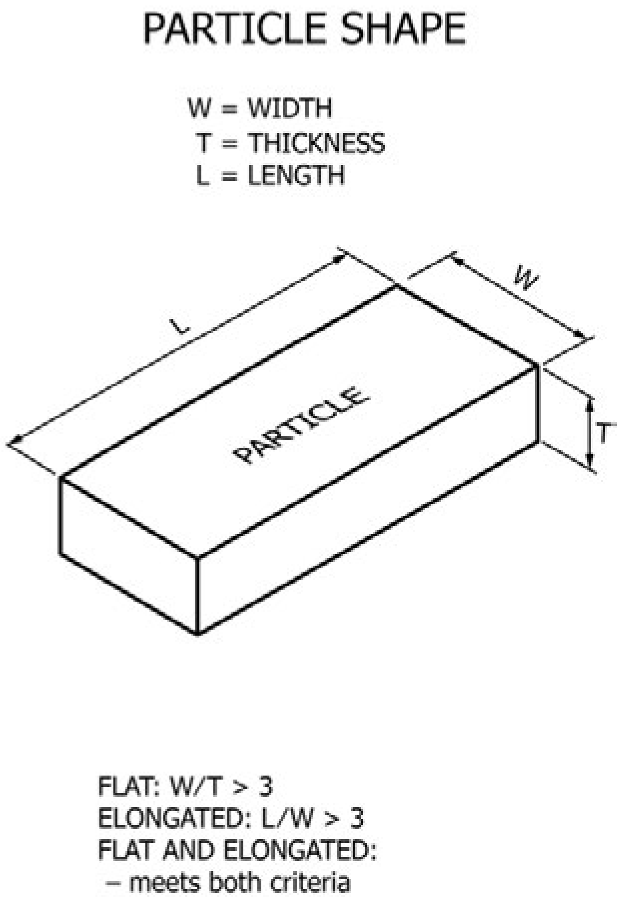


FIG. 4 Criteria for Particle Shape

TABLE 4 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 5 Criteria for Describing the Reaction with HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 6 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

for example, trace of fines. A component quantity described as trace shall not be included in the total of 100 % for the components.

TABLE 7 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 8 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least ¼ in. (6 mm) thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils in Section 14.

13.2 The soil is *coarse grained* if it contains more than 50 % coarse-grained soils. Follow the procedures for identifying coarse-grained soils in Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 (425 µm) sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to air dry or dry by artificial means, with a temperature not to exceed 140°F (60°C).

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 9—The process of molding and drying usually produces higher strengths than those determined using natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in Table 9. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate

TABLE 9 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 11 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 10. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. (3 mm). The thread will crumble at a diameter of ⅛ in. (3 mm) when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 11.

TABLE 10 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 12.

14.6 Decide if the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 13).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 13).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 13).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 13).

NOTE 10—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 13 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness and Plasticity
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 11—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the terms "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains more than 50 % coarse-grained soil)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report: Data Sheet(s)/Form(s)

16.1 Record as a minimum the following information (data):

16.1.1 Project specific information such as Project number, Project name, Project location if this information is available.

16.1.2 The person performing the soil identification.

16.1.3 Sample specific information including boring number, sample number, depth, sample location, such as test pit or station number etc. if this information is available.

16.1.4 The specimen characteristics which should be in the soil description are listed in Table 14. At a minimum the group name, group symbol and color shall be recorded.

NOTE 12—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 13—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 14—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D2487, it must be distinctly and clearly stated in any

TABLE 14 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, and fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if applicable) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 1 in. (25 mm); no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incorporated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown.

X2.4.3 *Broken Shells*—About 60 % uniformly graded gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % nonplastic fines; "Poorly Graded Gravel with Silt and Sand (GP-GM)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D2488 – 09a) that may impact the use of this standard. (July 15, 2017)

(1) Revised various sections to clarify wording.
(2) Added D4427 and E11 to Section 2 - Reference Documents.
(3) Added definitions for fine grained and coarse grained soils to Section 3.
(4) Replaced flow charts 1a, 1b and 2 with clearer versions.
(5) Corrected units in Table 1.
(6) Updated photos in Figure 3.
(7) Expanded Section 10 regarding sample order.
(8) Revised Section 16 - Report to conform to D18 SPM.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

GUIDANCE

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDGUID-101-R2, *Design and Installation of Monitoring Wells*, replaces SESDPROC-101-R1 **General:** Corrected any typographical, grammatical and/or editorial errors. **Cover Page:** Cover page was updated to reflect reorganization and new personnel. **Section 2.2.5:** Added Direct Push Technology as drilling method. **Section 2.7:** Added additional cautions regarding early sampling of permanent wells **Section 2.8:** Added greater detail to decommissioning procedures **Section 4:** Generalized description of screen point installation. Added section on direct push technology well installation.	January 16, 2018
SESDGUID-101-R1, *Design and Installation of Monitoring Wells*, replaces SESDPROC-101-R0.	January 29, 2013
SESDGUID-101-R0, *Design and Installation of Monitoring Wells*, Original Issue	February 18, 2008

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when designing and installing permanent and temporary groundwater monitoring wells to be used for collection of groundwater samples.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when designing, constructing and installing groundwater monitoring wells. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used for any aspect of the design, construction and/or installation of a groundwater monitoring well, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

USEPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Science and Ecosystem Support Division, Region 4, Athens, GA, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Groundwater Sampling, SESDPROC-301, Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, Most Recent Version

EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation*

ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in Aquifers*

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when constructing and installing groundwater monitoring wells. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy (SHEMP) Manual (Most Recent Version) and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. Section 2.6, Safety Procedures for Drilling Activities, contains detailed and specific safety guidelines that must be followed by Branch personnel when conducting activities related to monitoring well construction and installation.

1.5.2 Procedural Precautions

The following precautions should be considered when constructing and installing groundwater monitoring wells.

- Special care must be taken to minimize or prevent inadvertent cross-contamination between borehole locations. Equipment, tools and well materials must be cleaned and/or decontaminated according to procedures found in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).
- All field activities are documented in a bound logbook according to the procedures found in SESD Operating Procedure for Logbooks (SESDPROC-010).

2 Permanent Monitoring Well Design Considerations

2.1 General

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures should be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- Short-and long-term objectives;
- Purpose of the well(s);
- Probable duration of the monitoring program;
- Contaminants likely to be monitored;
- Surface and subsurface geologic conditions;
- Properties of the aquifer(s) to be monitored;
- Well screen placement;
- General site conditions; and
- Potential site health and safety hazards.

In designing permanent monitoring wells, the most reliable, obtainable data should be utilized. Once the data have been assembled and the well design(s) completed, a drilling method(s) must be selected. The preferred drilling methods for installing monitoring wells are those that temporarily case the borehole during drilling and the construction of the well, e.g. hollow-stem augers and sonic methods. However, site conditions or project criteria may not allow using these methods. When this occurs, alternate methods should be selected that will achieve the project objectives. The following discussion of methods and procedures for designing and installing monitoring wells will cover the different aspects of selecting materials and methods, drilling boreholes, and installing monitoring devices.

2.2 Drilling Methods

The following drilling methods may be used to install environmental monitoring wells or collect samples under various subsurface conditions. In all cases the preferred methods are those that case the hole during drilling, i.e. Hollow Stem Augers (HSA) and sonic methods using an override system. Other methods may be used where specific subsurface or project criteria dictate.

2.2.1 Hollow Stem Auger (HSA)

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiraled steel flight, welded onto the exterior. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be used at the bottom of the augers to keep out most of the soils and/or water that have a tendency to enter the bottom of the augers during drilling. Potable water (analyzed for contaminants of concern) may be poured into the augers during drilling to equalize pressure so that the inflow of formation materials will be held to a minimum. Water-tight center bits are not acceptable because they create suction when extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, defeating the purpose of the center plug. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by drilling and washing out the plug using a rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. Bottom plugs can be used where no soil sampling is conducted during the drilling process. The bottom plug is wedged into the bottom of the auger bit and is knocked out at depth with drill pipe or the weight of the casing and screen assembly. The plug material should be compatible with the screen and casing materials. The use of wood bottom plugs is not acceptable. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

2.2.2 Solid Stem Auger

This type of auger consists of a sealed hollow or solid stem or shaft with a continuous spiraled steel flight welded on the outside of the stem. An auger bit connected to the bottom disturbs soil material when rotated and the helical flights transport cuttings to the surface. At the desired depth the entire auger string is removed to gain access to the bottom of the borehole. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock. Each method can be employed without introducing foreign materials into the borehole such as water and drilling fluids, minimizing the potential for cross contamination. Minimizing the risk of cross contamination is one of the most important factors to consider when selecting the appropriate drilling method(s) for a project.

2.2.3 Sonic Methods

These methods generally alternately advance concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer 'override' string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of the stratigraphy prior to sampling or disposal. Because there are no auger flights to increase the borehole diameter, the quantity of cuttings removed from the hole is minimized as compared to hollow stem augering. With moderate rotation, smearing of the formation materials on the borehole walls is reduced as well. This drilling method is useful in a variety of materials, from flowing sands to heavily consolidated or indurated formations.

In flowing sands, the drill casings can be filled and/or pressurized with potable water to prevent excess entry of formation materials into the drill string. The same QA/QC requirements for sampling of material introduced to the borehole apply as in other drilling methods. Because the amount of water introduced into the borehole can be significant, an approximation of the water used in the drilling process should be logged for use in estimating appropriate well development withdrawal.

Sonic drilling allows a larger diameter temporary casing to be set into a confining layer while drilling proceeds into deeper aquifers. This temporary casing is then removed during the grouting operation. In many cases this will be acceptable technique. However, the level of contamination in the upper aquifer, the importance of the lower aquifers for drinking water uses, the permeability and continuity of the confining layer, and state regulations should be taken into account when specifying this practice as opposed to permanent outer casing placed into the confining unit. Note that when using the temporary casing practice, it is critical that grout be mixed and placed properly as specified elsewhere in this section.

Because the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, particular care should be taken that the well casing is placed in the center of the drill stem while placing the filter pack. Centralizers should be used in most cases to facilitate centering, particularly in the case of deep wells with PVC casing.

2.2.4 Rotary Methods

These methods consist of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe, (or within a concentric drill stem in reverse rotary). Except in the case of air rotary, the drilling fluid provides a hydrostatic pressure that reduces or prevents borehole collapse. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole.

Due to the introduction of the various circulating fluids, the use of rotary methods requires that the potential for contamination by these fluids be evaluated. Water and mud rotary methods present the possibility of trace contamination of halogenated compounds when municipal water supplies are used as a potable water source. Air rotary drilling can introduce contamination through the use of lubricants or entrained material in the air stream. Unless contaminated formations are cased off, the circulation of drilling fluids presents a danger of cross contamination between formations. In any of the rotary (or sonic) methods, care must be exercised in the selection and use of compounds to prevent galling of drill stem threads.

2.2.4.1 Water Rotary

When using water rotary, potable water (that has been analyzed for contaminants of concern) should be used. If potable water (or a higher-quality water) is not available on-site, then potable water will have to be transported to the site or an alternative drilling method will have to be selected. Water does not clog the formation materials, but the suspended drilling fines can be carried into the formation, resulting in a very difficult to develop well. This method is most appropriate for setting isolation casing.

2.2.4.2 Air Rotary

Air rotary drilling uses air as a drilling fluid to entrain cuttings and carry them to the surface. High air velocities, and consequently large air volumes and compressor horsepower are required. “Down-the-hole” (DTH) percussion hammers driven by the air stream can be used with this method to rapidly penetrate bedrock materials. Where a casing through unconsolidated material is required to prevent borehole collapse, it can be driven in conjunction with advancement of the drill stem.

When using air rotary drilling in any zone of potential contamination, the cuttings exiting the borehole must be controlled. This can be done using the dual-tube reverse circulation method where cuttings are carried to the surface inside dual-wall drill pipe and separated with a cyclone separator. An air diverter with hose or pipe carrying cuttings to a waste container is also an acceptable alternative. Allowing cuttings to blow uncontrolled from the borehole is not acceptable.

When using air rotary, the issue of contaminants being introduced into the borehole by the air stream must be addressed. Screw compressor systems should have a coalescing filter system in good working order to capture excess entrained compressor oils. The lubricant to be used with DTH hammers as well as thread lubricants to be used on drill stem should be evaluated for their potential impact on analytical samples.

2.2.4.3 Mud Rotary

Mud rotary is an undesirable drilling method because contamination can be introduced into the borehole from the constituents in the drilling mud, cross contamination can occur along the borehole column, and it is difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminates from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. QA/QC samples of drilling muds and potable water should be sampled at a point of discharge from the circulation system to assure that pumps and piping systems are not contributing cross-contamination from previous use.

2.2.5 Direct Push Technology

Direct Push Technology (DPT) uses hollow drive rods either driven percussively or by large forces from a rig weighted or anchored to the ground. Percussive rigs are used for general soil and groundwater investigations and the push only rigs are generally used for cone penetrometer testing (CPT). DPT does not bring cuttings to the surface but instead compresses them into the borehole walls. A variety of tool systems are available to perform soil sampling, groundwater sampling, well installation, and to profile contamination with in situ systems. The light tooling, small crews required, and reduced IDW can make DPT operations an economical investigation tool. Although significant depths have been explored with DPT, investigations are generally limited to 100 ft (and more practically 50 ft.) in unconsolidated materials.

2.2.6 Other Methods

Other methods such as the cable-tool method, jetting method, and boring (bucket auger) method are available. If these and/or other methods are selected for monitoring well installations, they should be approved by a senior field geologist before field work is initiated.

2.3 Borehole Construction

2.3.1 Annular Space

The borehole or hollow stem auger should be of sufficient diameter so that well construction can proceed without major difficulties. For open boreholes, the annular space should be approximately 2" to allow the uniform deposition of well materials around the screen and riser, and to allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. For example, a 2" nominal diameter (nom.) casing would require a 6" inside diameter (ID) borehole.

In hollow stem augers and sonic method drill casing, the ID should be of sufficient size to allow the passage of the tremie pipe to be used for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. In general, 4-1/4" ID should be the minimum size used for placement of 2" nom. casing and 8-1/4" ID for 4" nom. casing. Larger augers should be used where installation difficulties due to geologic conditions or greater depths are anticipated, e.g. larger augers might be required to place a bentonite pellet seal through a long water column.

2.3.2 Over-drilling the Borehole

Sometimes it is necessary to over-drill the borehole in anticipation of material entering the augers during center bit removal or knocking out of the bottom plug. Normally, 3 to 5 feet is sufficient for over-drilling. The borehole can also be over-drilled to allow for an extra space or a "sump" area below the well screen. This "sump" area provides a space to attach a 5 or 10 foot section of well casing to the bottom of the well screen. The extra space or "sump" below the well screen serves as a catch basin or storage area for sediment that flows into the well and drops out of suspension. These "sumps" are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the "sump" preventing the well screen from clogging or "silting up". If the borehole is inadvertently drilled deeper than desired, it can be backfilled to the design depth with bentonite pellets, chips, or the filter sand that is to be used for the filter pack.

2.3.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6-inches of the filter pack material should be placed under the bottom of the well screen to provide a firm base. Also, the filter pack should extend a minimum of 2-feet above the top of the well screen to allow for settling and to isolate the screened interval from the grouting material. In open boreholes, the filter pack should be placed by the tremie or positive displacement method. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.

2.3.4 Filter Pack Seal – Bentonite Pellet Seal (Plug)

Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Bentonite pellets are compressed to a bulk density of 70-80 lbs/ft^3 and hydrate to a 30% min. solids material. Where neat cement grouts are to be used, the placement of a bentonite pellet seal above the filter pack is mandatory to prevent the possibility of grout infiltration into the screened interval prior to setting. Bentonite chips or other sealing products should not be substituted in this application. Where bentonite grouts are to be used, the placement of a bentonite pellet seal is optional, but desirable.

Since bentonite pellets begin hydrating rapidly, they can be very difficult to place properly. They are generally placed by pouring slowly into open boreholes, hollow stem augers or sonic drill pipe. In some cases, pellets are placed by tremie pipe and flushed into place with potable water. A tamper can be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs.

Pellet seals should be designed for a two-foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where neat cement grouts are to be used, the pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.

2.3.5 Grouting the Annular Space

The annular space between the casing and the borehole wall should be filled with either a 30% solids bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout selected should be evaluated as to its intended use and integrity. Bentonite grouts are preferred unless the application dictates the use of another material.

Bentonite grout shall be a 30% solids pure bentonite grout. Drilling muds are not acceptable for grouting. The grout should be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is the greater depth. The bentonite pellet seal or filter pack should not be disturbed during grout placement, either by the use of a side discharge port on the tremie tube, or by maintaining clearance between the bottom of the tremie tube and the bentonite seal or filter pack. The grout should be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. The preferred method of achieving proper solids content is by measurement of ingredients per the manufacturer's specifications during mixing with a final check by grout balance after mixing. Bentonite grouts should have a minimum density of 10 lbs/gal to ensure proper gelling and low permeability. The density of the first batch of grout should be measured while mixing to verify proper measurement of ingredients. In addition, the grouting operation should not cease until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. Estimating the grout density is not acceptable.

Cement grouts are generally dictated where a high level of dissolved solids or a particular dissolved constituent would prevent proper gelling of a bentonite grout. Neat cement grouts (cement without additives) should be mixed using 6 gallons of water per 94-lb bag of Type 1 Portland cement to a density of 15lbs/gal. The addition of bentonite (5 to 10 percent) to the cement grout can be used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated on a case by case basis by a senior field geologist.

2.3.6 Above Ground Riser Pipe and Outer Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. A vent hole should be drilled into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. Generally, outer protective casings used over 2-inch well casings are 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings are 6 inches square and 5 feet long. Other types of protective casing including those constructed of pipe are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a weep hole to allow drainage of accumulated rain or spilled purge water. The weep hole should be approximately 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pad to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas.

Prior to installing the protective casing, the bentonite grout in the borehole annulus is excavated to a depth of approximately two feet. The protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. In areas where frost heave of the surface pad is possible, the protective casing should first be pressed into the top surface of the bentonite grout seal and concrete poured around the protective casing. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The use of granular material instead of concrete between the protective casing and riser will also facilitate the future conversion of the well to a flush-mount finish, if required.

The protective casing should extend above the ground surface to a height so that the top of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

2.3.7 Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The surface pad should be formed around the well casing. Concrete should be placed into the pad forms and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad is dependent on the well casing size. If the well casing is 2 inches in diameter, the pad should be 3 feet x 3 feet x 4 inches. If the well casing is 4 inches in diameter, the pad should be 4 feet x 4 feet x 6 inches. Round concrete surface pads are also acceptable. The finished pad should be slightly sloped so that drainage will flow away from the protective casing and off of the pad. A minimum of one inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.

2.3.8 Surface Protection – Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of three bumper guards consisting of steel pipes 3 to 4 inches in diameter and a minimum 5-foot length should be installed. These bumper guards should be installed to a minimum depth of 2 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. Substantial steel rails and/or other steel materials can be used in place of steel pipe. Welding bars between the bumper posts can provide additional strength and protection in high traffic areas, but the protective bumpers should not be connected to the protective casing.

2.4 Construction Techniques

2.4.1 Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Deviation from plumb should be within 1° per 50ft of depth. Slanted boreholes are undesirable and should be noted in the boring logs and final construction logs. The depth and volume of the borehole, including the over-drilling if applicable, should have been calculated and the appropriate materials procured prior to drilling activities.

The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing them at the same time is to suspend the string of well screen and casings in the borehole by means of a hoist on the drill rig. This wireline method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed.

No lubricating oils or grease should be used on casing threads. No glue of any type should be used to secure casing joints. Viton® O-rings can be used where the joints are designed for same.

Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals should be decided based on site conditions.

When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite pellet seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems.

After the string of well screen and casing is plumb, the filter pack material should then be placed around the well screen to the designated depth. With cased drilling methods, the sand should be poured into the casing or augers until the lower portion is filled. The casing or augers are then withdrawn, allowing the sand to flow into the evacuated space. With hollow stem augers, sand should always fill the augers 6-12 inches, maintained by pouring the sand while checking the level with a weighted tag line. The filter pack sand in open boreholes should be installed by tremie methods, using water to wash the sand through the pipe to the point of placement.

After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet. When installing the seal for use with cement grouts, the bentonite pellet seal should be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer.

After the pellet seal has hydrated for the specified time, the grout should then be pumped by the tremie method into the annular space around the casings. The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed.

After the surface pad and protective casing are installed, bumper guards should be installed (if needed). The bumper guards should be placed around the concrete surface pad in a configuration that provides maximum protection to the well. Each piece of steel pipe or approved material should be installed into an 8-to 10-inch diameter hole, to a minimum depth of 2 feet below ground surface, and filled with concrete. As previously stated, the bumper guard should extend above the ground surface a minimum of 3 feet. The total length of each bumper guard should be a minimum of 5 feet.

After the wells have been installed, the outer protective casing should be painted with a highly visible paint. The wells should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed slightly above grade to minimize standing water and promote runoff. Permanent identification markings should be placed on the covers or in the concrete plug around the cover. Expansive sealing plugs should be used to cap the well riser to prevent infiltration of any water that might enter the flush cover.

2.4.2 Double-Cased Wells

Double-cased wells should be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross-contamination or when flowing sands make it impossible to install a monitoring well using conventional methods. A highly contaminated surface soil zone may also be cased off so that drilling may continue below the casing with reduced danger of cross contamination. A pilot borehole should be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) should then be placed into the borehole and sealed with grout. The borehole and outer casing should extend into tight clay a minimum of two feet and into competent bedrock a minimum of 1 foot. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and\or fracturing of the bedrock. The final depths should be approved by a senior field geologist. The size of the outer casing should be of sufficient inside diameter to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole should be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable.

The outer casing should be grouted by the tremie, displacement, grout shoe, or Halliburton method from the bottom to the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. A minimum of 24 hours should be allowed for the grout plug (seal) to cure before attempting to drill through it. The grout mixture used to seal the outer annular space should be either a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing should consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout cures to a gel-like material, and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care should be taken to avoid cracking, shattering, or washing out the seal. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing should be driven into place and a grout seal placed in the bottom of the casing.

2.4.2.1 Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution should be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding (washing), and/or shattering of the seal. Low volume air hammers may be used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. If the structural integrity of the grout seal is in question, a pressure test can be utilized to check for leaks. A visual test can also be made by examining the cement/concrete core that is collected when the seal is cored with a diamond coring bit. If the seal leaks (detected by pressure testing) and/ or the core is cracked or shattered, or if no core is recovered because of washing, excessive down pressure, etc., the seal is not acceptable. The concern over the structural integrity of the grout seal applies to all double cased wells. Any proposed method of double casing and/or seal testing will be evaluated on its own merits, and will have to be approved by a senior field geologist before and during drilling activities, if applicable. When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired

immediately or abandoned. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being non-detectable. The installation of open bedrock wells is generally not acceptable in the Superfund and RCRA programs, because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by an approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted, but the packers have to remain in the well permanently and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

2.5 Well Construction Materials

2.5.1 Introduction

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

2.5.2 Well Screen and Casing Materials

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. If the monitoring program is designed to analyze for organic compounds, stainless steel materials are the preferred choice. If the monitoring program calls for the analyses of only inorganic compounds or the contaminants or formation are highly corrosive, then rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type WC (Well Casing) are acceptable. PVC materials may be acceptable for monitoring identified organic compounds in a soluble aqueous phase where incompatibilities are known to not exist. EPA document EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation* should be used for guidance in this area and in the use of PVC with non-aqueous phase liquids (NAPLs). Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the type of materials that can be used. A preliminary field investigation should be conducted to determine the geologic conditions, so that the most suitable materials can be selected. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation should be evaluated and approved by a senior field geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction on RCRA and Superfund sites are listed in order of preference:

1. Stainless Steel (304 or 316)
2. Rigid PVC meeting NSF Standard 14 (type WC)
3. Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water. In cases where a driven casing is used, or a high strength outer casing is needed, carbon steel may be acceptable in non-corrosive aquifers. This outer casing should have threaded connections. Welding casing is not an acceptable practice unless all relevant safety issues have been adequately addressed.

The minimum nominal casing size for most permanent monitoring wells will be 2". Where a complete program of installation, monitoring, and abandonment is being designed, smaller wells may be installed if suitable purging and sampling equipment for the smaller diameter wells can be specified and obtained. The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less than 5 feet long are generally only used in temporary monitoring wells where ground water samples are collected for screening purposes.

2.5.3 Filter Pack Materials

The filter pack materials should consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition. The required grain-size distribution or particle sizes of the filter pack materials should be selected based upon a sieve analysis conducted on the soil samples collected from the aquifer materials and/or the formation(s) to be monitored. Filter pack materials should not be accepted unless proper documentation can be furnished as to the composition, grain-size distribution, cleaning procedure, and chemical analysis. If a data search reveals that there is enough existing data to adequately design the well screen and filter pack, then it may not be necessary to conduct a sieve analysis on the formation materials to be monitored. However, all data and design proposals will be evaluated and approved by a senior staff geologist before field activities begin.

2.5.4 Filter Pack and Well Screen Design

The majority of monitoring wells are installed in shallow ground water aquifers that consist of silts, clays, and sands in various combinations. These shallow aquifers are not generally characteristic of aquifers used for drinking water. Therefore, modifications to the procedures used for the design of water well filter packs may be required. In cases where insufficient experience exists with local or similar materials, the filter pack and well screen design should be based on the results of a sieve analysis conducted on soil samples collected from the aquifer or the formation(s) that will be monitored.

In formations consisting primarily of fines (silts and clays), the procedures for water well screen design may result in requirements for filter packs and screen slot sizes that are not available. In those cases the selection of 0.010" screen slots with a 20-40 sand filter pack, or 0.005" screen slots with 100 sand filter pack for very fine formations, will be acceptable practice. Table 6.6.1 provides size specifications for the selection of sand packs for fine formation materials. ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in Aquifers*, may be consulted for further guidance on specifications for sand appropriate for these applications.

Table 6.6.1
Sand Pack Specifications

Screen Opening (in)	Sand Pack Mesh Name	1% Passing Size (d-1) (in)	10% Passing Size (d-10) (in)	30% Passing Size (d-30) (in)	Derived 60% Passing Size (d-60) (in)	Range for Uniformity Coefficient
0.005-0.006	100	.0035 - .0047	.0055 - .0067	.0067 - .0083	.0085 - .0134	1.3 - 2.0
0.010"	20-40	.0098 - .0138	.0157 - .0197	.0197 -.0236	.020 - .0315	1.1 - 1.6

The following procedure should be used in coarser grained formations:

The data from the sieve analysis are plotted on a grain-size distribution graph, and a grain-size distribution curve is generated. From this grain-size distribution curve, the uniformity coefficient (Cu) of the aquifer material is determined. The Cu is the ratio of the 60 percent finer material (d60) to the 10 percent finer material (d10)

$$Cu = (d60/d10)$$

The Cu ratio is a way of grading or rating the uniformity of grain size. For example, a Cu of unity means that the individual grain sizes of the material are nearly all the same, while a Cu with a large number indicates a large range of particle sizes. As a general rule, a Cu of 2.5 or less should be used in designing the filter pack and well screen.

Before designing the filter pack and well screen, the following factors should be considered:

1. Select the well screen slot openings that will retain 90 percent of the filter pack material.

2. The filter pack material should be of the size that minimizes head losses through the pack and also prevents excessive sediment (sand, silt, clay) movement into the well.

3. A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well-rounded is preferred.

4. The filter pack design is based on the gradation of the finest aquifer materials being analyzed.

Steps to design a filter pack in aquifers:

1. Construct a grain-size distribution curve, on a grain-size distribution graph, from the sieve analysis of the aquifer materials. The filter pack design (as stated above) is based on the gradation of the finest aquifer materials.

2. Multiply the d30 size from the grain-size distribution graph by a factor of four to nine (Pack-Aquifer ratio). A factor of four is used if the formation is fine-grained and uniform (Cu is less than 3), six if it is coarse-grained and non-uniform, and up to nine if it is highly non-uniform and contains silt. Head losses through filter packs increase as the Pack-Aquifer (P-A) ratios decrease. In order to design a fairly stable filter pack with a minimum head loss, the d30 size should be multiplied by a factor of four.

3. Plot the point from step 2 on the d30 abscissa of a grain-size distribution graph and draw a smooth curve with a uniformity coefficient of approximately 2.5.

4. A curve for the permissible limits of the filter pack is drawn plus or minus 8 per cent of the desired curve with the Cu of 2.5.

5. Select the slot openings for the well screen that will retain 90 per cent or more of the filter pack material.

The specific steps and procedures for sieve analysis and filter pack design can be found in soil mechanics, ground water, and water well design books. The staff geologists and/or engineers should be responsible for the correct design of the monitoring wells and should be able to perform the design procedures.

2.6 Safety Procedures for Drilling Activities

A site health and safety plan should be developed and approved by the Branch Safety Officer or designee prior to any drilling activities, and should be followed during all drilling activities. The driller or designated safety person should be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, utilities should be marked or cleared by the appropriate state or municipal utility protection organization. In developed areas, additional measures should be taken to locate utilities not covered by the utility protection program. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

1. All drilling personnel should wear safety hats, safety glasses, and steel toed boots. Ear plugs are required and will be provided by the safety officer or driller.

2. Work gloves (cotton, leather, etc.) should be worn when working around or while handling drilling equipment.

3. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

4. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating. Rod wipers, rather than gloves or bare hands should be used to remove mud, or other material, from drill stem as it is withdrawn from the borehole.

5. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.

6. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

7. Keep the drilling area clear of any excess debris, tools, or drilling equipment.

8. The driller will direct all drilling activities. No work on the rig or work on the drill site will be conducted outside of the driller's direction. Overall drill site activities will be in consultation with the site geologist or engineer, if present.

9. Each drill rig will have a first-aid kit and a fire extinguisher located on the rig in a location quickly accessible for emergencies. All drilling personnel will be familiarized with their location.

10. Work clothes will be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.

11. Rings, watches, or other jewelry will not be worn while working around the drill rig.

12. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, the area will be vacated until it is safe to return.

2.7 Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity may stabilize but the water remains turbid. In this case the well may still contain well construction materials, such as drilling mud in the form of a mud cake and/or formation soils that have not been washed out of the borehole. Excessive or thick drilling mud cannot be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist should make the decision as to the development completion of each well. All field decisions should be documented in the field log book.

The following development procedures, listed in approximate increasing order of the energy applied to the formation materials, are generally used to develop wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These development procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, over-pumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development and should only be used where there is a specific need for the procedure. Air-lift pumping is permissible where an eductor pipe is used and several well volumes of water are removed from the well by other pumping means after air-lift pumping. Additional time before the first sampling event should be allowed when using air development methods, particularly airlift. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

Wells can require a considerable length of time to equilibrate with the aquifer after construction and development. The length of time between development and the first sampling event should be as long as possible with times from 1 to 14 days recommended. The possibility of the first sampling event's results being non-representative should always be considered.

2.8 Well Decommissioning (Abandonment)

When a decision is made to decommission (abandon) a monitoring well, the borehole should be sealed in such a manner that the well cannot act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly decommission a well, the preferred method is to completely 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. In order to comply with state well decommissioning requirements, the appropriate state agency should be notified (if applicable) of monitoring well decommissioning. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

2.8.1 Decommissioning Procedures

As previously stated, the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present.

A PVC well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by water or drilling mud. Another method is to use a solid-stem auger with a carbide tooth pilot bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials.

Where state regulations and conditions permit, it may be permissible to grout the casing in place. This decision should be based on confidence in the original well construction practice, protection of drinking water aquifers, and anticipated future property uses. The pad should be demolished and the area around the casing excavated. The casing should be sawn off at a depth of three feet below ground surface. The screen and riser should be tremie grouted with a 30% solids bentonite grout. Pouring bentonite chips into the well will be acceptable with wells large enough for the chips to fall to the bottom (generally 4” or larger).

3 Temporary Monitoring Well Installation

3.1 Introduction

Five types of temporary monitoring well installation techniques have been demonstrated as acceptable. The type selected for a particular site is dependent upon site conditions. The project leader and site geologist should be prepared to test temporary well installations on site and select the best solution. Temporary wells are cost effective, may be installed quickly, and can provide a rapid assessment of ground water quality.

Temporary monitoring well locations are not permanently marked, nor are their elevations normally determined. Sand pack materials may or may not be used, but typically there is no bentonite seal, grout, surface completion, or extensive development (as it normally applies to permanent monitoring wells). Temporary wells are generally installed, purged, sampled, removed, and backfilled in a matter of hours.

Due to the nature of construction, turbidity levels may initially be high. However, these levels may be reduced by low flow purging and sampling techniques as described in SESD Operating Procedure for Groundwater Sampling, SESDPROC-301.

Temporary wells may be left overnight, for sampling the following day, but the well must be secured, both against tampering and against the fall hazard of the open annulus. If the well is not sampled immediately after construction, the well should be purged prior to sampling as specified in SESD Operating Procedure for Groundwater Sampling, SESDPROC-301.

3.2 Data Limitation

Temporary wells described in this section are best used for delineation of contaminant plumes at a point in time, for some site screening purposes, or for determination of groundwater elevations and gradients. They are not intended to replace permanent monitoring wells. Temporary wells can be used in conjunction with a mobile laboratory, where quick-turnaround analytical results can be used to rapidly delineate contaminant plumes.

3.3 Temporary Well Materials

Materials used in construction of temporary monitoring wells are the same standard materials used in the construction of permanent monitoring wells. Sand used for the filter pack (if any) should be as specified in Section 2.5.3, Filter Pack Materials. The well screen and casing should be stainless steel for ruggedness and suitability for steam cleaning and solvent rinsing. Other materials may be acceptable, on a case by case basis. Some commercially available temporary well materials, pre-packed riser, screen and filter pack assemblies are available commercially; however, these pre-assembled materials cannot be cleaned. Appropriate QA/QC must be performed to assure there will be no introduction of contamination.

3.4 Temporary Monitoring Well Borehole Construction

Borehole construction for temporary wells is as specified in Section 2.3, using a drill rig. 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 removed completely) prior to sampling. When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). In situations where borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled. 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.

3.5 Temporary Monitoring Well Types

Five types of monitoring wells which have been shown to be acceptable are presented in the order of increasing difficulty to install and increasing cost:

3.5.1 No Filter Pack

This is the most common temporary well and is effective in many situations. After the borehole is completed, the casing and screen are simply inserted. This is the least expensive and fastest well to install. This type of well is extremely sensitive to turbidity fluctuations because there is no filter pack. Care should be taken to not disturb the casing during purging and sampling.

3.5.2 Inner Filter Pack

This type differs from the "No Filter Pack" well in that a filter pack is placed inside the screen to a level approximately 6 inches above the well screen. This ensures that all water within the casing has passed through the filter pack. For this type well to function properly, the static water level must be at least 6-12 inches above the filter pack. The screen slots may plug with this construction method.

3.5.3 Traditional Filter Pack

For this type of well, the screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. It may be difficult to effectively place a filter pack in open boreholes, due to collapse.

3.5.4 Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be effective in aquifers where fine silts or clays predominate.

3.5.5 Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and riser, with attendant increases in assembly and installation time. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. The use of pre-packed well screens in this application will require rinse blanks of each batch of screens. Pre-pack Screen assemblies cannot be decontaminated for reuse.

3.6 Decommissioning

Temporary well boreholes must be decommissioned after sampling and removal of the screen and riser. Use of cuttings for backfilling holes will not be acceptable practice.

4 Direct-Push Technology in Groundwater Investigations

4.1 Screen Point Samplers

Screen Point samplers allow temporary wells to be established quickly and can return high quality samples. The sampler consists of a stainless steel or PVC screen housed in a hollow steel sheath and topped with a drive cap to adapt to the drive rods in use. A disposable point is inserted in the bottom of the sheath and serves to prevent soil from entering the sheath and damaging the screen during driving.

After driving the sampler to the target depth, an inner rod is inserted to hold the screen down at the bottom of the borehole while the sheath and rods are withdrawn to expose the screen. The disposable point stays at the bottom of the borehole. The inner rod system is withdrawn and sampling can commence immediately.

O-rings are commonly used on the disposable point. The additional friction from the O-ring can prevent the point from being driven off of the sampler in loose material or when encountering a hollow space such as during redriving.

Screen point samplers are deployed to a specified interval. If a greater sampling depth is desired after deployment, the sampler must be withdrawn, reassembled with a new point, and redriven to the greater depth. The standard screens can be withdrawn to a shallower interval if needed, but the sampler would still be accessing the deeper aquifer to some extent.

4.1.1 Special Considerations for Screen Point Samplers

Decommissioning (Abandonment)

Like other wells, temporary screen points should be properly decommissioned. The most common means of decommissioning at SESD is to withdraw the screen point sampler, remove the screen, install a new disposable point, and redrive the sheath to the previously screened interval. A grouting head is attached to the probe rods, and grout pressure applied while withdrawing the rods to pull the disposable point free. The grout volume pumped is carefully managed to match the volume grouted during rod withdrawal.

Where preventing cross-connection of aquifers is critical or potential caving would prevent re-entry, a disposable screen can be used with some systems. The disposable screen is not linked to the sheath and will pull out and be left in the borehole. After sampling, the grouting head is attached to the rods, the rods pumped full of grout, and the sampler sheath is pulled off of the screen. Grouting proceeds as with re-entry grouting.

Geoprobe® Screen Points samplers have a feature available to knock a plug out of the bottom of the screen and thread a small diameter high-pressure grouting tube to the bottom of the borehole. Grout is pumped through the tubing while rods are withdrawn and left threaded over the tubing aboveground. As this system is unwieldy and cannot reliably pump grout over 20% solids, it is not used at SESD.

SESD pressure-grouts soil sampling boreholes by reentry grouting or tremie grouting when depths exceed 10 ft, or groundwater is encountered. Shallower boreholes can be decommissioned by pouring pellets in short lifts and hydrating each lift with water, or by pouring a pourable grout.

Screen Material Selection

The screen point screens are available in stainless steel and PVC. Because of stainless steel's durability, ability to be cleaned and re-used, and overall inertness and compatibility with most contaminants, it is the material most used for SESD investigations. When stainless steel screens are stowed wet, they should be segregated from carbon steel components. Contact of the stainless screens with carbon steel when wet will cause galvanic corrosion that will shed chrome-bearing material when first flushed.

4.2 Groundwater Profiling

Rapid investigations can be facilitated by the use of groundwater profiling systems. A groundwater profiler allows a sampler to be advanced from one area of interest to the next with a discrete groundwater sample collected at each. The system may allow soil samples to be collected during advancement. As some sampler components are common for all samples, the groundwater profiler does not offer the same protection from cross-contamination that separate screen point samples would.

4.3 Small-Diameter Well Installation

With some limitations, direct push technology can be used to install permanent monitoring wells of quality commensurate with other drilling systems. The use of small diameter wells limits the possibilities for the pumps to be used in sampling. For shallow groundwater with water levels higher than 25 ft below ground surface, peristaltic pumps can be used with no limitation on minimum well diameter. For water levels deeper than 25 feet below ground surface, bladder pumps may be the only pumping option and well diameters should be 1" nominal diameter with an absolute minimum of ¾" nominal diameter.

Well materials are difficult to place with DPT systems and best results will be achieved with total depths less than 50 ft. It is also difficult or impossible to place bentonite seals, and caution should be used when aquifer isolation is particularly important. Grout should be placed in the annular space by tremie pipe, as with conventional drilling installation. Grout placement by tremie will likely rule out the use of the smaller diameter tool strings such as 2.125” and 2.25” outside diameter (od). A 3.5” tool string with 2.75” inside diameter (id) will allow room for a 1” nom. diam. casing with grout pumped through ½” nom. dia. tremie. Pre-pack screens are available to install 2” nom. dia. wells in 3.5” od tool string, but grout cannot be placed by tremie with these systems and they should not be used.

Pre-packed screens are typically used, consisting of a slotted well screen surrounded by a sand filter pack wrapped in stainless steel screen wire. Sand packs wrapped by textile materials capable of or intended to filter fines or lower turbidity are unacceptable. Above the pre-packed screen standard well casing matching the slotted screen diameter is used.

Installation involves driving a tool string with disposable point to depth, placing the screen and casing inside, and withdrawing the tool string to dislodge the disposable point. The drive casing is withdrawn to fully expose the screen. Filter pack sand is then added during drive casing withdrawal until sand is placed to 2 ft above the screen. There is a narrow annular space between the pre-pack screen and borehole walls that the added sand may not fully fill. The placement of 2 ft of sand above the screen allows for settling.

Bentonite grout mixed to 30% solids content is then installed by tremie pipe while withdrawing the remaining drive casing. Care must be taken to not jet out the placed filter sand by resting the tremie on the bottom.

Alternate systems are available that use a polyethylene and foam skirt to isolate a bentonite seal wrapped in kraft paper from the screened interval. These systems result in natural development of the entire annular space around the pre-pack screen and introduce several materials that may have compatibility, contaminant leaching, or long-term stability issues. Although the placement of a bentonite seal is desirable, SESD does not use these systems due to concern over the other issues.

APPENDIX E – Field Forms

PARSONS #

DAILY PRODUCTION REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

Contract NO **W91238-21-D-0008**	Title and Location **Former Titan 1-A Missile Facility, Lincoln, California**	Date
Contractor **Parsons**	Superintendent Arnold Pimentel	
AM Weather	PM Weather	MAX TEMP (F) / MIN TEMP (F)

Description of tasks	**EMPLOYER**
Work Performed Today	
Work Planned for Tomorrow	

Staff Onsite

EMPLOYER	Who	Time Onsite	Time Offsite	Time Onsite	Time Offsite

Visitors

AFFILIATION	Who	Time Onsite	Time Offsite	Notes:

JOB SAFETY	WAS A JOB SAFETY MEETING HELD THIS DATE? (If YES attach copy of the meeting minutes)	☐ YES	☐ NO
	WERE THERE ANY LOST TIME ACCIDENTS THIS DATE? (If YES attach copy of completed OSHA report)	☐ YES	☐ NO

Responsible Party	Stop Work/Safety Inspections Conducted	☐ Safety Requirements Met

Equipment and/or Material Received or Leaving Jobsite Today

Responsible Party	Quantity	Definable Feature of Work and Description of Equipment Received

IDW Generated/Removed

Responsible Party	Quantity	Description of IDW

PARSONS

DAILY PRODUCTION REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

Contract NO **W91238-21-D-0008**	Title and Location **Former Titan 1-A Missile Facility, Lincoln, California**	Date

Contractor **Parsons**	Superintendent Arnold Pimentel

Samples Shipped Today

Sample ID	Media	Destination	COC

Well Installation/Development Dates/ Soil Vapor Probe Installation Dates

ID	Drilled	Installed	Developed	Well box installed

PARSONS PROJECT MANAGER DATE

Photo 1:

Photo 2:

Hole No. ____________ **Well No.** ____________

DRILLING LOG	CLIENT	INSTALLATION *Former Titan 1-A Missile Facility, Lincoln, California*	SHEET OF SHEETS

1. PROJECT *Treatability Study*	10. DATE HOLE	STARTED	COMPLETED

2. LOCATION *(Coordinates or Station)*	11. DRILLING METHOD / DRILLING RIG
3. DRILLING CONTRACTOR	12. SIZE AND TYPE OF BIT
4. NAME OF DRILLER	13. TOTAL NO. OF SAMPLES TAKEN ANALYTICAL ☐____ IDW ☐____ OTHER ☐ ____________ ☐ ____________
5. NAME OF GEOLOGIST	14. TOTAL RECOVERY FOR BORING
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED__________________________ DEGREES FROM VERTICAL	15. TOTAL NUMBER CORE BOXES 16. DATUM FOR ELEVATION SHOWN ☐ TBM ☐ MSL ☐ TOC ☐ OTHER______________________
7. THICKNESS OF OVERBURDEN	17. ELEVATION ☐ GROUND SURFACE___________ ☐ TOP OF CASING__________
8. DEPTH DRILLED INTO ROCK	18. ELEVATION GROUND WATER
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF GEOLOGIST

DEPTH (FT) a	GRAPHIC LOG b	ASTM SOIL CLASS SYMBOLS c	CLASSIFICATION OF MATERIALS *(Description)* d	PID (ppm) e	REMARKS *(Drilling time, water loss, depth of weathering, type of PID reading, etc., if significant)* g

DRILLING LOG (Cont. Sheet)	ELEVATION	**Hole No.**

PROJECT *Treatability Study*	INSTALLATION *Former Titan 1-A Missile Facility, Lincoln, California*	SHEET OF SHEETS

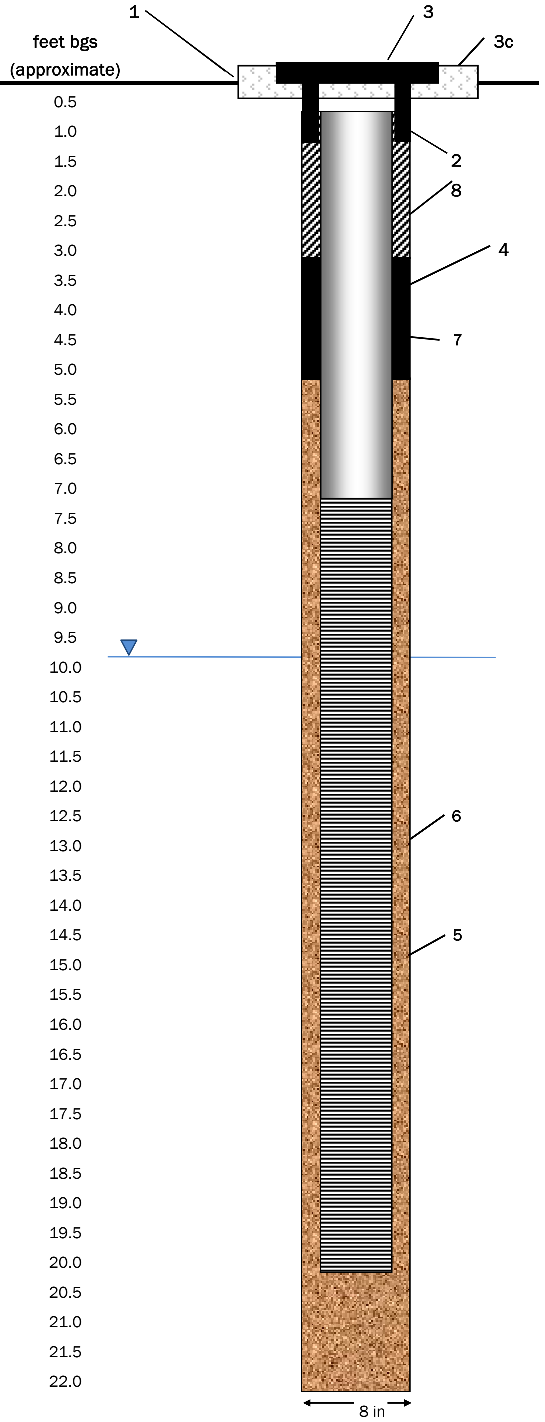
DEPTH (FT) a	GRAPHIC LOG b	ASTM SOIL CLASS SYMBOLS c	CLASSIFICATION OF MATERIALS *(Description)* d	PID (ppm) e	REMARKS *(Drilling time, water loss, depth of weathering, type of PID reading, etc., if significant)* g

CONTRACTOR	WELL NUMBER	Date
PARSONS		

Groundwater Monitoring Well Completion Data Record

PROJECT : Treatability Study at Former Titan 1-A Missile Facility
LOCATION: Lincoln, California
DRILLING SUBCONTRACTOR:
DRILLER:
DRILLING METHOD / EQUIPMENT:
HELPERS:
WATER LEVEL:
START:
END:
GEOLOGIST:

Flush Mount Surface Completion



DRAWING NOT TO SCALE

1- Ground elevation at well :

2- Measuring point elevation : top of the casing - north side

3- Surface completion casing :
   a) type / diameter
   b) Pad Material
   c) Pad Dimensions

4- Well casing :
   a) type / diameter
   b) height above ground
   c) length below ground
   d) type / quantity of sealant
   e) well centralizers

5- Well screen :
   a) type / diameter
   b) slot size
   c) top screen (feet bgs)
   d) bottom screen (feet bgs)

6- Well screen filter pack :
   a) type
   b) top filter pack (feet bgs)
   c) bottom filter pack (feet bgs)

7- Bentonite seal :
   a) method of placement
   b) type
   c) top seal (feet bgs)
   d) bottom seal (feet bgs)

8- Grout :
   a) type
   b) grout mix
   c) method of placement
   c) top grout (feet bgs)
   d) bottom grout (feet bgs)

9- Borehole diameter:

CONTRACTOR	WELL NUMBER	Date
Parsons		

Groundwater Monitoring Well Completion Data Record

PROJECT : Treatability Study at Former Titan 1-A Missile Facility

LOCATION: Lincoln, California

DRILLING SUBCONTRACTOR:

DRILLER:

DRILLING METHOD / EQUIPMENT:

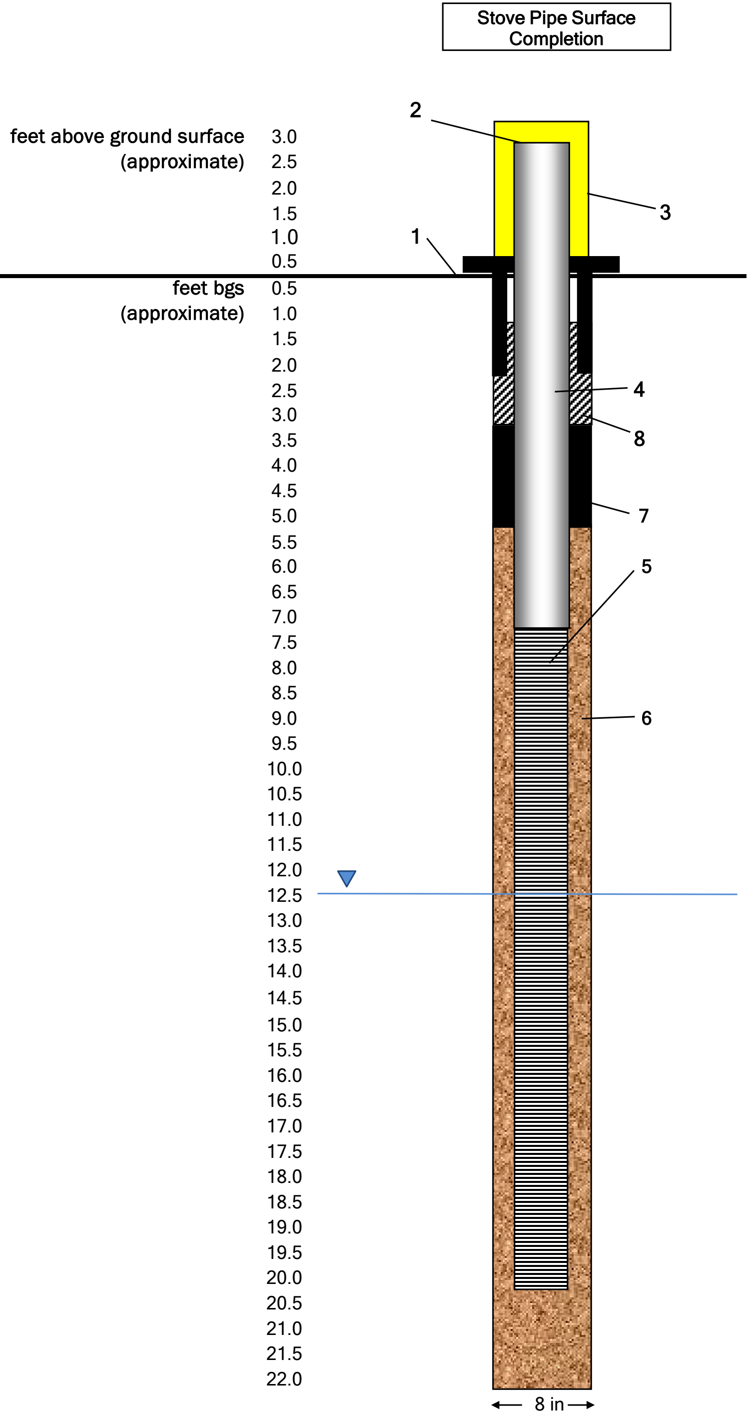
HELPERS:

WATER LEVEL:

START:

END:

GEOLOGIST:



DRAWING NOT TO SCALE

1- Ground elevation at well :

2- Measuring point elevation : top of the casing - north side

3- Surface completion casing :
- a) type / diameter
- b) height above ground
- c) length below ground
- d) type of sealant
- e) protective bollards

4- Well casing :
- a) type / diameter
- b) height above ground
- c) length below ground
- d) type / quantity of sealant
- e) well centralizers

5- Well screen :
- a) type / diameter
- b) slot size
- c) top screen (feet bgs)
- d) bottom screen (feet bgs)

6- Well screen filter pack :
- a) type
- b) top filter pack (feet bgs)
- c) bottom filter pack (feet bgs)

7- Bentonite seal :
- a) method of placement
- b) type
- c) top seal (feet bgs)
- d) bottom seal (feet bgs)

8- Grout :
- a) type
- b) grout mix
- c) method of placement
- c) top grout (feet bgs)
- d) bottom grout (feet bgs)

9- Borehole diameter:

PARSONS

WELL DEVELOPMENT FIELD FORM

PAGE OF

Well ID:
Project Name: *Treatability Study at Former Titan 1-A Missile Facility*
Start Date:

Site Location: *Lincoln, California*
Screen Interval (ft):_______________ (TOC / bgs)
Well Diameter (inch):_______________
End Date:

Date Well Installed:
(1)**Depth to Water (DTW)(ft):**__________ (TOC / bgs)
(2)**Total Well Depth (ft): Start:**__________**End:**__________ (TOC / bgs)

Well Drilling Company:
DTW After Development (ft):_________ (TOC / bgs)
Volume Fluid / Water Lost to Formation (gal) =

Development Operator:
Parsons Oversight:
PID initial (TOC) (ppm) =

Calculations:

Length of the water column: __________ (ft) - __________ (ft) = __________ (ft)
(2) (1) (3)

Purge Volume (PV): 1. PV = _________volume of fluid lost (gal) **x 3** = __________ (gal)

2. PV = __________ (ft) x ______ (gal/ft) **x 3** = __________ (gal)
(3) (4)

3. PV = __________ (ft) x ______ (gal/ft) **x 10** = __________ (gal)
(3) (4)

Volume of Schedule 40 PVC Pipe

Well Diameter (inches)	gal/linear ft. (4)
1.0	0.041
2.0	0.163
3.0	0.367
4.0	0.653

Well Development Method and Equipment:

( ) Bailing ___________________________
( ) Surge Block ________________________
( ) Over-Pumping ______________________
( ) Other: ____________________________

Well Development Criteria

Volume Purged > PV#1 and PV#2	Yes / No
Turbidity < 30 NTU?	Yes / No
Have field parameters stabilized?	Yes / No

Type of Meter(s) Used:

( ) YSI ______________
( ) HACH Turbidity Meter __________
( ) Horiba _____________
( )

==> If turbidity >30 NTU after PV#3 consider **<==**
(1.) Modify procedure (inc/dec pump depth and speed) . **(2.)** Longer duration if decreasing turbidity trend . **(3.)** Evaluate (a) is well likely to meet turbidity criteria? (b) alternative methods ? (c) if well should be P&A'd?

Time **(24 hrs)**	**Vol. Purged** **(gallons)**	**Purge Rate** **(GPM)**	**Water Level** **(ft)**	**pH** **(units)** (± 0.1)	**Temp.** **(^{0}C or ^{0}F)** ---	**Spec.Cond.** **(uS/cm)** (± 3%)	**DO** **(mg/l)** (± 0.3)	**ORP** **(mv)** (± 10mV)	**Turbidity** **(NTUs)** (< 30 & ± 10%)		**Comments** **(e.g., color, odor, pump placement)** START Time and Stabilization Criteria

Notes/Recommendations: ____

WELL GAUGING DATA

Project # _*750764.01003*________________ Date ____________________ Client ______________________

Project Name: *Treatability Study*	**Site:** *Former Titan 1-A Missile Facility, Lincoln, CA*
Sampler:	**Date:**

Well ID	Time	Well Size (in.)	Sheen / Odor	Depth to Immiscible Liquid (ft.)	Thickness of Immiscible Liquid (ft.)	Volume of Immiscibles Removed (ml)	Depth to water (ft.)	Depth to well bottom (ft.)	Survey Point: TOB or TOC	Notes

LOW FLOW WELL MONITORING DATA SHEET

Project Name: *Treatability Study*	Site: *Former Titan 1-A Missile Facility, Lincoln, California*
Sampler:	Start Date:
Well I.D.:	Well Diameter: 2 3 4 6 8 ____
Total Well Depth:	Depth to Water Pre: Post:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: PVC Grade	Flow Cell Type:____________________________

Purge Method: Electric Submersible Peristaltic Pump Bladder Pump
Sampling Method: Dedicated Tubing New Tubing Other______________

Flow Rate: ________________________ Pump Depth:__________________________

Time	**Temp. (^{o}C or ^{o}F)**	**pH**	**Cond. (mS or µS)**	**Turbidity (NTUs)**	**D.O. (mg/L)**	**ORP (mV)**	**Water Removed (gals. or mL)**	**Depth to Water**

Did well dewater? Yes No	Amount actually evacuated:
Sampling Time:	Sampling Date:
Sample I.D.:	Laboratory:
Analyzed for: See COC	Other:
Equipment Blank I.D.: @ Time	Duplicate I.D.:

EQUIPMENT CALIBRATION LOG

Equipment Type	Serial Number	Date	Calibration Time	Calibration Gas	Zero Air	Calibration Gas Reading	Calibrated By	Comments

PASSIVE FLUX METER DATA SHEET

Project Name: *Treatability Study*	Site: *Former Titan 1-A Missile Facility, Lincoln, California*
Sampler:	Start Date:
Well I.D.:	Well Diameter: 2 3 4 6 8 ____
Total Well Depth:	Well Condition:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: PVC Grade	

Passive Flux Meter Data

Length of PFM:	Diameter of PFM:
Number of sample intervals:	Length of sample intervals:
Date and Time Deployed:	Depth to Water Pre: Post:
	Depth to top of PFM:
Date and Time Retrieved:	Depth to Water Pre: Post:

Comments:

Sample Collection Data

Date	Time	Sample Depth Top	 Bottom	Sample I.D.

Comments:

Laboratory:	Analyzed for: See COC

Duplicate I.D.: @ Time

Equipment Blank I.D.: @ Time

GROUNDWATER SAMPLING INSTRUMENT CALIBRATION SHEET

Project Name: *Treatability Study at Former Titan 1-A Missile Facility, Lincoln, CA*

Job Number: ____

Date and Time: ____

Technician (Printed Name / Signature): ____

Field Parameter Multimeter

Model: ____

Serial Number: ____

Rental ID: ____

Specific Conductivity Standard, 1.413 mS/cm @ 25°C reads: ____ mS/cm @ ____°C

pH Standard 7.00 SU@ 25°C reads: ____ SU @____ °C / ORP reads: ____ mV

pH Standard 4.00 SU@ 25°C reads: ____ SU @____ °C / ORP reads: ____ mV

pH Standard 10.00 SU@ 25°C reads: ____ SU @____ °C / ORP reads: ____ mV

ORP Standard 240 mV @ 25°C reads: ____ Mv @____ °C / pH reads: ____ SU

Dissolved Oxygen is calibrated to 100%
saturated air at the current barometric pressure of ____ mb x 0.0295 = ____ inHg

Calibration Standard	Batch / Lot Number	Expiration Date
Specific Conductivity		
pH Standard 4.00		
pH Standard 7.00		
pH Standard 10.00		
ORP Standard 240mV		
pH Electrode Solution		
DO sensor electrode solution		

Turbidity Meter

SITE VISITOR LOG

Treatability Study at
Former Titan 1-A Missile Facility, Lincoln, California

Date	Time	Visitor Name	Company	Received Safety Briefing?	Staff Conducting Safety Briefing

CHAIN OF CUSTODY

EMAX Laboratories, Inc.	3051 Fujita St., Torrance, CA 90505 Tel # : 310-618-8889 FAX#: 310-618-0818 Email: info@emaxlabs.com	**PO NUMBER: 0015461** SAMPLE STORAGE	**EMAX CONTROL NO.** **PROJECT CODE:**

	MATRIX CODE	PRESERVATIVE CODE	TAT
CLIENT: Parsons			
PROJECT: Titan 1-A Semi-Annual Groundwater and Soil Vapor Sampling	DW=Drinking Water	IC = Ice	☐ Rush __24__hrs.
COORDINATOR	GW=Ground Water	HC = HCl	☐ Rush __48_hrs
TEL FAX EMAIL	WW=Waste Water	HN=HNO3	☐ Rush_72_hrs
SEND REPORT TO : carrie.ross@parsons.com; mark.rigby@parsons.com; sandra.delasfuentes@parsons.us	SD=Solid Waste SL=Sludge	SH=NaO3	☐ 7 days
COMPANY	SS=Soil/ Sediment	ST=Na2S2O3	☐ 14 days
ADDRESS	WP=Wipes PP=Pure Products	ZA=Zinc Acetate	☐ 21 days
	AR=Air	HS=H2SO4	
EMAX PM	O=		

ANALYSIS REQUIRED
- VOCs via SW8260
- Title 22 metals via SW6010/7471
- TCLP VOCs via SW1311/8260
- TCLP metals via SW1311/6010/7471
- STLC metals via SWWET/6010/7471

SAMPLE ID		SAMPLING			CONTAINER			MATRIX CODE	QC	PRESERVATIVE CODE										COMMENTS
LAB	CLIENT	LOCATION	DATE	TIME	NO.	SIZE	TYPE													
* 1																				
* 2																				
* 3																				
* 4																				
* 5																				
* 6																				
* 7																				
* 8																				
* 9																				
10																				

Instructions: Please have the analytical results sent to

Mark.rigby@parsons.com

carrie.ross@parsons.com

sandra.delasfuentes@parsons.us

Cooler #	Temp. (^{o}C)	Sample #s

SAMPLER

COURIER/AIRBILL

RELINQUISHED BY	Date	Time	RECEIVED BY

NOTICE: Turn-around-time (TAT) for samples shall not begin until all discrepancies have been resolved. For samples received and discrepancies resolved after 1500 hrs, TAT shall start at 0800 hrs the next business day. The client is responsible for all cost associated with sample disposal. Samples shall be disposed of as soon as practical (but not prior to fifteen (15) calendar days) after issuance of analytical report unless a different sample disposal schedule is pre-arranged with EMAX. Disposal fee for samples defined by CA Title 22 as non-hazardous shall be $5.00 per sample. EMAX will return hazardous samples to the client at the client's expense unless directed in writing otherwise.

Project J09CA1108-01

APPENDIX F – Laboratory Accreditation

CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

EMAX Laboratories, Inc.
3051 Fujita Street
Torrance, CA 90505

Fulfills the requirements of

ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.4)

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: 10 January 2026
Certificate Number: L2278

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 QSM V5.4)

EMAX Laboratories, Inc.

3051 Fujita Street
Torrance, CA 90505
Farina Madamba
310-618-8889

TESTING

Valid to: **January 10, 2026** Certificate Number: **L2278**

Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	AK101	GRO
GC	AK102	DRO
GC	AK 103	RRO
GFAA	CA 939M	Organo Lead
Platinum Electrode	EPA 120.1	Specific Conductance
Electrode	EPA 150.1	pH
Turbidimetric	EPA 180.1	Turbidity
ICP	EPA 200.7	Aluminum
ICP	EPA 200.7	Antimony
ICP	EPA 200.7	Arsenic
ICP	EPA 200.7	Barium
ICP	EPA 200.7	Beryllium
ICP	EPA 200.7	Boron
ICP	EPA 200.7	Cadmium
ICP	EPA 200.7	Calcium
ICP	EPA 200.7	Chromium
ICP	EPA 200.7	Cobalt

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 200.7	Copper
ICP	EPA 200.7	Iron
ICP	EPA 200.7	Lead
ICP	EPA 200.7	Lithium
ICP	EPA 200.7	Magnesium
ICP	EPA 200.7	Manganese
ICP	EPA 200.7	Molybdenum
ICP	EPA 200.7	Nickel
ICP	EPA 200.7	Potassium
ICP	EPA 200.7	Selenium
ICP	EPA 200.7	Silver
ICP	EPA 200.7	Sodium
ICP	EPA 200.7	Strontium
ICP	EPA 200.7	Thallium
ICP	EPA 200.7	Tin
ICP	EPA 200.7	Titanium
ICP	EPA 200.7	Vanadium
ICP	EPA 200.7	Zinc
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc
IC	EPA 218.6	Hexavalent Chromium
COLD VAPOR	EPA 245.1	Mercury
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Phosphate
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromate
IC	EPA 300.0	Chlorate
IC	EPA 300.0	Nitrate-Nitrite
IC	EPA 300M	Lactate
IC	EPA 300M	Acetate
IC	EPA 300M	Propionate
IC	EPA 300M	Butyrate
IC	EPA 300M	Pyruvate
IC	EPA 314.0	Perchlorate
Spectrometric	EPA 410.4	COD
Spectrometric	EPA 420.1	Phenols
GC	EPA 504.1	DBCP
GC	EPA 504.1	EDB
GC	EPA 608/608.3	Aldrin
GC	EPA 608/608.3	alpha-BHC
GC	EPA 608/608.3	beta-BHC
GC	EPA 608/608.3	delta-BHC
GC	EPA 608/608.3	gamma-BHC (Lindane)
GC	EPA 608/608.3	DDD (4,4)
GC	EPA 608/608.3	DDE (4,4)

Non-Potable Water

Technology	Method	Analyte
GC	EPA 608/608.3	DDT (4,4)
GC	EPA 608/608.3	Dieldrin
GC	EPA 608/608.3	Endosulfan I
GC	EPA 608/608.3	Endosulfan II
GC	EPA 608/608.3	Endosulfan sulfate
GC	EPA 608/608.3	Endrin
GC	EPA 608/608.3	Endrin Aldehyde
GC	EPA 608/608.3	Heptachlor
GC	EPA 608/608.3	Heptachlor epoxide
GC	EPA 608/608.3	Methoxychlor
GC	EPA 608/608.3	alpha-Chlordane
GC	EPA 608/608.3	gamma-Chlordane
GC	EPA 608/608.3	Endrin Ketone
GC	EPA 608/608.3	Toxaphene
GC	EPA 608/608.3	Technical Chlordane
GC	EPA 608/608.3	cis-Nonachlor
GC	EPA 608/608.3	DDD (2,4)
GC	EPA 608/608.3	DDE (2,4)
GC	EPA 608/608.3	DDT (2,4)
GC	EPA 608/608.3	Mirex
GC	EPA 608/608.3	Oxychlordane
GC	EPA 608/608.3	trans-Nonachlor
GC	EPA 608/608.3	PCB1016
GC	EPA 608/608.3	PCB1221
GC	EPA 608/608.3	PCB1232
GC	EPA 608/608.3	PCB1242
GC	EPA 608/608.3	PCB1248
GC	EPA 608/608.3	PCB1254
GC	EPA 608/608.3	PCB1260
GC	EPA 608/608.3	PCB1262
GC	EPA 608/608.3	PCB1268
GC-MS	EPA 624/624.1	Acrolein
GC-MS	EPA 624/624.1	Acrylonitrile
GC-MS	EPA 624/624.1	Benzene
GC-MS	EPA 624/624.1	Bromodichloromethane
GC-MS	EPA 624/624.1	Bromoform
GC-MS	EPA 624/624.1	Bromomethane
GC-MS	EPA 624/624.1	Carbon tetrachloride

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 624/624.1	Chlorobenzene
GC-MS	EPA 624/624.1	2-Chloroethyl vinyl ether
GC-MS	EPA 624/624.1	Chloroethane
GC-MS	EPA 624/624.1	Chloroform
GC-MS	EPA 624/624.1	Chloromethane
GC-MS	EPA 624/624.1	Dibromochloromethane
GC-MS	EPA 624/624.1	1,1-Dichloroethane
GC-MS	EPA 624/624.1	1,2-Dichloroethane
GC-MS	EPA 624/624.1	1,2-Dichlorobenzene
GC-MS	EPA 624/624.1	1,3-Dichlorobenzene
GC-MS	EPA 624/624.1	1,4-Dichlorobenzene
GC-MS	EPA 624/624.1	Dichlorodifluoromethane
GC-MS	EPA 624/624.1	1,1-Dichloroethene
GC-MS	EPA 624/624.1	cis-1,2-Dichloroethene
GC-MS	EPA 624/624.1	trans-1,2-Dichloroethene
GC-MS	EPA 624/624.1	1,2-Dichloropropane
GC-MS	EPA 624/624.1	cis-1,3-Dichloropropene
GC-MS	EPA 624/624.1	trans-1,3-Dichloropropene
GC-MS	EPA 624/624.1	Ethylbenzene
GC-MS	EPA 624/624.1	Methylene Chloride
GC-MS	EPA 624/624.1	tert-Butyl methyl ether
GC-MS	EPA 624/624.1	Styrene
GC-MS	EPA 624/624.1	1,1,2,2-Tetrachloroethane
GC-MS	EPA 624/624.1	Tetrachloroethene
GC-MS	EPA 624/624.1	Toluene
GC-MS	EPA 624/624.1	1,1,1-Trichloroethane
GC-MS	EPA 624/624.1	1,1,2-Trichloroethane
GC-MS	EPA 624/624.1	1,2,4-Trichlorobenzene
GC-MS	EPA 624/624.1	Trichloroethene
GC-MS	EPA 624/624.1	Trichlorofluoromethane
GC-MS	EPA 624/624.1	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 624/624.1	Vinyl Chloride
GC-MS	EPA 624/624.1	m-Xylene & p-xylene
GC-MS	EPA 624/624.1	o-Xylene
GC-MS	EPA 625/625.1	Acenaphthene
GC-MS	EPA 625/625.1	Acenaphthylene
GC-MS	EPA 625/625.1	Aniline

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 625/625.1	Anthracene
GC-MS	EPA 625/625.1	Azobenzene
GC-MS	EPA 625/625.1	Benzidine
GC-MS	EPA 625/625.1	Benzo(a)anthracene
GC-MS	EPA 625/625.1	benzo(a)pyrene
GC-MS	EPA 625/625.1	Benzo(b)fluoranthene
GC-MS	EPA 625/625.1	Benzo(e)pyrene
GC-MS	EPA 625/625.1	Benzo(g,h,i)perylene
GC-MS	EPA 625/625.1	Benzo(k)fluoranthene
GC-MS	EPA 625/625.1	Benzoic Acid
GC-MS	EPA 625/625.1	Benzyl Alcohol
GC-MS	EPA 625/625.1	Biphenyl
GC-MS	EPA 625/625.1	bis(2-chloroethoxy)methane
GC-MS	EPA 625/625.1	bis(2-chloroethyl)ether
GC-MS	EPA 625/625.1	2,2-oxybis(1-chloropropane)
GC-MS	EPA 625/625.1	bis(2-Ethylhexyl)adipate
GC-MS	EPA 625/625.1	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 625/625.1	4-Bromophenyl-phenylether
GC-MS	EPA 625/625.1	Butylbenzylphthalate
GC-MS	EPA 625/625.1	Carbazole
GC-MS	EPA 625/625.1	4-Chloro-3-methylphenol
GC-MS	EPA 625/625.1	4-Chloroaniline
GC-MS	EPA 625/625.1	2-Chloronaphthalene
GC-MS	EPA 625/625.1	2-Chlorophenol
GC-MS	EPA 625/625.1	4-Chlorophenyl-phenylether
GC-MS	EPA 625/625.1	Chrysene
GC-MS	EPA 625/625.1	Dibenzo(a,h)anthracene
GC-MS	EPA 625/625.1	Dibenzofuran
GC-MS	EPA 625/625.1	1,2-Dichlorobenzene
GC-MS	EPA 625/625.1	1,3-Dichlorobenzene
GC-MS	EPA 625/625.1	1,4-Dichlorobenzene
GC-MS	EPA 625/625.1	3,3'-Dichlorobenzidine
GC-MS	EPA 625/625.1	2,4-Dichlorophenol
GC-MS	EPA 625/625.1	Diethylphthalate
GC-MS	EPA 625/625.1	2,6-Dimethylnaphthalene
GC-MS	EPA 625/625.1	2,4-Dimethylphenol
GC-MS	EPA 625/625.1	Dimethylphthalate
GC-MS	EPA 625/625.1	Di-n-butylphthalate

Non-Potable Water

Technology	Method	Analyte
GC-MS	EPA 625/625.1	4,6-Dinitro-2-methylphenol
GC-MS	EPA 625/625.1	2,4-Dinitrophenol
GC-MS	EPA 625/625.1	2,4-Dinitrotoluene
GC-MS	EPA 625/625.1	2,6-Dinitrotoluene
GC-MS	EPA 625/625.1	Di-n-octylphthalate
GC-MS	EPA 625/625.1	1,2-Diphenylhydrazine
GC-MS	EPA 625/625.1	Fluoranthene
GC-MS	EPA 625/625.1	Fluorene
GC-MS	EPA 625/625.1	Hexachlorobenzene
GC-MS	EPA 625/625.1	Hexachlorobutadiene
GC-MS	EPA 625/625.1	Hexachlorocyclopentadiene
GC-MS	EPA 625/625.1	Hexachloroethane
GC-MS	EPA 625/625.1	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 625/625.1	Isophorone
GC-MS	EPA 625/625.1	1-Methylnaphthalene
GC-MS	EPA 625/625.1	2-Methylnaphthalene
GC-MS	EPA 625/625.1	1-Methylphenanthrene
GC-MS	EPA 625/625.1	2-Methylphenol
GC-MS	EPA 625/625.1	3/4-Methylphenol
GC-MS	EPA 625/625.1	Naphthalene
GC-MS	EPA 625/625.1	2-Nitroaniline
GC-MS	EPA 625/625.1	3-Nitroaniline
GC-MS	EPA 625/625.1	4-Nitroaniline
GC-MS	EPA 625/625.1	Nitrobenzene
GC-MS	EPA 625/625.1	2-Nitrophenol
GC-MS	EPA 625/625.1	4-Nitrophenol
GC-MS	EPA 625/625.1	n-Nitrosodimethylamine
GC-MS	EPA 625/625.1	n-Nitroso-di-n-propylamine
GC-MS	EPA 625/625.1	n-Nitrosodiphenylamine
GC-MS	EPA 625/625.1	Pentachlorophenol
GC-MS	EPA 625/625.1	Perylene
GC-MS	EPA 625/625.1	Phenanthrene
GC-MS	EPA 625/625.1	Phenol
GC-MS	EPA 625/625.1	Pyrene
GC-MS	EPA 625/625.1	Pyridine
GC-MS	EPA 625/625.1	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 625/625.1	1,2,4-Trichlorobenzene
GC-MS	EPA 625/625.1	2,3,4-Trichlorophenol

Non-Potable Water

Technology	Method	Analyte
GC-MS	EPA 625/625.1	2,3,5-Trichlorophenol
GC-MS	EPA 625/625.1	2,4,5-Trichlorophenol
GC-MS	EPA 625/625.1	2,4,6-Trichlorophenol
GC-MS	EPA 625/625.1	2,3,5-Trimethylnaphthalene
Gravimetric	EPA 1664A / 1664 B	Oil & Grease
Pensky-Martens	EPA 1010 / 1010A	Ignitability
ICP	EPA 6010B / 6010C	Aluminum
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead
ICP	EPA 6010B / 6010C	Lithium
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Lithium
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Mercury
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc
HPLC-MS	EPA 6850	Perchlorate
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7470A	Mercury
GC	EPA 8015B / 8015C / 8015D	GRO
GC	EPA 8015B / 8015C / 8015D	DRO
GC	EPA 8015B / 8015C / 8015D	ORO
GC	EPA 8015B / 8015C	Diethylene Glycol
GC	EPA 8015B / 8015C	Ethanol
GC	EPA 8015B / 8015C	Ethylene Glycol
GC	EPA 8015B / 8015C	Isopropanol

Non-Potable Water

Technology	Method	Analyte
GC	EPA 8015B / 8015C / 8015D	JP4
GC	EPA 8015B / 8015C	Methanol
GC	EPA 8015B / 8015C	Propylene Glycol
GC	EPA 8015B / 8015C / 8015D	JP5
GC	EPA 8015B / 8015C	Triethylene Glycol
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8081A / 8081B	cis-Nonachlor
GC	EPA 8081A / 8081B	DDD (2,4)
GC	EPA 8081A / 8081B	DDE (2,4)
GC	EPA 8081A / 8081B	DDT (2,4)
GC	EPA 8081A / 8081B	Mirex
GC	EPA 8081A / 8081B	Oxychlordane
GC	EPA 8081A / 8081B	trans-Nonachlor
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232
GC	EPA 8082 / 8082A	PCB1242

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8082 / 8082A	PCB 110
GC	EPA 8141A / 8141B	Azinphos-methyl
GC	EPA 8141A / 8141B	Bolstar
GC	EPA 8141A / 8141B	Chlorpyrifos
GC	EPA 8141A / 8141B	Coumaphos

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8141A / 8141B	Total Demeton
GC	EPA 8141A / 8141B	Diazinon
GC	EPA 8141A / 8141B	Dichlorvos
GC	EPA 8141A / 8141B	Disulfoton
GC	EPA 8141A / 8141B	Ethoprop
GC	EPA 8141A / 8141B	Fensulfothion
GC	EPA 8141A / 8141B	Fenthion
GC	EPA 8141A / 8141B	Merphos
GC	EPA 8141A / 8141B	Mevinphos
GC	EPA 8141A / 8141B	Naled
GC	EPA 8141A / 8141B	Methyl Parathion
GC	EPA 8141A / 8141B	Phorate
GC	EPA 8141A / 8141B	Ronnel
GC	EPA 8141A / 8141B	Stirophos
GC	EPA 8141A / 8141B	Tokuthion
GC	EPA 8141A / 8141B	Trichloronate
GC	EPA 8141A / 8141B	Dimethoate
GC	EPA 8141A / 8141B	EPN
GC	EPA 8141A / 8141B	Famphur
GC	EPA 8141A / 8141B	Malathion
GC	EPA 8141A / 8141B	Ethyl Parathion
GC	EPA 8141A / 8141B	O,O,O-Triethylphosphorothioate
GC	EPA 8141A / 8141B	Sulfotepp
GC	EPA 8141A / 8141B	Thionazin
GC	EPA 8141A / 8141B	Tributyl Phosphate
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5-Dichlorobenzoic acid
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP

Non-Potable Water

Technology	Method	Analyte
GC	EPA 8151A	4-Nitrophenol
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex
GC	EPA 8151A	2,4,5-T
GC-MS	EPA 8260B / 8260C	Acetone
GC-MS	EPA 8260B / 8260C	Acetonitrile
GC-MS	EPA 8260B / 8260C	Acrolein
GC-MS	EPA 8260B / 8260C	Acrylonitrile
GC-MS	EPA 8260B / 8260C	Benzene
GC-MS	EPA 8260B / 8260C	Bromobenzene
GC-MS	EPA 8260B / 8260C	Bromochloromethane
GC-MS	EPA 8260B / 8260C	Bromodichloromethane
GC-MS	EPA 8260B / 8260C	Bromoform
GC-MS	EPA 8260B / 8260C	Bromomethane
GC-MS	EPA 8260B / 8260C	tert-Butyl alcohol
GC-MS	EPA 8260B / 8260C	2-Butanone (MEK)
GC-MS	EPA 8260B / 8260C	n-Butylbenzene
GC-MS	EPA 8260B / 8260C	sec-Butylbenzene
GC-MS	EPA 8260B / 8260C	tert-Butylbenzene
GC-MS	EPA 8260B / 8260C	Carbon disulfide
GC-MS	EPA 8260B / 8260C	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C	Chlorobenzene
GC-MS	EPA 8260B / 8260C	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B / 8260C	Chloroethane
GC-MS	EPA 8260B / 8260C	Chloroform
GC-MS	EPA 8260B / 8260C	1-Chlorohexane
GC-MS	EPA 8260B / 8260C	Chloromethane
GC-MS	EPA 8260B / 8260C	2-Chlorotoluene
GC-MS	EPA 8260B / 8260C	4-Chlorotoluene
GC-MS	EPA 8260B / 8260C	Isopropyl ether (DIPE)
GC-MS	EPA 8260B / 8260C	Dibromochloromethane
GC-MS	EPA 8260B / 8260C	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C	Dibromomethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	1,3-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B / 8260C	1,4-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	Dichlorodifluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	Dichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloropropene
GC-MS	EPA 8260B / 8260C	1,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	1,3-Dichloropropane
GC-MS	EPA 8260B / 8260C	2,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	cis-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	trans-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Ethylbenzene
GC-MS	EPA 8260B / 8260C	2-Hexanone (MBK)
GC-MS	EPA 8260B / 8260C	Hexachlorobutadiene
GC-MS	EPA 8260B / 8260C	Iodomethane
GC-MS	EPA 8260B / 8260C	Isopropylbenzene
GC-MS	EPA 8260B / 8260C	p-Isopropyltoluene
GC-MS	EPA 8260B / 8260C	Methylene Chloride
GC-MS	EPA 8260B / 8260C	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B / 8260C	tert-Butyl methyl ether
GC-MS	EPA 8260B / 8260C	Naphthalene
GC-MS	EPA 8260B / 8260C	n-Propylbenzene
GC-MS	EPA 8260B / 8260C	Styrene
GC-MS	EPA 8260B / 8260C	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B / 8260C	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	Tetrachloroethene
GC-MS	EPA 8260B / 8260C	Toluene
GC-MS	EPA 8260B / 8260C	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	Trichloroethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	Trichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B / 8260C	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	Vinyl Acetate
GC-MS	EPA 8260B / 8260C	Vinyl Chloride
GC-MS	EPA 8260B / 8260C	m-Xylene & p-xylene
GC-MS	EPA 8260B / 8260C	o-Xylene
GC-MS	EPA 8260B / 8260C	Allyl Chloride
GC-MS	EPA 8260B / 8260C	Benzyl chloride
GC-MS	EPA 8260B / 8260C	Chloroprene
GC-MS	EPA 8260B / 8260C	Cyclohexane
GC-MS	EPA 8260B / 8260C	1,4-Dioxane
GC-MS	EPA 8260B / 8260C	2-Chloro-1,1,1-trifluoroethane
GC-MS	EPA 8260B / 8260C	Chlorotrifluoroethylene
GC-MS	EPA 8260B / 8260C	cis-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C	Ethanol
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Isobutyl Alcohol
GC-MS	EPA 8260B / 8260C	Methacrylonitrile
GC-MS	EPA 8260B / 8260C	Methyl Methacrylate
GC-MS	EPA 8260B / 8260C	Pentachloroethane
GC-MS	EPA 8260B / 8260C	Propionitrile
GC-MS	EPA 8260B / 8260C	Sec-Propyl alcohol
GC-MS	EPA 8260B / 8260C	Tetrahydrofuran
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C SIM	Benzene
GC-MS	EPA 8260B / 8260C SIM	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C SIM	Chloroform
GC-MS	EPA 8260B / 8260C SIM	Chloromethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	trans-1,2-Dichloroethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C SIM	Tetrachloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	Trichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C SIM	Vinyl Chloride
GC-MS	EPA 8260B / 8260C SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	2,2-oxybis(1-chloropropane)
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene

Non-Potable Water

Technology	Method	Analyte
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2,6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol
GC-MS	EPA 8270C / 8270D	3/4-Methylphenol
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D	1,2,4,5-Tetrachlorobenzene
GC-MS	EPA 8270C / 8270D	1,3,5-Trinitrobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dinitrobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	1,4-Naphthoquinone
GC-MS	EPA 8270C / 8270D	1-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	1-Naphthylamine
GC-MS	EPA 8270C / 8270D	2,6-Dichlorophenol
GC-MS	EPA 8270C / 8270D	2-acetylaminofluorene
GC-MS	EPA 8270C / 8270D	2-Naphthylamine
GC-MS	EPA 8270C / 8270D	2-Picoline
GC-MS	EPA 8270C / 8270D	3,3-Dimethylbenzidine
GC-MS	EPA 8270C / 8270D	3,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3,5-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3-Methylchlolanthrene
GC-MS	EPA 8270C / 8270D	4-Aminobiphenyl
GC-MS	EPA 8270C / 8270D	4-Nitroquinoline-N-oxide
GC-MS	EPA 8270C / 8270D	5-Nitro-o-toluidine
GC-MS	EPA 8270C / 8270D	7,12-Dimethylbenz(a)anthracene
GC-MS	EPA 8270C / 8270D	a,a-dimethylphenethylamine
GC-MS	EPA 8270C / 8270D	Acetophenone
GC-MS	EPA 8270C / 8270D	Aramite
GC-MS	EPA 8270C / 8270D	Atrazine
GC-MS	EPA 8270C / 8270D	Biphenyl

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Chlorobenzilate
GC-MS	EPA 8270C / 8270D	Diallate
GC-MS	EPA 8270C / 8270D	Dibenzo(a,j)acridine
GC-MS	EPA 8270C / 8270D	Dimethoate
GC-MS	EPA 8270C / 8270D	Dinoseb
GC-MS	EPA 8270C / 8270D	Diphenyl ether
GC-MS	EPA 8270C / 8270D	Disulfoton
GC-MS	EPA 8270C / 8270D	Ethyl methacrylate
GC-MS	EPA 8270C / 8270D	Ethyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Ethyl parathion
GC-MS	EPA 8270C / 8270D	Famphur
GC-MS	EPA 8270C / 8270D	Hexachlorophene
GC-MS	EPA 8270C / 8270D	Hexachloropropene
GC-MS	EPA 8270C / 8270D	Isodrin
GC-MS	EPA 8270C / 8270D	Isosafrole
GC-MS	EPA 8270C / 8270D	kepone
GC-MS	EPA 8270C / 8270D	Methapyrilene
GC-MS	EPA 8270C / 8270D	Methyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Methyl parathion
GC-MS	EPA 8270C / 8270D	N-nitrosodiethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosodi-n-butylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomethylethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomorpholine
GC-MS	EPA 8270C / 8270D	N-Nitrosopiperdine
GC-MS	EPA 8270C / 8270D	N-Nitrosopyrrolidine
GC-MS	EPA 8270C / 8270D	O,O,O-triethyl phosphorothi
GC-MS	EPA 8270C / 8270D	o-toluidine
GC-MS	EPA 8270C / 8270D	p-Dimethylaminoazobenze
GC-MS	EPA 8270C / 8270D	Pentachlorobenzene
GC-MS	EPA 8270C / 8270D	Pentachloroethane
GC-MS	EPA 8270C / 8270D	Pentachloronitrobenzene
GC-MS	EPA 8270C / 8270D	Phenacetin
GC-MS	EPA 8270C / 8270D	Phorate
GC-MS	EPA 8270C / 8270D	p-phenylenediamine
GC-MS	EPA 8270C / 8270D	Pronamide
GC-MS	EPA 8270C / 8270D	Safrole
GC-MS	EPA 8270C / 8270D	Sulfotepp
GC-MS	EPA 8270C / 8270D	Thionazin

Non-Potable Water

Technology	Method	Analyte
GC-MS	EPA 8270C / 8270D	Benzaldehyde
GC-MS	EPA 8270C / 8270D	Caprolactam
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene

Non-Potable Water

Technology	Method	Analyte
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D SIM	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D SIM	Diethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Dimethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-octylphthalate
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
HPLC	EPA 8330A / 8330 B	HMX
HPLC	EPA 8330A / 8330 B	RDX
HPLC	EPA 8330A / 8330 B	1,3,5-TNB
HPLC	EPA 8330A / 8330 B	1,3-DNB
HPLC	EPA 8330A / 8330 B	Tetryl
HPLC	EPA 8330A / 8330 B	Nitrobenzene
HPLC	EPA 8330A / 8330 B	2,4,6-TNT
HPLC	EPA 8330A / 8330 B	4-AM-2,6-DNT
HPLC	EPA 8330A / 8330 B	2-AM-4,6-DNT
HPLC	EPA 8330A / 8330 B	2,6-DNT
HPLC	EPA 8330A / 8330 B	2,4-DNT

Non-Potable Water

Technology	Method	Analyte
HPLC	EPA 8330A / 8330 B	2-Nitrotoluene
HPLC	EPA 8330A / 8330 B	4-Nitrotoluene
HPLC	EPA 8330A / 8330 B	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
HPLC	EPA 8330A	2,4-Diamino-6-nitrotoluene
HPLC	EPA 8330A	2,6-Diamino-4-nitrotoluene
HPLC	EPA 8330A	Picric Acid
HPLC	EPA 8332	Nitroglycerine
HPLC	EPA 8332	PETN
Spectrometric	EPA 9014	Cyanide
Electrode	EPA 9040B / 9040C	pH
IC	EPA 9056 / 9056A	Bromate
IC	EPA 9056 / 9056A	Bromide
IC	EPA 9056 / 9056A	Chloride
IC	EPA 9056 / 9056A	Fluoride
IC	EPA 9056 / 9056A	Nitrate
IC	EPA 9056 / 9056A	Nitrite
IC	EPA 9056 / 9056A	Phosphate
IC	EPA 9056 / 9056A	Sulfate
IC	EPA 9056 / 9056A	Chlorate
IC	EPA 9056 / 9056A	Nitrate - Nitrite
Combustion-IR	EPA 9060A	TOC
Spectrometric	EPA 9065	Phenols
Gravimetric	EPA 9070A	Oil & Grease
GC	RSK175	Methane
GC	RSK175	Acetylene
GC	RSK175	Ethylene
GC	RSK175	Ethane
GC	RSK175	Propane
GC	RSK175	Carbon dioxide
GC	RSK175	Propene
Spectrometric	SM 4500-NH3F-2011 SM 4500-NH3F-1997	Ammonia
Spectrometric	SM 4500-NOrgC-2011NH3F-2011 SM 4500-NOrgC-1997NH3F-1997	TKN
Spectrometric	SM 4500-PE-2011 SM 4500-PE-1999	Phosphorus
Turbidimetric	SM 2130B-2011/ SM 2130B-2001	Turbidity

Non-Potable Water

Technology	Method	Analyte
Titrimetric	SM 2310B-2011/ SM 2310B-1997	Acidity
Titrimetric	SM 2320B-2011/ SM 2320B-1997	Alkalinity
Titrimetric	SM 2340C-2011/ SM 2340C-1997	Hardness
Platinum Electrode	SM 2510B-2011/ SM 2510B-1997	Specific Conductance
Electrical Conductivity	SM 2520B-1993	Salinity
Gravimetric	SM 2540C-2011/ SM 2540C-1997	TDS
Gravimetric	SM 2540D-2011/ SM 2540D-1997	TSS
Gravimetric	SM 2540B-2011/ SM 2540B-1997	Total Residue
Gravimetric	SM 2540F-2011/ SM 2540F-1997	Settleable Residue
Spectrometric	SM 3500-FeB-2011 SM 3500-FeB-1997	Ferrous iron
IC	SM 4110B-2011/ SM 4110B-2000	Bromate
IC	SM 4110B-2011/ SM 4110B-2000	Bromide
IC	SM 4110B-2011/ SM 4110B-2000	Chloride
IC	SM 4110B-2011/ SM 4110B-2000	Fluoride
IC	SM 4110B-2011/ SM 4110B-2000	Nitrate
IC	SM 4110B-2011/ SM 4110B-2000	Nitrite
IC	SM 4110B-2011/ SM 4110B-2000	Phosphate
IC	SM 4110B-2011/ SM 4110B-2000	Sulfate
IC	SM 4110B-2011/ SM 4110B-2000	Chlorate
IC	SM 4110B-2011/ SM 4110B-2000	Nitrate – Nitrite
Titrimetric	SM 4500-Cl-B-2011 SM 4500-Cl-B-1997	Chloride
Spectrometric	SM 4500-CN E-2011 SM 4500-CN E-1999	Cyanide
Electrode	SM 4500-HB-2011/ SM 4500-HB-2000	pH
Spectrometric	SM 4500-NO2B-2011 SM 4500-NO2B-2000	Nitrite-N
Spectrometric	SM 4500-NO3E-2011 SM 4500-NO3E-2000	Nitrate-N
Spectrometric	SM 4500-P E-2011/ SM 4500-P E-1999	Ortho-phosphate
Spectrometric	SM 4500-P E(PB5)-2011 SM 4500-P E(PB5)-1999	Phosphorus
Spectrometric	SM 4500-S2D-2011 SM 4500-S2D-2000	Sulfide
Titrimetric	SM 4500-S2F-2011 SM 4500-S2F-2000	Sulfide
Spectrometric	SM 4500-SiO2C-2011 SM 4500-SiO2C-1997	Silica

Non-Potable Water		
Technology	**Method**	**Analyte**
Electrode	SM 5210B-2011/ SM 5210B-2001	BOD
Spectrometric	SM 5220D-2011/ SM 5220D-1997	COD
Combustion-IR	SM 5310B-2011/ SM 5310B-2000	TOC
Spectrometric	SM 5540C-2011/ SM 5540C-2000	Surfactants (MBAS)
Distillation	EPA 9010C	Cyanide
MicroDistillation	QuickChem 10-204-00-1-X	Cyanide
ICP/ICP-MS	SM 2340B-2011/ SM 2340B-1997	Hardness
GC	EPA 8011	DBCP
GC	EPA 8011	EDB
Platinum Electrode	EPA 9050A	Specific Conductance
Gravimetric	SM 5520B-2011/ SM 5520B-2001	Oil & Grease
Preparation	**Method**	**Type**
Purge & Trap	EPA 5030B / EPA 5030C	Volatiles Prep
Acid Digestion	EPA 3010A / EPA 200.8 / EPA 200.7	Metals Prep
Continuous Liquid-Liquid	EPA 3520C	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
TCLP	EPA 1311	Leaching
SPLP	EPA 1312	Leaching

Drinking Water		
Technology	**Method**	**Analyte**
Platinum Electrode	EPA 120.1	Specific Conductance
Electrode	EPA 150.1	pH
Turbidimetric	EPA 180.1	Turbidity
Turbidimetric	SM 2130B-2011/ SM 2130B-2001	Turbidity
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt

Drinking Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc
IC	EPA 218.6	Hexavalent Chromium
Cold Vapor	EPA 245.1	Mercury
IC	EPA 300.0	Bromate
IC	EPA 300.0	Bromide
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Phosphate
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Chlorate
IC	EPA 300.0	Nitrate - Nitrite
IC	EPA 300M	Acetate
IC	EPA 300M	Butyrate
IC	EPA 300M	Lactate
IC	EPA 300M	Propionate
IC	EPA 300M	Pyruvate

Drinking Water

Technology	Method	Analyte
IC	EPA 314.0	Perchlorate
Spectrometric	EPA 410.4	COD
Spectrometric	EPA 420.1	Phenols
GC	EPA 504.1	DBCP
GC	EPA 504.1	EDB
GC-MS	EPA 524.2	Acetone
GC-MS	EPA 524.2	Benzene
GC-MS	EPA 524.2	Bromobenzene
GC-MS	EPA 524.2	Bromochloromethane
GC-MS	EPA 524.2	Bromodichloromethane
GC-MS	EPA 524.2	Bromoform
GC-MS	EPA 524.2	Bromomethane
GC-MS	EPA 524.2	tert-Butyl alcohol
GC-MS	EPA 524.2	2-Butanone (MEK)
GC-MS	EPA 524.2	n-Butylbenzene
GC-MS	EPA 524.2	sec-Butylbenzene
GC-MS	EPA 524.2	tert-Butylbenzene
GC-MS	EPA 524.2	Carbon disulfide
GC-MS	EPA 524.2	Carbon tetrachloride
GC-MS	EPA 524.2	Chlorobenzene
GC-MS	EPA 524.2	Chloroethane
GC-MS	EPA 524.2	Chloroform
GC-MS	EPA 524.2	Chloromethane
GC-MS	EPA 524.2	2-Chlorotoluene
GC-MS	EPA 524.2	4-Chlorotoluene
GC-MS	EPA 524.2	Dibromochloromethane
GC-MS	EPA 524.2	1,2-Dibromo-3-chloropropane
GC-MS	EPA 524.2	1,2-Dibromoethane
GC-MS	EPA 524.2	Dibromomethane
GC-MS	EPA 524.2	1,1-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichlorobenzene
GC-MS	EPA 524.2	1,3-Dichlorobenzene
GC-MS	EPA 524.2	1,4-Dichlorobenzene
GC-MS	EPA 524.2	Dichlorodifluoromethane
GC-MS	EPA 524.2	1,1-Dichloroethene

Drinking Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 524.2	cis-1,2-Dichloroethene
GC-MS	EPA 524.2	trans-1,2-Dichloroethene
GC-MS	EPA 524.2	1,1-Dichloropropene
GC-MS	EPA 524.2	1,2-Dichloropropane
GC-MS	EPA 524.2	1,3-Dichloropropane
GC-MS	EPA 524.2	2,2-Dichloropropane
GC-MS	EPA 524.2	cis-1,3-Dichloropropene
GC-MS	EPA 524.2	trans-1,3-Dichloropropene
GC-MS	EPA 524.2	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 524.2	Ethylbenzene
GC-MS	EPA 524.2	2-Hexanone (MBK)
GC-MS	EPA 524.2	Hexachlorobutadiene
GC-MS	EPA 524.2	Isopropyl ether (DIPE)
GC-MS	EPA 524.2	Isopropylbenzene
GC-MS	EPA 524.2	p-Isopropyltoluene
GC-MS	EPA 524.2	Methylene Chloride
GC-MS	EPA 524.2	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 524.2	tert-Butyl methyl ether
GC-MS	EPA 524.2	Naphthalene
GC-MS	EPA 524.2	n-Propylbenzene
GC-MS	EPA 524.2	Styrene
GC-MS	EPA 524.2	tert-Amyl methyl ether (TAME)
GC-MS	EPA 524.2	1,1,1,2-Tetrachloroethane
GC-MS	EPA 524.2	1,1,2,2-Tetrachloroethane
GC-MS	EPA 524.2	Tetrachloroethene
GC-MS	EPA 524.2	Toluene
GC-MS	EPA 524.2	1,1,1-Trichloroethane
GC-MS	EPA 524.2	1,1,2-Trichloroethane
GC-MS	EPA 524.2	1,2,3-Trichlorobenzene
GC-MS	EPA 524.2	1,2,4-Trichlorobenzene
GC-MS	EPA 524.2	Trichloroethene
GC-MS	EPA 524.2	Trichlorofluoromethane
GC-MS	EPA 524.2	1,2,3-Trichloropropane
GC-MS	EPA 524.2	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 524.2	1,2,4-Trimethylbenzene

Drinking Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 524.2	1,3,5-Trimethylbenzene
GC-MS	EPA 524.2	Vinyl Chloride
GC-MS	EPA 524.2	m-Xylene & p-xylene
GC-MS	EPA 524.2	o-Xylene
Titrimetric	SM 2320B-2011/ SM 2320B-1997	Alkalinity
HPLC-MS	EPA 6850	Perchlorate
Colorimetric	SM 2120B-2011/ SM 2120B-2001	Color
Threshold Odor Test	SM 2150B-2011/ SM 2150B-1997	Odor
ICP/ICP-MS by Calculation	SM 2340B-2011/ SM 2340B-1997	Hardness
Titrimetric	SM 2340C-2011/ SM 2340C-1997	Hardness
Platinum Electrode	SM 2510B-2011/ SM 2510B-1997	Specific Conductance
Gravimetric	SM 2540B-2011/ SM 2540B-1997	Total Residue
Gravimetric	SM 2540C-2011/ SM 2540C-1997	TDS
Gravimetric	SM 2540D-2011/ SM 2540D-1997	TSS
Spectrometric	SM 3500-Fe B-2011/ SM 3500-Fe B-1997	Ferrous Iron
IC	SM 4110B-2011/ SM 4110B-2000	Bromate
IC	SM 4110B-2011/ SM 4110B-2000	Bromide
IC	SM 4110B-2011/ SM 4110B-2000	Chloride
IC	SM 4110B-2011/ SM 4110B-2000	Fluoride
IC	SM 4110B-2011/ SM 4110B-2000	Nitrate
IC	SM 4110B-2011/ SM 4110B-2000	Nitrite
IC	SM 4110B-2011/ SM 4110B-2000	Nitrate - Nitrite
IC	SM 4110B-2011/ SM 4110B-2000	Phosphate
IC	SM 4110B-2011/ SM 4110B-2000	Sulfate
IC	SM 4110B-2011/ SM 4110B-2000	Chlorate
Titrimetric	SM 4500-Cl B-2011/ SM 4500-Cl B-1997	Chloride
Spectrometric	SM 4500-CN E-2011 SM 4500-CN E-1999	Cyanide
Spectrometric	SM 4500-CN G-2011 SM 4500-CN G-1999	Cyanides Amenable to Chlorination
Electrode	SM 4500-HB-2011/ SM 4500-HB-2000	pH
Spectrometric	SM 4500-NH3 F-2011 SM 4500-NH3 F-1997	Ammonia
Spectrometric	SM 4500-NO2 B-2011 SM 4500-NO2 B-2000	Nitrite-N
Spectrometric	SM 4500-NO3 E-2011 SM 4500-NO3 E-2000	Nitrate-N

Drinking Water

Technology	Method	Analyte
Spectrometric	SM 4500-NOrgC-2011 NH3F-2011 SM 4500-NOrgC-1997 NH3F-1997	TKN
Spectrometric	SM 4500-P E-2011/ SM 4500-P E-1999	Ortho-phosphate
Spectrometric	SM 4500-P E(PB5)-2011 SM 4500-P E(PB5)-1999	Phosphorus
Spectrometric	SM 4500-S2D-2011 SM 4500-S2D-2000	Sulfide
Titrimetric	SM 4500-S2 F-2011 SM 4500-S2 F-2000	Sulfide
Spectrometric	SM 4500-SiO2 C-2011 SM 4500-SiO2 C-1997	Silica
Spectrometric	SM 5220D-2011/ SM 5220D-1997	COD
Combustion-IR	SM 5310B-2011/ SM 5310B-2000	TOC
Spectrometric	SM 5540C-2011/ SM 5540C-2000	Surfactants
MicroDistillation	QuickChem 10-204-00-1-X	Cyanide

Solid and Chemical Materials

Technology	Method	Analyte
GC	AK101	GRO
GC	AK102	DRO
GC	AK103	RRO
GC	AZ8015	DRO (C10-C22)
GC	AZ8015	ORO (C22-C32)
Visual	s.7.3 SW-846	Reactive Cyanide
Visual	s.7.3 SW-846	Reactive Sulfide
Spectrometric	SM 4500-NH3 F-2011 SM 4500-NH3 F-1997	Ammonia
Spectrometric	SM 4500-NOrgC-2011 NH3F-2011 SM 4500-NOrgC-1997 NH3F-1997	TKN
Spectrometric	SM 4500-NO2B-2011 SM 4500-NO2B-2000	Nitrite-N
Spectrometric	SM 4500-NO3E-2011 SM 4500-NO3E-2000	Nitrate-N
Spectrometric	SM 4500-P E-2011/ SM 4500-P E-1999	Ortho-phosphate
Spectrometric	SM 4500-P E(PB5)-2011 SM 4500-P E(PB5)-1999	Phosphorus
Titrimetric	Walkley Black	TOC
Electrode	EPA 9045C / 9045D	pH

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Spectrometric	EPA 9065	Phenols
Pensky-Martens	EPA 1010 / 1010A	Ignitability
ICP	EPA 6010B / 6010C	Aluminum
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead
ICP	EPA 6010B / 6010C	Lithium
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Lithium
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Mercury
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc
HPLC-MS	EPA 6850	Perchlorate
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7471A / 7471B	Mercury
GC	EPA 8011	DBCP
GC	EPA 8011	EDB
GC	EPA 8015B / 8015C / 8015D	GRO
GC	EPA 8015B / 8015C / 8015D	DRO
GC	EPA 8015B / 8015C / 8015D	ORO
GC	EPA 8015B / 8015C / 8015D	JP5
GC	EPA 8015B / 8015C	Ethanol
GC	EPA 8015B / 8015C	Isopropanol
GC	EPA 8015B / 8015C	Diethylene Glycol
GC	EPA 8015B / 8015C	Ethylene Glycol
GC	EPA 8015B / 8015C	Triethylene Glycol

Solid and Chemical Materials

Technology	Method	Analyte
GC	EPA 8015B / 8015C / 8015D	JP4
GC	EPA 8015B / 8015C	Methanol
GC	EPA 8015B / 8015C	Propylene Glycol
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8081A / 8081B	cis-Nonachlor
GC	EPA 8081A / 8081B	DDD (2,4)
GC	EPA 8081A / 8081B	DDE (2,4)
GC	EPA 8081A / 8081B	DDT (2,4)
GC	EPA 8081A / 8081B	Mirex
GC	EPA 8081A / 8081B	Oxychlordane
GC	EPA 8081A / 8081B	trans-Nonachlor
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232
GC	EPA 8082 / 8082A	PCB1242
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105
GC	EPA 8082 / 8082A	PCB 110
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8141A / 8141B	Azinphos-methyl
GC	EPA 8141A / 8141B	Bolstar
GC	EPA 8141A / 8141B	Chlorpyrifos
GC	EPA 8141A / 8141B	Coumaphos
GC	EPA 8141A / 8141B	Total Demeton
GC	EPA 8141A / 8141B	Diazinon

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8141A / 8141B	Dichlorvos
GC	EPA 8141A / 8141B	Disulfoton
GC	EPA 8141A / 8141B	Ethoprop
GC	EPA 8141A / 8141B	Fensulfothion
GC	EPA 8141A / 8141B	Fenthion
GC	EPA 8141A / 8141B	Merphos
GC	EPA 8141A / 8141B	Mevinphos
GC	EPA 8141A / 8141B	Naled
GC	EPA 8141A / 8141B	Methyl Parathion
GC	EPA 8141A / 8141B	Phorate
GC	EPA 8141A / 8141B	Ronnel
GC	EPA 8141A / 8141B	Stirophos
GC	EPA 8141A / 8141B	Tokuthion
GC	EPA 8141A / 8141B	Trichloronate
GC	EPA 8141A / 8141B	Dimethoate
GC	EPA 8141A / 8141B	EPN
GC	EPA 8141A / 8141B	Famphur
GC	EPA 8141A / 8141B	Malathion
GC	EPA 8141A / 8141B	Ethyl Parathion
GC	EPA 8141A / 8141B	O,O,O-Triethylphosphorothioate
GC	EPA 8141A / 8141B	Sulfotepp
GC	EPA 8141A / 8141B	Thionazin
GC	EPA 8141A / 8141B	Tributyl Phosphate
GC-MS	EPA 8260B / 8260C	Acetone
GC-MS	EPA 8260B / 8260C	Acrolein
GC-MS	EPA 8260B / 8260C	Acrylonitrile
GC-MS	EPA 8260B / 8260C	Benzene
GC-MS	EPA 8260B / 8260C	Bromobenzene
GC-MS	EPA 8260B / 8260C	Bromochloromethane
GC-MS	EPA 8260B / 8260C	Bromodichloromethane
GC-MS	EPA 8260B / 8260C	Bromoform
GC-MS	EPA 8260B / 8260C	Bromomethane
GC-MS	EPA 8260B / 8260C	tert-Butyl alcohol
GC-MS	EPA 8260B / 8260C	2-Butanone (MEK)
GC-MS	EPA 8260B / 8260C	n-Butylbenzene
GC-MS	EPA 8260B / 8260C	sec-Butylbenzene
GC-MS	EPA 8260B / 8260C	tert-Butylbenzene
GC-MS	EPA 8260B / 8260C	Carbon disulfide

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C	Chlorobenzene
GC-MS	EPA 8260B / 8260C	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B / 8260C	Chloroethane
GC-MS	EPA 8260B / 8260C	Chloroform
GC-MS	EPA 8260B / 8260C	1-Chlorohexane
GC-MS	EPA 8260B / 8260C	Chloromethane
GC-MS	EPA 8260B / 8260C	2-Chlorotoluene
GC-MS	EPA 8260B / 8260C	4-Chlorotoluene
GC-MS	EPA 8260B / 8260C	Isopropyl ether (DIPE)
GC-MS	EPA 8260B / 8260C	Dibromochloromethane
GC-MS	EPA 8260B / 8260C	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C	Dibromomethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C	1,2-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	1,3-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B / 8260C	1,4-Dichlorobenzene
GC-MS	EPA 8260B / 8260C	Dichlorodifluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C	Dichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,1-Dichloropropene
GC-MS	EPA 8260B / 8260C	1,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	1,3-Dichloropropane
GC-MS	EPA 8260B / 8260C	2,2-Dichloropropane
GC-MS	EPA 8260B / 8260C	cis-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	trans-1,3-Dichloropropene
GC-MS	EPA 8260B / 8260C	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Ethylbenzene
GC-MS	EPA 8260B / 8260C	2-Hexanone (MBK)
GC-MS	EPA 8260B / 8260C	Hexachlorobutadiene
GC-MS	EPA 8260B / 8260C	Iodomethane
GC-MS	EPA 8260B / 8260C	Isopropylbenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	p-Isopropyltoluene
GC-MS	EPA 8260B / 8260C	Methylene Chloride
GC-MS	EPA 8260B / 8260C	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B / 8260C	tert-Butyl methyl ether
GC-MS	EPA 8260B / 8260C	Naphthalene
GC-MS	EPA 8260B / 8260C	n-Propylbenzene
GC-MS	EPA 8260B / 8260C	Styrene
GC-MS	EPA 8260B / 8260C	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B / 8260C	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C	Tetrachloroethene
GC-MS	EPA 8260B / 8260C	Toluene
GC-MS	EPA 8260B / 8260C	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B / 8260C	Trichloroethene
GC-MS	EPA 8260B / 8260C	Trichlorofluoromethane
GC-MS	EPA 8260B / 8260C	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B / 8260C	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B / 8260C	Vinyl Acetate
GC-MS	EPA 8260B / 8260C	Vinyl Chloride
GC-MS	EPA 8260B / 8260C	m-Xylene & p-xylene
GC-MS	EPA 8260B / 8260C	o-Xylene
GC-MS	EPA 8260B / 8260C	2-Butanol
GC-MS	EPA 8260B / 8260C	Cyclohexane
GC-MS	EPA 8260B / 8260C	1,4-Dioxane
GC-MS	EPA 8260B / 8260C	2-Chloro-1,1,1-trifluoroethane
GC-MS	EPA 8260B / 8260C	Chlorotrifluoroethylene
GC-MS	EPA 8260B / 8260C	cis-1,4-Dichloro-2-butene
GC-MS	EPA 8260B / 8260C	Ethanol
GC-MS	EPA 8260B / 8260C	Ethyl Methacrylate
GC-MS	EPA 8260B / 8260C	Isobutyl Alcohol
GC-MS	EPA 8260B / 8260C	Methacrylonitrile
GC-MS	EPA 8260B / 8260C	Methyl Methacrylate

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B / 8260C	Pentachloroethane
GC-MS	EPA 8260B / 8260C	Propionitrile
GC-MS	EPA 8260B / 8260C	Sec-Propyl alcohol
GC-MS	EPA 8260B / 8260C	Tetrahydrofuran
GC-MS	EPA 8260B / 8260C	Allyl Chloride
GC-MS	EPA 8260B / 8260C	Benzyl chloride
GC-MS	EPA 8260B / 8260C	Chloroprene
GC-MS	EPA 8260B / 8260C	Methyl Acetate
GC-MS	EPA 8260B / 8260C	Methylcyclohexane
GC-MS	EPA 8260B / 8260C SIM	Benzene
GC-MS	EPA 8260B / 8260C SIM	Carbon tetrachloride
GC-MS	EPA 8260B / 8260C SIM	Chloroform
GC-MS	EPA 8260B / 8260C SIM	Chloromethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dibromoethane
GC-MS	EPA 8260B / 8260C SIM	1,2-Dichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	trans-1,2-Dichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B / 8260C SIM	Tetrachloroethene
GC-MS	EPA 8260B / 8260C SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B / 8260C SIM	Trichloroethene
GC-MS	EPA 8260B / 8260C SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B / 8260C SIM	Vinyl Chloride
GC-MS	EPA 8260B / 8260C SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	2,2-oxybis(1-chloropropane)
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2,6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol
GC-MS	EPA 8270C / 8270D	3/4-Methylphenol
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D	1,2,4,5-Tetrachlorobenzene
GC-MS	EPA 8270C / 8270D	1,3,5-Trinitrobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dinitrobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dioxane
GC-MS	EPA 8270C / 8270D	1,4-Naphthoquinone

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	1-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	1-Naphthylamine
GC-MS	EPA 8270C / 8270D	2,6-Dichlorophenol
GC-MS	EPA 8270C / 8270D	2-acetylaminofluorene
GC-MS	EPA 8270C / 8270D	2-Naphthylamine
GC-MS	EPA 8270C / 8270D	2-Picoline
GC-MS	EPA 8270C / 8270D	3,3-Dimethylbenzidine
GC-MS	EPA 8270C / 8270D	3,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3,5-Dimethylphenol
GC-MS	EPA 8270C / 8270D	3-Methylchlolanthrene
GC-MS	EPA 8270C / 8270D	4-Aminobiphenyl
GC-MS	EPA 8270C / 8270D	4-Nitroquinoline-N-oxide
GC-MS	EPA 8270C / 8270D	5-Nitro-o-toluidine
GC-MS	EPA 8270C / 8270D	7,12-Dimethylbenz(a)anthracene
GC-MS	EPA 8270C / 8270D	Acetophenone
GC-MS	EPA 8270C / 8270D	Aramite
GC-MS	EPA 8270C / 8270D	Atrazine
GC-MS	EPA 8270C / 8270D	Chlorobenzilate
GC-MS	EPA 8270C / 8270D	Diallate
GC-MS	EPA 8270C / 8270D	Dibenzo(a,j)acridine
GC-MS	EPA 8270C / 8270D	Dimethoate
GC-MS	EPA 8270C / 8270D	Dinoseb
GC-MS	EPA 8270C / 8270D	Diphenyl ether
GC-MS	EPA 8270C / 8270D	Disulfoton
GC-MS	EPA 8270C / 8270D	Ethyl methacrylate
GC-MS	EPA 8270C / 8270D	Ethyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Ethyl parathion
GC-MS	EPA 8270C / 8270D	Famphur
GC-MS	EPA 8270C / 8270D	Hexachlorophene
GC-MS	EPA 8270C / 8270D	Hexachloropropene
GC-MS	EPA 8270C / 8270D	Isodrin
GC-MS	EPA 8270C / 8270D	Isosafrole
GC-MS	EPA 8270C / 8270D	kepone
GC-MS	EPA 8270C / 8270D	Methapyrilene
GC-MS	EPA 8270C / 8270D	Methyl methanesulfonate
GC-MS	EPA 8270C / 8270D	Methyl parathion
GC-MS	EPA 8270C / 8270D	N-nitrosodiethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosodi-n-butylamine

Solid and Chemical Materials

Technology	Method	Analyte
GC-MS	EPA 8270C / 8270D	N-Nitrosomethylethylamine
GC-MS	EPA 8270C / 8270D	N-Nitrosomorpholine
GC-MS	EPA 8270C / 8270D	N-Nitrosopiperdine
GC-MS	EPA 8270C / 8270D	N-Nitrosopyrrolidine
GC-MS	EPA 8270C / 8270D	O,O,O-triethyl phosphorothi
GC-MS	EPA 8270C / 8270D	o-toluidine
GC-MS	EPA 8270C / 8270D	p-Dimethylaminoazobenze
GC-MS	EPA 8270C / 8270D	Pentachlorobenzene
GC-MS	EPA 8270C / 8270D	Pentachloroethane
GC-MS	EPA 8270C / 8270D	Pentachloronitrobenzene
GC-MS	EPA 8270C / 8270D	Phenacetin
GC-MS	EPA 8270C / 8270D	Phorate
GC-MS	EPA 8270C / 8270D	p-phenylenediamine
GC-MS	EPA 8270C / 8270D	Pronamide
GC-MS	EPA 8270C / 8270D	Safrole
GC-MS	EPA 8270C / 8270D	Sulfotepp
GC-MS	EPA 8270C / 8270D	Thionazin
GC-MS	EPA 8270C / 8270D	Benzaldehyde
GC-MS	EPA 8270C / 8270D	Caprolactam
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane
GC-MS	EPA 8270C / 8270D SIM	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D SIM	Diethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Dimethylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D SIM	Di-n-octylphthalate
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	1,3,5-TNB
HPLC	EPA 8330A	1,3-DNB
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2,4,6-TNT
HPLC	EPA 8330A	4-AM-2,6-DNT
HPLC	EPA 8330A	2-AM-4,6-DNT
HPLC	EPA 8330A	2,6-DNT
HPLC	EPA 8330A	2,4-DNT
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
HPLC	EPA 8330A	2,4-Diamino-6-nitrotoluene
HPLC	EPA 8330A	2,6-Diamino-4-nitrotoluene
HPLC	EPA 8330A	Picric Acid
HPLC	EPA 8332	Nitroglycerine
HPLC	EPA 8332	PETN
IC	EPA 9056 / 9056A	Bromate
IC	EPA 9056 / 9056A	Bromide
IC	EPA 9056 / 9056A	Chloride
IC	EPA 9056 / 9056A	Fluoride
IC	EPA 9056 / 9056A	Nitrate
IC	EPA 9056 / 9056A	Nitrite
IC	EPA 9056 / 9056A	Phosphate
IC	EPA 9056 / 9056A	Sulfate
IC	EPA 9056 / 9056A	Chlorate

Solid and Chemical Materials

Technology	Method	Analyte
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5-Dichlorobenzoic acid
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex
GC	EPA 8151A	2,4,5-T
GC	EPA 8151A	4-Nitrophenol
Spectrometric	EPA 9014	Cyanide
Spectrometric	EPA 9014	Cyanides Amenable to Chlorination
Gravimetric	EPA 9071B	Oil & Grease
GFAA	CA 939M	Organo Lead
Preparation	**Method**	**Type**
Purge &Trap	EPA 5030B / EPA 5035	Volatiles Prep
Acid Digestion	EPA 3050B Modified	Metals Prep
Alkaline Digestion	EPA 3060A	Hexavalent Chrom
Soxhlet	EPA 3540C	Organic Extraction
Sonication	EPA 3550C	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
Microwave	EPA 3546	Organic Extraction
TCLP	EPA 1311	Leaching
SPLP	EPA 1312	Leaching
Florisil Clean-up	EPA 3620C	Extract Clean-Up
Sulfur Clean-up	EPA 3660B	Extract Clean-Up
Acid/Permanganate Clean-up	EPA 3665A	Extract Clean-Up

Air and Emissions		
Technology	**Method**	**Analyte**
GC-MS	TO-15	1,1,1-trichloroethane
GC-MS	TO-15	1,1,2,2-tetrachloroethane
GC-MS	TO-15	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	TO-15	1,1,2-trichloroethane
GC-MS	TO-15	1,1-dichloroethane
GC-MS	TO-15	1,1-Dichloroethene
GC-MS	TO-15	1,2,4-trichlorobenzene
GC-MS	TO-15	1,2,4-trimethylbenzene
GC-MS	TO-15	1,2-dibromoethane
GC-MS	TO-15	1,2-dichloroethane
GC-MS	TO-15	1,2-dichloroethene
GC-MS	TO-15	1,2-dichloropropane
GC-MS	TO-15	1,3,5-trimethylbenzene
GC-MS	TO-15	1,3-Butadiene
GC-MS	TO-15	1,3-Butadiene, 1,1,2,3,4,Hexachloro
GC-MS	TO-15	1,2-dichlorobenzene
GC-MS	TO-15	1,3-dichlorobenzene
GC-MS	TO-15	1,4-dichlorobenzene
GC-MS	TO-15	1,4-Dioxane
GC-MS	TO-15	2,2,4-Trimethylpentane
GC-MS	TO-15	4-Ethyltoluene
GC-MS	TO-15	Acetone
GC-MS	TO-15	Acrylonitrile
GC-MS	TO-15	Allyl Chloride
GC-MS	TO-15	Benzene
GC-MS	TO-15	Benzyl Chloride
GC-MS	TO-15	Bromodichloromethane
GC-MS	TO-15	Bromoform
GC-MS	TO-15	Bromomethane
GC-MS	TO-15	Carbon Disulfide
GC-MS	TO-15	Carbon Tetrachloride
GC-MS	TO-15	Chlorobenzene
GC-MS	TO-15	Chloroethane

Air and Emissions

Technology	Method	Analyte
GC-MS	TO-15	Chloroethene
GC-MS	TO-15	Chloroform
GC-MS	TO-15	Chloromethane
GC-MS	TO-15	cis-1,3-Dichloropropene
GC-MS	TO-15	Cyclohexane
GC-MS	TO-15	Dibromochloromethane
GC-MS	TO-15	Dichlorodifluoromethane
GC-MS	TO-15	Dichlorotetrafluoroethane
GC-MS	TO-15	Ethyl Acetate
GC-MS	TO-15	Ethylbenzene
GC-MS	TO-15	Isopropyl Alcohol
GC-MS	TO-15	m+p-Xylene
GC-MS	TO-15	Methyl butyl Ketone
GC-MS	TO-15	Methyl Ethyl Ketone
GC-MS	TO-15	Methyl Isobutyl Ketone
GC-MS	TO-15	Methyl Tert-Butyl Ether
GC-MS	TO-15	Methylene Chloride
GC-MS	TO-15	n-Heptane
GC-MS	TO-15	n-Hexane
GC-MS	TO-15	o-Xylene
GC-MS	TO-15	Styrene
GC-MS	TO-15	Tetrachloroethylene
GC-MS	TO-15	Tetrahydrofuran
GC-MS	TO-15	Toluene
GC-MS	TO-15	Trans-1,2-Dichloroethene
GC-MS	TO-15	trans-1,3-Dichloropropene
GC-MS	TO-15	Trichloroethylene
GC-MS	TO-15	Trichloromonofluoromethan
GC-MS	TO-15	Vinyl Acetate
GC-MS	TO-15	Vinyl Bromide

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2278.

Jason Stine, Vice President

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

CERTIFICATE OF ENVIRONMENTAL LABORATORY ACCREDITATION

Is hereby granted to

EMAX Laboratories, Inc.

3051 Fujita St.

Torrance, CA 90505

Scope of the certificate is limited to the
“Fields of Accreditation”
which accompany this Certificate.

Continued accredited status depends on compliance with applicable laws and regulations, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **2672**

Effective Date: **7/1/2023**

Expiration Date: **6/30/2025**

Sacramento, California
subject to forfeiture or revocation

Christine Sotelo, Program Manager
Environmental Laboratory Accreditation Program

CALIFORNIA STATE
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Fields of Accreditation

EMAX Laboratories, Inc.

3051 Fujita St.
Torrance, CA 90505
Phone: 3106188889

Certificate Number: 2672
Expiration Date: 6/30/2025

Field of Accreditation: 102 - Inorganic Chemistry of Drinking Water

102.015	001	Hydrogen Ion (pH)	EPA 150.1
102.020	001	Turbidity	EPA 180.1
102.026	001	Calcium	EPA 200.7
102.026	002	Magnesium	EPA 200.7
102.026	003	Potassium	EPA 200.7
102.026	005	Sodium	EPA 200.7
102.026	006	Hardness (Calculation)	EPA 200.7
102.030	001	Bromide	EPA 300.0
102.030	002	Chlorate	EPA 300.0
102.030	003	Chloride	EPA 300.0
102.030	005	Fluoride	EPA 300.0
102.030	006	Nitrate (as N)	EPA 300.0
102.030	007	Nitrite (as N)	EPA 300.0
102.030	008	Phosphate,Ortho (as P)	EPA 300.0
102.030	009	Sulfate (as SO4)	EPA 300.0
102.045	001	Perchlorate	EPA 314.0
102.095	001	Turbidity	SM 2130 B-2001
102.100	001	Alkalinity	SM 2320 B-1997
102.120	001	Hardness (Calculation)	SM 2340 B-1997
102.121	001	Hardness	SM 2340 C-1997
102.130	001	Specific Conductance	SM 2510 B-1997
102.140	001	Residue, Filterable TDS	SM 2540 C-1997
102.150	001	Chloride	SM 4110 B-2000
102.150	002	Fluoride	SM 4110 B-2000
102.150	003	Nitrate (as N)	SM 4110 B-2000
102.150	004	Nitrite (as N)	SM 4110 B-2000
102.150	005	Phosphate,Ortho (as P)	SM 4110 B-2000
102.150	006	Sulfate (as SO4)	SM 4110 B-2000
102.170	001	Chloride	SM 4500-Chloride B-1997
102.203	001	Hydrogen Ion (pH)	SM 4500-H+ B-2000
102.220	001	Nitrite (as N)	SM 4500-NO2 B-2000
102.232	002	Nitrate (as N)	SM 4500-NO3- E-2000
102.240	001	Phosphate,Ortho (as P)	SM 4500-P E-1999

102.260	001	Organic Carbon-Total (TOC)	SM 5310 B-2000
102.261	001	Dissolved Organic Carbon (DOC)	SM 5310 B-2000
102.270	001	Surfactants	SM 5540 C-2000

Field of Accreditation:103 - Toxic Chemical Elements of Drinking Water

103.130	001	Aluminum	EPA 200.7
103.130	003	Barium	EPA 200.7
103.130	004	Beryllium	EPA 200.7
103.130	007	Chromium	EPA 200.7
103.130	008	Copper	EPA 200.7
103.130	009	Iron	EPA 200.7
103.130	011	Manganese	EPA 200.7
103.130	012	Nickel	EPA 200.7
103.130	015	Silver	EPA 200.7
103.130	017	Zinc	EPA 200.7
103.130	018	Boron	EPA 200.7
103.140	001	Aluminum	EPA 200.8
103.140	002	Antimony	EPA 200.8
103.140	003	Arsenic	EPA 200.8
103.140	004	Barium	EPA 200.8
103.140	005	Beryllium	EPA 200.8
103.140	006	Cadmium	EPA 200.8
103.140	007	Chromium	EPA 200.8
103.140	009	Lead	EPA 200.8
103.140	010	Manganese	EPA 200.8
103.140	012	Nickel	EPA 200.8
103.140	013	Selenium	EPA 200.8
103.140	014	Silver	EPA 200.8
103.140	015	Thallium	EPA 200.8
103.140	016	Zinc	EPA 200.8
103.140	017	Boron	EPA 200.8
103.140	018	Vanadium	EPA 200.8
103.160	001	Mercury	EPA 245.1
103.310	001	Chromium VI (Hexavalent Chromium)	EPA 218.6

Field of Accreditation:104 - Volatile Organic Chemistry of Drinking Water

104.030	001	1,2-Dibromoethane (EDB)	EPA 504.1
104.030	002	1,2-Dibromo-3-chloropropane (DBCP)	EPA 504.1
104.200	001	1,1,1,2-Tetrachloroethane	EPA 524.2
104.200	002	1,1,1-Trichloroethane	EPA 524.2
104.200	003	1,1,2,2-Tetrachloroethane	EPA 524.2
104.200	004	1,1,2-Trichloroethane	EPA 524.2
104.200	005	1,1-Dichloroethane	EPA 524.2
104.200	006	1,1-Dichloroethylene (1,1-Dichloroethene)	EPA 524.2

104.200	007	1,2,3-Trichlorobenzene	EPA 524.2
104.200	008	1,2,4-Trichlorobenzene	EPA 524.2
104.200	009	1,2,4-Trimethylbenzene	EPA 524.2
104.200	010	1,2-Dichlorobenzene	EPA 524.2
104.200	011	1,2-Dichloroethane (Ethylene Dichloride)	EPA 524.2
104.200	012	1,2-Dichloropropane	EPA 524.2
104.200	013	1,3,5-Trimethylbenzene	EPA 524.2
104.200	014	1,3-Dichlorobenzene	EPA 524.2
104.200	015	1,4-Dichlorobenzene	EPA 524.2
104.200	016	2-Chlorotoluene	EPA 524.2
104.200	017	4-Chlorotoluene	EPA 524.2
104.200	018	Benzene	EPA 524.2
104.200	019	Carbon Disulfide	EPA 524.2
104.200	020	Carbon Tetrachloride	EPA 524.2
104.200	021	Chlorobenzene	EPA 524.2
104.200	022	cis-1,2-Dichloroethylene (cis 1,2 Dichloroethene)	EPA 524.2
104.200	023	cis-1,3-Dichloropropylene (cis 1,3 Dichloropropene)	EPA 524.2
104.200	024	Dichlorodifluoromethane	EPA 524.2
104.200	025	Dichloromethane (Methylene Chloride)	EPA 524.2
104.200	027	Ethyl tert-butyl Ether (ETBE)	EPA 524.2
104.200	028	Ethylbenzene	EPA 524.2
104.200	029	Isopropylbenzene	EPA 524.2
104.200	030	Methyl isobutyl ketone (MIBK, 4-Methyl-2-pentanone)	EPA 524.2
104.200	031	Methyl tert-butyl Ether (MTBE)	EPA 524.2
104.200	032	Naphthalene	EPA 524.2
104.200	033	n-Butylbenzene	EPA 524.2
104.200	034	N-propylbenzene	EPA 524.2
104.200	035	sec-Butylbenzene	EPA 524.2
104.200	036	Styrene	EPA 524.2
104.200	037	t-Butyl alcohol (2-Methyl-2-propanol)	EPA 524.2
104.200	038	tert-Amyl Methyl Ether (TAME)	EPA 524.2
104.200	039	tert-Butylbenzene	EPA 524.2
104.200	040	Tetrachloroethylene (Tetrachloroethene)	EPA 524.2
104.200	041	Toluene	EPA 524.2
104.200	042	trans-1,2-Dichloroethylene (trans- 1,2 Dichloroethene	EPA 524.2
104.200	043	trans-1,3-Dichloropropylene (trans-1,3 Dichloroprope	EPA 524.2
104.200	044	Trichloroethylene (Trichloroethene)	EPA 524.2
104.200	045	Trichlorofluoromethane	EPA 524.2
104.200	046	Trichlorotrifluoroethane	EPA 524.2
104.200	047	Vinyl Chloride	EPA 524.2
104.200	102	m+p-Xylene	EPA 524.2
104.200	103	o-Xylene	EPA 524.2

104.200	201	Bromodichloromethane	EPA 524.2
104.200	202	Bromoform	EPA 524.2
104.200	203	Chloroform	EPA 524.2
104.200	204	Dibromochloromethane (Chlorodibromomethane)	EPA 524.2

Field of Accreditation:108 - Inorganic Constituents in Non-Potable Water

108.001	001	Specific Conductance	EPA 120.1
108.009	001	Turbidity	EPA 180.1
108.013	001	Calcium	EPA 200.7
108.013	002	Magnesium	EPA 200.7
108.013	004	Potassium	EPA 200.7
108.013	006	Sodium	EPA 200.7
108.015	001	Calcium	EPA 200.8
108.015	002	Magnesium	EPA 200.8
108.015	003	Potassium	EPA 200.8
108.015	005	Sodium	EPA 200.8
108.017	001	Bromide	EPA 300.0
108.017	002	Chloride	EPA 300.0
108.017	003	Fluoride	EPA 300.0
108.017	004	Nitrate (as N)	EPA 300.0
108.017	005	Nitrate-Nitrite (as N)	EPA 300.0
108.017	006	Nitrite (as N)	EPA 300.0
108.017	007	Phosphate,Ortho (as P)	EPA 300.0
108.017	008	Sulfate (as SO4)	EPA 300.0
108.045	001	Chemical Oxygen Demand	EPA 410.4
108.047	001	Phenols, Total	EPA 420.1
108.053	001	Oil & Grease, Total Recoverable	EPA 1664 A
108.055	001	Color	SM 2120 B-2011
108.059	001	Turbidity	SM 2130 B-2011
108.061	001	Acidity	SM 2310 B-2011
108.063	001	Alkalinity	SM 2320 B-2011
108.065	001	Hardness (Calculation)	SM 2340 B-2011
108.067	001	Hardness	SM 2340 C-2011
108.069	001	Specific Conductance	SM 2510 B-2011
108.071	001	Residue, Total	SM 2540 B-2011
108.073	001	Residue, Filterable TDS	SM 2540 C-2011
108.075	001	Residue, Non-filterable TSS	SM 2540 D-2011
108.079	001	Residue, Settleable	SM 2540 F-2011
108.095	001	Bromide	SM 4110 B-2011
108.095	002	Chloride	SM 4110 B-2011
108.095	003	Fluoride	SM 4110 B-2011
108.095	004	Nitrate (as N)	SM 4110 B-2011
108.095	005	Nitrate-Nitrite (as N)	SM 4110 B-2011

108.095	006	Nitrite (as N)	SM 4110 B-2011
108.095	007	Phosphate,Ortho (as P)	SM 4110 B-2011
108.095	008	Sulfate (as SO4)	SM 4110 B-2011
108.115	001	Chloride	SM 4500-Chloride B-2011
108.125	001	Cyanide, Total	SM 4500-CN E-2011
108.137	001	Hydrogen Ion (pH)	SM 4500-H+ B-2011
108.145	001	Ammonia (as N)	SM 4500-NH3 F-2011
108.145	002	Kjeldahl Nitrogen,Total (as N)	SM 4500-NH3 F-2011
108.153	001	Nitrite (as N)	SM 4500-NO2 B-2011
108.157	001	Nitrate-Nitrite (as N)	SM 4500-NO3 E-2011
108.175	001	Phosphate,Ortho (as P)	SM 4500-P E-2011
108.175	002	Phosphorus,Total	SM 4500-P E-2011
108.184	001	Silica, Dissolved	SM 4500-SiO2 C-2011
108.201	001	Sulfide (as S)	SM 4500-S D-2011
108.203	001	Sulfide (as S)	SM 4500-S F-2011
108.207	001	Biochemical Oxygen Demand	SM 5210 B-2011
108.213	001	Chemical Oxygen Demand	SM 5220 D-2011
108.215	001	Organic Carbon-Total (TOC)	SM 5310 B-2011
108.221	001	Oil & Grease, Total Recoverable	SM 5520 B-2011
108.225	001	Surfactants	SM 5540 C-2011

Field of Accreditation: 109 - Metals and Trace Elements in Non-Potable Water

109.623	001	Aluminum	EPA 200.7
109.623	002	Antimony	EPA 200.7
109.623	003	Arsenic	EPA 200.7
109.623	004	Barium	EPA 200.7
109.623	005	Beryllium	EPA 200.7
109.623	006	Boron	EPA 200.7
109.623	007	Cadmium	EPA 200.7
109.623	008	Chromium	EPA 200.7
109.623	009	Cobalt	EPA 200.7
109.623	010	Copper	EPA 200.7
109.623	011	Iron	EPA 200.7
109.623	012	Lead	EPA 200.7
109.623	013	Manganese	EPA 200.7
109.623	014	Molybdenum	EPA 200.7
109.623	015	Nickel	EPA 200.7
109.623	016	Selenium	EPA 200.7
109.623	017	Silver	EPA 200.7
109.623	018	Thallium	EPA 200.7
109.623	019	Tin	EPA 200.7
109.623	020	Titanium	EPA 200.7
109.623	021	Vanadium	EPA 200.7

109.623	022	Zinc	EPA 200.7
109.625	001	Aluminum	EPA 200.8
109.625	002	Antimony	EPA 200.8
109.625	003	Arsenic	EPA 200.8
109.625	004	Barium	EPA 200.8
109.625	005	Beryllium	EPA 200.8
109.625	006	Boron	EPA 200.8
109.625	007	Cadmium	EPA 200.8
109.625	008	Chromium	EPA 200.8
109.625	009	Cobalt	EPA 200.8
109.625	010	Copper	EPA 200.8
109.625	012	Iron	EPA 200.8
109.625	013	Lead	EPA 200.8
109.625	014	Manganese	EPA 200.8
109.625	015	Molybdenum	EPA 200.8
109.625	016	Nickel	EPA 200.8
109.625	017	Selenium	EPA 200.8
109.625	018	Silver	EPA 200.8
109.625	019	Thallium	EPA 200.8
109.625	020	Tin	EPA 200.8
109.625	021	Titanium	EPA 200.8
109.625	022	Vanadium	EPA 200.8
109.625	023	Zinc	EPA 200.8
109.629	001	Chromium VI (Hexavalent Chromium)	EPA 218.6
109.635	001	Mercury	EPA 245.1

Field of Accreditation:110 - Volatile Organic Constituents in Non-Potable Water

110.040	003	Acrolein	EPA 624.1
110.040	004	Acrylonitrile	EPA 624.1
110.040	005	Benzene	EPA 624.1
110.040	006	Bromodichloromethane	EPA 624.1
110.040	007	Bromoform	EPA 624.1
110.040	008	Bromomethane (Methyl Bromide)	EPA 624.1
110.040	010	Carbon Tetrachloride	EPA 624.1
110.040	011	Chlorobenzene	EPA 624.1
110.040	012	Chloroethane	EPA 624.1
110.040	013	2-Chloroethyl vinyl Ether	EPA 624.1
110.040	014	Chloroform	EPA 624.1
110.040	015	Chloromethane (Methyl Chloride)	EPA 624.1
110.040	016	Dibromochloromethane (Chlorodibromomethane)	EPA 624.1
110.040	017	1,2-Dichlorobenzene	EPA 624.1
110.040	018	1,3-Dichlorobenzene	EPA 624.1
110.040	019	1,4-Dichlorobenzene	EPA 624.1

110.040	020	1,1-Dichloroethane	EPA 624.1
110.040	021	1,2-Dichloroethane (Ethylene Dichloride)	EPA 624.1
110.040	022	1,1-Dichloroethylene (1,1-Dichloroethene)	EPA 624.1
110.040	023	trans-1,2-Dichloroethylene (trans- 1,2 Dichloroethene	EPA 624.1
110.040	024	1,2-Dichloropropane	EPA 624.1
110.040	025	cis-1,3-Dichloropropylene (cis 1,3 Dichloropropene)	EPA 624.1
110.040	026	trans-1,3-Dichloropropylene (trans-1,3 Dichloroprope	EPA 624.1
110.040	029	Ethylbenzene	EPA 624.1
110.040	031	Methylene Chloride (Dichloromethane)	EPA 624.1
110.040	034	1,1,2,2-Tetrachloroethane	EPA 624.1
110.040	035	Tetrachloroethylene (Tetrachloroethene)	EPA 624.1
110.040	037	Toluene	EPA 624.1
110.040	038	1,1,1-Trichloroethane	EPA 624.1
110.040	039	1,1,2-Trichloroethane	EPA 624.1
110.040	040	Trichloroethylene (Trichloroethene)	EPA 624.1
110.040	041	Vinyl Chloride	EPA 624.1
110.040	043	o-Xylene	EPA 624.1
110.040	045	Trichlorofluoromethane	EPA 624.1
110.040	046	m+p-Xylene	EPA 624.1

Field of Accreditation:111 - Semi-volatile Organic Constituents in Non-Potable Water

111.055	001	Aldrin	EPA 608.3
111.055	002	alpha-BHC	EPA 608.3
111.055	003	beta-BHC	EPA 608.3
111.055	004	delta-BHC	EPA 608.3
111.055	005	gamma-BHC (Lindane)	EPA 608.3
111.055	006	Chlordane	EPA 608.3
111.055	007	4,4'-DDD	EPA 608.3
111.055	008	4,4'-DDE	EPA 608.3
111.055	009	4,4'-DDT	EPA 608.3
111.055	010	Dieldrin	EPA 608.3
111.055	011	Endosulfan I	EPA 608.3
111.055	012	Endosulfan II	EPA 608.3
111.055	013	Endosulfan Sulfate	EPA 608.3
111.055	014	Endrin	EPA 608.3
111.055	015	Endrin Aldehyde	EPA 608.3
111.055	016	Heptachlor	EPA 608.3
111.055	017	Heptachlor Epoxide	EPA 608.3
111.055	019	PCB-1016 (Aroclor-1016)	EPA 608.3
111.055	020	PCB-1221 (Aroclor-1221)	EPA 608.3
111.055	021	PCB-1232 (Aroclor-1232)	EPA 608.3
111.055	022	PCB-1242 (Aroclor-1242)	EPA 608.3
111.055	023	PCB-1248 (Aroclor-1248)	EPA 608.3

111.055	024	PCB-1254 (Aroclor-1254)	EPA 608.3
111.055	025	PCB-1260 (Aroclor-1260)	EPA 608.3
111.055	046	Methoxychlor	EPA 608.3
111.055	060	Toxaphene	EPA 608.3
111.160	001	Acenaphthene	EPA 625.1
111.160	002	Acenaphthylene	EPA 625.1
111.160	003	Anthracene	EPA 625.1
111.160	004	Benzidine	EPA 625.1
111.160	005	Benzo(a)anthracene	EPA 625.1
111.160	006	Benzo(a)pyrene	EPA 625.1
111.160	007	Benzo(b)fluoranthene	EPA 625.1
111.160	008	Benzo(g,h,i)perylene	EPA 625.1
111.160	009	Benzo(k)fluoranthene	EPA 625.1
111.160	010	Bis(2-chloroethoxy) Methane	EPA 625.1
111.160	011	Bis(2-chloroethyl) Ether	EPA 625.1
111.160	012	bis(2-Chloroisopropyl) ether (2,2'-Oxybis[1-chloroprop	EPA 625.1
111.160	013	Bis(2-ethylhexyl)phthalate (Di(2-ethylhexyl) phthalate)	EPA 625.1
111.160	014	4-Bromophenyl Phenyl Ether	EPA 625.1
111.160	015	Butyl Benzyl Phthalate	EPA 625.1
111.160	016	2-Chloronaphthalene	EPA 625.1
111.160	017	4-Chlorophenyl Phenyl Ether	EPA 625.1
111.160	018	Chrysene	EPA 625.1
111.160	019	Dibenz(a,h)anthracene	EPA 625.1
111.160	020	3,3'-Dichlorobenzidine	EPA 625.1
111.160	021	Diethyl Phthalate	EPA 625.1
111.160	022	Dimethyl Phthalate	EPA 625.1
111.160	023	Di-n-butyl Phthalate	EPA 625.1
111.160	024	2,4-Dinitrotoluene	EPA 625.1
111.160	025	2,6-Dinitrotoluene	EPA 625.1
111.160	026	Di-n-octyl Phthalate	EPA 625.1
111.160	027	Fluoranthene	EPA 625.1
111.160	028	Fluorene	EPA 625.1
111.160	029	Hexachlorobenzene	EPA 625.1
111.160	030	Hexachlorobutadiene	EPA 625.1
111.160	031	Hexachloroethane	EPA 625.1
111.160	032	Indeno(1,2,3-c,d)pyrene	EPA 625.1
111.160	033	Isophorone	EPA 625.1
111.160	034	Naphthalene	EPA 625.1
111.160	035	Nitrobenzene	EPA 625.1
111.160	036	N-nitroso-di-n-propylamine	EPA 625.1
111.160	037	Phenanthrene	EPA 625.1
111.160	038	Pyrene	EPA 625.1

111.160	039	1,2,4-Trichlorobenzene	EPA 625.1
111.160	040	4-Chloro-3-methylphenol	EPA 625.1
111.160	041	2-Chlorophenol	EPA 625.1
111.160	042	2,4-Dichlorophenol	EPA 625.1
111.160	043	2,4-Dimethylphenol	EPA 625.1
111.160	044	2,4-Dinitrophenol	EPA 625.1
111.160	045	2-Methyl-4,6-dinitrophenol	EPA 625.1
111.160	046	2-Nitrophenol	EPA 625.1
111.160	047	4-Nitrophenol	EPA 625.1
111.160	048	Pentachlorophenol	EPA 625.1
111.160	049	Phenol	EPA 625.1
111.160	050	2,4,6-Trichlorophenol	EPA 625.1
111.160	098	Hexachlorocyclopentadiene	EPA 625.1
111.160	108	N-nitrosodimethylamine	EPA 625.1
111.160	110	N-nitrosodiphenylamine	EPA 625.1
111.160	140	Carbazole	EPA 625.1
111.160	141	o-Cresol	EPA 625.1
111.160	143	1,2-Diphenylhydrazine	EPA 625.1
111.160	145	Pyridine	EPA 625.1
111.160	147	m+p-Cresol	EPA 625.1
111.160	148	2-Methylnaphthalene	EPA 625.1
111.160	149	1-Methylphenanthrene	EPA 625.1
111.160	151	2,4,5-Trichlorophenol	EPA 625.1

Field of Accreditation:114 - Inorganic Constituents in Hazardous Waste

114.315	001	Aluminum	EPA 6010 B
114.315	002	Antimony	EPA 6010 B
114.315	003	Arsenic	EPA 6010 B
114.315	004	Barium	EPA 6010 B
114.315	005	Beryllium	EPA 6010 B
114.315	006	Boron	EPA 6010 B
114.315	007	Cadmium	EPA 6010 B
114.315	008	Calcium	EPA 6010 B
114.315	009	Chromium	EPA 6010 B
114.315	010	Cobalt	EPA 6010 B
114.315	011	Copper	EPA 6010 B
114.315	012	Iron	EPA 6010 B
114.315	013	Lead	EPA 6010 B
114.315	014	Magnesium	EPA 6010 B
114.315	015	Manganese	EPA 6010 B
114.315	016	Molybdenum	EPA 6010 B
114.315	017	Nickel	EPA 6010 B
114.315	018	Potassium	EPA 6010 B

114.315	019	Selenium	EPA 6010 B
114.315	020	Silver	EPA 6010 B
114.315	021	Sodium	EPA 6010 B
114.315	022	Strontium	EPA 6010 B
114.315	023	Thallium	EPA 6010 B
114.315	024	Tin	EPA 6010 B
114.315	025	Titanium	EPA 6010 B
114.315	026	Vanadium	EPA 6010 B
114.315	027	Zinc	EPA 6010 B
114.335	001	Aluminum	EPA 6020
114.335	002	Antimony	EPA 6020
114.335	003	Arsenic	EPA 6020
114.335	004	Barium	EPA 6020
114.335	005	Beryllium	EPA 6020
114.335	006	Cadmium	EPA 6020
114.335	007	Chromium	EPA 6020
114.335	008	Cobalt	EPA 6020
114.335	009	Copper	EPA 6020
114.335	010	Lead	EPA 6020
114.335	011	Manganese	EPA 6020
114.335	012	Nickel	EPA 6020
114.335	013	Silver	EPA 6020
114.335	014	Thallium	EPA 6020
114.335	015	Zinc	EPA 6020
114.435	001	Chromium VI (Hexavalent Chromium)	EPA 7196 A
114.465	001	Chromium VI (Hexavalent Chromium)	EPA 7199
114.535	001	Mercury	EPA 7471 A
114.725	001	Cyanide, Total	EPA 9014
114.745	001	Fluoride	EPA 9056

Field of Accreditation:115 - Leaching/Extraction Tests and Physical Characteristics of Hazardous Waste

115.055	001	Waste Extraction Test (WET)	CCR Chapter11, Article 5, Ap Interim
115.085	001	Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311
115.095	001	Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312
115.135	001	Corrosivity - pH Determination	EPA 9045 C

Field of Accreditation:116 - Volatile Organic Compounds in Hazardous Waste

116.215	001	1,2-Dibromoethane (EDB)	EPA 8011
116.215	002	1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011
116.220	001	Gasoline Range Organics (GRO)	EPA 8015 B
116.265	001	Benzene	EPA 8260 B
116.265	002	Bromobenzene	EPA 8260 B
116.265	003	Bromochloromethane	EPA 8260 B
116.265	004	Bromodichloromethane	EPA 8260 B

116.265	005	Bromoform	EPA 8260 B
116.265	006	Bromomethane (Methyl Bromide)	EPA 8260 B
116.265	007	n-Butylbenzene	EPA 8260 B
116.265	008	sec-Butylbenzene	EPA 8260 B
116.265	009	tert-Butylbenzene	EPA 8260 B
116.265	010	Carbon Disulfide	EPA 8260 B
116.265	011	Carbon Tetrachloride	EPA 8260 B
116.265	012	Chlorobenzene	EPA 8260 B
116.265	013	Chlorodibromomethane (Dibromochloromethane)	EPA 8260 B
116.265	014	Chloroethane	EPA 8260 B
116.265	015	Chloroform	EPA 8260 B
116.265	016	Chloromethane (Methyl Chloride)	EPA 8260 B
116.265	017	Dibromomethane	EPA 8260 B
116.265	018	Dichlorodifluoromethane (Freon 12)	EPA 8260 B
116.265	019	cis-1,2-Dichloroethylene (cis 1,2 Dichloroethene)	EPA 8260 B
116.265	020	trans-1,2-Dichloroethylene (trans- 1,2 Dichloroethene	EPA 8260 B
116.265	021	cis-1,3-Dichloropropylene (cis 1,3 Dichloropropene)	EPA 8260 B
116.265	022	trans-1,3-Dichloropropylene (trans-1,3 Dichloroprope	EPA 8260 B
116.265	023	Ethylbenzene	EPA 8260 B
116.265	024	Hexachlorobutadiene	EPA 8260 B
116.265	025	Methyl tert-butyl Ether (MTBE)	EPA 8260 B
116.265	026	Methylene Chloride (Dichloromethane)	EPA 8260 B
116.265	027	Naphthalene	EPA 8260 B
116.265	029	N-propylbenzene	EPA 8260 B
116.265	030	Styrene	EPA 8260 B
116.265	031	Tetrachloroethylene (Tetrachloroethene)	EPA 8260 B
116.265	032	Toluene	EPA 8260 B
116.265	033	Trichloroethylene (Trichloroethene)	EPA 8260 B
116.265	034	Trichlorofluoromethane	EPA 8260 B
116.265	035	Vinyl Chloride	EPA 8260 B
116.265	036	m+p-Xylene	EPA 8260 B
116.265	037	o-Xylene	EPA 8260 B
116.265	040	1,1-Dichloroethane	EPA 8260 B
116.265	041	1,1-Dichloroethylene (1,1-Dichloroethene)	EPA 8260 B
116.265	042	1,1,1-Trichloroethane	EPA 8260 B
116.265	043	1,1,1,2-Tetrachloroethane	EPA 8260 B
116.265	044	1,1,2,2-Tetrachloroethane	EPA 8260 B
116.265	045	1,1,2-Trichloroethane	EPA 8260 B
116.265	046	1,2-Dichlorobenzene	EPA 8260 B
116.265	047	1,2-Dichloroethane (Ethylene Dichloride)	EPA 8260 B
116.265	048	1,2-Dibromoethane (EDB)	EPA 8260 B
116.265	049	1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260 B

116.265	050	1,2-Dichloropropane	EPA 8260 B
116.265	051	1,2,3-Trichloropropane (TCP)	EPA 8260 B
116.265	052	1,2,4-Trichlorobenzene	EPA 8260 B
116.265	053	1,3-Dichlorobenzene	EPA 8260 B
116.265	054	1,4-Dichlorobenzene	EPA 8260 B
116.265	055	2-Chloroethyl vinyl Ether	EPA 8260 B
116.265	056	4-Chlorotoluene	EPA 8260 B
116.265	057	4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	EPA 8260 B

Field of Accreditation:117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.235	002	Diesel Range Organics (DRO)	EPA 8015 B
117.315	001	Aldrin	EPA 8081 A
117.315	002	alpha-BHC	EPA 8081 A
117.315	003	beta-BHC	EPA 8081 A
117.315	004	delta-BHC	EPA 8081 A
117.315	005	gamma-BHC (Lindane)	EPA 8081 A
117.315	006	Chlordane (total)	EPA 8081 A
117.315	008	4,4'-DDD	EPA 8081 A
117.315	009	4,4'-DDE	EPA 8081 A
117.315	010	4,4'-DDT	EPA 8081 A
117.315	011	Dieldrin	EPA 8081 A
117.315	012	Endosulfan I	EPA 8081 A
117.315	013	Endosulfan II	EPA 8081 A
117.315	014	Endosulfan Sulfate	EPA 8081 A
117.315	015	Endrin	EPA 8081 A
117.315	016	Endrin Aldehyde	EPA 8081 A
117.315	017	Endrin Ketone	EPA 8081 A
117.315	018	Heptachlor	EPA 8081 A
117.315	019	Heptachlor Epoxide	EPA 8081 A
117.315	020	Methoxychlor	EPA 8081 A
117.315	021	Toxaphene	EPA 8081 A
117.335	001	Aroclor 1016	EPA 8082
117.335	002	Aroclor 1221	EPA 8082
117.335	003	Aroclor 1232	EPA 8082
117.335	004	Aroclor 1242	EPA 8082
117.335	005	Aroclor 1248	EPA 8082
117.335	006	Aroclor 1254	EPA 8082
117.335	007	Aroclor 1260	EPA 8082
117.405	001	Azinphos Methyl	EPA 8141 A
117.405	002	Chlorpyrifos	EPA 8141 A
117.405	003	Demeton-O	EPA 8141 A
117.405	004	Demeton-S	EPA 8141 A
117.405	005	Diazinon	EPA 8141 A

117.405	006	Dichlorvos (DDVP)	EPA 8141 A
117.405	007	Disulfoton	EPA 8141 A
117.405	008	Malathion	EPA 8141 A
117.405	009	Parathion Ethyl	EPA 8141 A
117.405	010	Parathion Methyl	EPA 8141 A
117.405	011	Phorate	EPA 8141 A
117.405	012	Ronnel	EPA 8141 A
117.405	013	Stirophos (Tetrachlorovinphos)	EPA 8141 A
117.425	001	2,4-D	EPA 8151 A
117.425	002	2,4-DB	EPA 8151 A
117.425	003	2,4,5-TP (Silvex)	EPA 8151 A
117.425	004	2,4,5-T	EPA 8151 A
117.425	005	Dalapon	EPA 8151 A
117.425	006	Dicamba	EPA 8151 A
117.425	007	Dichloroprop	EPA 8151 A
117.425	008	Dinoseb	EPA 8151 A
117.425	009	MCPA	EPA 8151 A
117.425	010	MCPP	EPA 8151 A
117.425	011	4-Nitrophenol	EPA 8151 A
117.425	012	Pentachlorophenol	EPA 8151 A
117.435	001	Acenaphthene	EPA 8270 C
117.435	002	Acenaphthylene	EPA 8270 C
117.435	003	Aniline	EPA 8270 C
117.435	004	Anthracene	EPA 8270 C
117.435	005	Benzidine	EPA 8270 C
117.435	006	Benzoic Acid	EPA 8270 C
117.435	007	Benzo(a)anthracene	EPA 8270 C
117.435	008	Benzo(b)fluoranthene	EPA 8270 C
117.435	009	Benzo(k)fluoranthene	EPA 8270 C
117.435	010	Benzo(g,h,i)perylene	EPA 8270 C
117.435	011	Benzo(a)pyrene	EPA 8270 C
117.435	012	Benzyl Alcohol	EPA 8270 C
117.435	013	Bis(2-chloroethoxy) Methane	EPA 8270 C
117.435	014	Bis(2-chloroethyl) Ether	EPA 8270 C
117.435	015	Bis(2-ethylhexyl)phthalate (Di(2-ethylhexyl) phthalate)	EPA 8270 C
117.435	016	Butyl Benzyl Phthalate	EPA 8270 C
117.435	017	Chrysene	EPA 8270 C
117.435	018	Dibenz(a,h)anthracene	EPA 8270 C
117.435	019	Dibenzofuran	EPA 8270 C
117.435	020	Di-n-butyl Phthalate	EPA 8270 C
117.435	021	Diethyl Phthalate	EPA 8270 C
117.435	022	Dimethyl Phthalate	EPA 8270 C

117.435	023	Di-n-octyl Phthalate	EPA 8270 C
117.435	024	Fluoranthene	EPA 8270 C
117.435	025	Fluorene	EPA 8270 C
117.435	026	Naphthalene	EPA 8270 C
117.435	027	Nitrobenzene	EPA 8270 C
117.435	028	Pentachlorobenzene	EPA 8270 C
117.435	029	Pentachlorophenol	EPA 8270 C
117.435	030	1-Chloronaphthalene	EPA 8270 C
117.435	031	1,2-Dichlorobenzene	EPA 8270 C
117.435	032	1,3-Dichlorobenzene	EPA 8270 C
117.435	033	1,4-Dichlorobenzene	EPA 8270 C
117.435	034	2-Chloronaphthalene	EPA 8270 C
117.435	035	2-Chlorophenol	EPA 8270 C
117.435	036	2,4-Dichlorophenol	EPA 8270 C
117.435	037	2,4-Dimethylphenol	EPA 8270 C
117.435	038	2,4-Dinitrophenol	EPA 8270 C
117.435	039	2,4-Dinitrotoluene	EPA 8270 C
117.435	040	2,6-Dichlorophenol	EPA 8270 C
117.435	041	2,6-Dinitrotoluene	EPA 8270 C
117.435	042	2-Nitroaniline	EPA 8270 C
117.435	043	2-Nitrophenol	EPA 8270 C
117.435	044	3-Nitroaniline	EPA 8270 C
117.435	045	3,3'-Dichlorobenzidine	EPA 8270 C
117.435	046	4-Chloroaniline	EPA 8270 C
117.435	047	4-Chloro-3-methylphenol	EPA 8270 C
117.435	048	4-Bromophenyl Phenyl Ether	EPA 8270 C
117.435	049	4-Chlorophenyl Phenyl Ether	EPA 8270 C
117.435	050	4-Nitroaniline	EPA 8270 C
117.435	051	4-Nitrophenol	EPA 8270 C
117.435	087	N-nitrosodiethylamine	EPA 8270 C
117.435	088	N-nitrosodimethylamine	EPA 8270 C
117.435	089	N-nitrosodiphenylamine	EPA 8270 C
117.435	090	N-nitroso-di-n-propylamine	EPA 8270 C
117.435	091	Indeno(1,2,3-c,d)pyrene	EPA 8270 C
117.435	092	Isophorone	EPA 8270 C
117.435	093	2-Methylnaphthalene	EPA 8270 C
117.435	094	Phenanthrene	EPA 8270 C
117.475	001	Acenaphthene	EPA 8310
117.475	002	Acenaphthylene	EPA 8310
117.475	003	Anthracene	EPA 8310
117.475	004	Benzo(a)anthracene	EPA 8310
117.475	005	Benzo(a)pyrene	EPA 8310

117.475	006	Benzo(b)fluoranthene	EPA 8310
117.475	007	Benzo(g,h,i)perylene	EPA 8310
117.475	008	Benzo(k)fluoranthene	EPA 8310
117.475	009	Chrysene	EPA 8310
117.475	010	Dibenz(a,h)anthracene	EPA 8310
117.475	011	Fluoranthene	EPA 8310
117.475	012	Fluorene	EPA 8310
117.475	013	Indeno(1,2,3-c,d)pyrene	EPA 8310
117.475	014	Naphthalene	EPA 8310
117.475	015	Phenanthrene	EPA 8310
117.475	016	Pyrene	EPA 8310
117.545	001	1,3,5-Trinitrobenzene	EPA 8330 A
117.545	002	1,3-Dinitrobenzene	EPA 8330 A
117.545	003	Nitrobenzene	EPA 8330 A
117.545	004	2,4,6-Trinitrotoluene	EPA 8330 A
117.545	005	2,4-Dinitrotoluene	EPA 8330 A
117.545	006	2,6-Dinitrotoluene	EPA 8330 A
117.545	007	2-Nitrotoluene	EPA 8330 A
117.545	008	3-Nitrotoluene	EPA 8330 A
117.545	009	4-Nitrotoluene	EPA 8330 A

Field of Accreditation:130 - Inorganic constituents in Hazardous waste (Matrix Aqueous)

130.010	001	Aluminum	EPA 6010 B
130.010	002	Antimony	EPA 6010 B
130.010	003	Arsenic	EPA 6010 B
130.010	004	Barium	EPA 6010 B
130.010	005	Beryllium	EPA 6010 B
130.010	006	Boron	EPA 6010 B
130.010	007	Cadmium	EPA 6010 B
130.010	008	Calcium	EPA 6010 B
130.010	009	Chromium	EPA 6010 B
130.010	010	Cobalt	EPA 6010 B
130.010	011	Copper	EPA 6010 B
130.010	012	Iron	EPA 6010 B
130.010	013	Lead	EPA 6010 B
130.010	014	Magnesium	EPA 6010 B
130.010	015	Manganese	EPA 6010 B
130.010	016	Molybdenum	EPA 6010 B
130.010	017	Nickel	EPA 6010 B
130.010	018	Potassium	EPA 6010 B
130.010	019	Selenium	EPA 6010 B
130.010	020	Silver	EPA 6010 B
130.010	021	Sodium	EPA 6010 B

130.010	022	Strontium	EPA 6010 B
130.010	023	Thallium	EPA 6010 B
130.010	024	Tin	EPA 6010 B
130.010	025	Titanium	EPA 6010 B
130.010	026	Vanadium	EPA 6010 B
130.010	027	Zinc	EPA 6010 B
130.030	001	Aluminum	EPA 6020
130.030	002	Antimony	EPA 6020
130.030	003	Arsenic	EPA 6020
130.030	004	Barium	EPA 6020
130.030	005	Beryllium	EPA 6020
130.030	006	Cadmium	EPA 6020
130.030	007	Chromium	EPA 6020
130.030	008	Cobalt	EPA 6020
130.030	009	Copper	EPA 6020
130.030	010	Lead	EPA 6020
130.030	011	Manganese	EPA 6020
130.030	012	Nickel	EPA 6020
130.030	013	Silver	EPA 6020
130.030	014	Thallium	EPA 6020
130.030	015	Zinc	EPA 6020
130.140	001	Chromium VI (Hexavalent Chromium)	EPA 7196 A
130.170	001	Chromium VI (Hexavalent Chromium)	EPA 7199
130.250	001	Mercury	EPA 7470 A
130.450	001	Cyanide, Total	EPA 9014
130.470	001	Fluoride	EPA 9056

Field of Accreditation:131 - Leaching/Extraction, Physical Chacterstics in Hazardous Waste (Matrix Aqueous)

131.010	001	Waste Extraction Test (WET)	CCR Chapter11, Article 5, Ap Interim
131.040	001	Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311
131.050	001	Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312
131.070	001	Ignitability	EPA 1010 A
131.110	001	Corrosivity - pH Determination	EPA 9040 B
131.120	001	Corrosivity - pH Determination	EPA 9040 C

Field of Accreditation:132 - Volatile Organic Compounds in Hazardous Waste (Matrix Aqueous)

132.010	001	1,2-Dibromoethane (EDB)	EPA 8011
132.010	002	1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011
132.015	001	Gasoline Range Organics (GRO)	EPA 8015 B
132.060	001	Benzene	EPA 8260 B
132.060	002	Bromobenzene	EPA 8260 B
132.060	003	Bromochloromethane	EPA 8260 B
132.060	004	Bromodichloromethane	EPA 8260 B
132.060	005	Bromoform	EPA 8260 B

132.060	006	Bromomethane (Methyl Bromide)	EPA 8260 B
132.060	007	n-Butylbenzene	EPA 8260 B
132.060	008	sec-Butylbenzene	EPA 8260 B
132.060	009	tert-Butylbenzene	EPA 8260 B
132.060	010	Carbon Disulfide	EPA 8260 B
132.060	011	Carbon Tetrachloride	EPA 8260 B
132.060	012	Chlorobenzene	EPA 8260 B
132.060	013	Chlorodibromomethane (Dibromochloromethane)	EPA 8260 B
132.060	014	Chloroethane	EPA 8260 B
132.060	015	Chloroform	EPA 8260 B
132.060	016	Chloromethane (Methyl Chloride)	EPA 8260 B
132.060	017	Dibromomethane	EPA 8260 B
132.060	018	Dichlorodifluoromethane (Freon 12)	EPA 8260 B
132.060	019	cis-1,2-Dichloroethylene (cis 1,2 Dichloroethene)	EPA 8260 B
132.060	020	trans-1,2-Dichloroethylene (trans- 1,2 Dichloroethene	EPA 8260 B
132.060	021	cis-1,3-Dichloropropylene (cis 1,3 Dichloropropene)	EPA 8260 B
132.060	022	trans-1,3-Dichloropropylene (trans-1,3 Dichloroprope	EPA 8260 B
132.060	023	Ethylbenzene	EPA 8260 B
132.060	024	Hexachlorobutadiene	EPA 8260 B
132.060	025	Methyl tert-butyl Ether (MTBE)	EPA 8260 B
132.060	026	Methylene Chloride (Dichloromethane)	EPA 8260 B
132.060	027	Naphthalene	EPA 8260 B
132.060	029	N-propylbenzene	EPA 8260 B
132.060	030	Styrene	EPA 8260 B
132.060	031	Tetrachloroethylene (Tetrachloroethene)	EPA 8260 B
132.060	032	Toluene	EPA 8260 B
132.060	033	Trichloroethylene (Trichloroethene)	EPA 8260 B
132.060	034	Trichlorofluoromethane	EPA 8260 B
132.060	035	Vinyl Chloride	EPA 8260 B
132.060	036	m+p-Xylene	EPA 8260 B
132.060	037	o-Xylene	EPA 8260 B
132.060	040	1,1-Dichloroethane	EPA 8260 B
132.060	041	1,1-Dichloroethylene (1,1-Dichloroethene)	EPA 8260 B
132.060	042	1,1,1-Trichloroethane	EPA 8260 B
132.060	043	1,1,1,2-Tetrachloroethane	EPA 8260 B
132.060	044	1,1,2,2-Tetrachloroethane	EPA 8260 B
132.060	045	1,1,2-Trichloroethane	EPA 8260 B
132.060	046	1,2-Dichlorobenzene	EPA 8260 B
132.060	047	1,2-Dichloroethane (Ethylene Dichloride)	EPA 8260 B
132.060	048	1,2-Dibromoethane (EDB)	EPA 8260 B
132.060	049	1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260 B
132.060	050	1,2-Dichloropropane	EPA 8260 B

132.060	051	1,2,3-Trichloropropane (TCP)	EPA 8260 B
132.060	052	1,2,4-Trichlorobenzene	EPA 8260 B
132.060	053	1,3-Dichlorobenzene	EPA 8260 B
132.060	054	1,4-Dichlorobenzene	EPA 8260 B
132.060	055	2-Chloroethyl vinyl Ether	EPA 8260 B
132.060	056	4-Chlorotoluene	EPA 8260 B
132.060	057	4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	EPA 8260 B

Field of Accreditation:133 - Semi-Volatile Organic Chemistry in Hazardous Waste (Matrix Aqueous)

133.010	002	Diesel Range Organics (DRO)	EPA 8015 B
133.090	001	Aldrin	EPA 8081 A
133.090	002	alpha-BHC	EPA 8081 A
133.090	003	beta-BHC	EPA 8081 A
133.090	004	delta-BHC	EPA 8081 A
133.090	005	gamma-BHC (Lindane)	EPA 8081 A
133.090	006	Chlordane	EPA 8081 A
133.090	008	4,4'-DDD	EPA 8081 A
133.090	009	4,4'-DDE	EPA 8081 A
133.090	010	4,4'-DDT	EPA 8081 A
133.090	011	Dieldrin	EPA 8081 A
133.090	012	Endosulfan I	EPA 8081 A
133.090	013	Endosulfan II	EPA 8081 A
133.090	014	Endosulfan Sulfate	EPA 8081 A
133.090	015	Endrin	EPA 8081 A
133.090	016	Endrin Aldehyde	EPA 8081 A
133.090	017	Endrin Ketone	EPA 8081 A
133.090	018	Heptachlor	EPA 8081 A
133.090	019	Heptachlor Epoxide	EPA 8081 A
133.090	020	Methoxychlor	EPA 8081 A
133.090	021	Toxaphene	EPA 8081 A
133.120	001	Aroclor 1016	EPA 8082
133.120	002	Aroclor 1221	EPA 8082
133.120	003	Aroclor 1232	EPA 8082
133.120	004	Aroclor 1242	EPA 8082
133.120	005	Aroclor 1248	EPA 8082
133.120	006	Aroclor 1254	EPA 8082
133.120	007	Aroclor 1260	EPA 8082
133.190	001	Azinphos Methyl	EPA 8141 A
133.190	002	Chlorpyrifos	EPA 8141 A
133.190	003	Demeton-O	EPA 8141 A
133.190	004	Demeton-S	EPA 8141 A
133.190	005	Diazinon	EPA 8141 A
133.190	006	Dichlorvos (DDVP)	EPA 8141 A

133.190	007	Disulfoton	EPA 8141 A
133.190	008	Malathion	EPA 8141 A
133.190	009	Parathion Ethyl	EPA 8141 A
133.190	010	Parathion Methyl	EPA 8141 A
133.190	011	Phorate	EPA 8141 A
133.190	012	Ronnel	EPA 8141 A
133.190	013	Stirophos (Tetrachlorovinphos)	EPA 8141 A
133.220	001	2,4-D	EPA 8151 A
133.220	002	2,4-DB	EPA 8151 A
133.220	003	2,4,5-TP (Silvex)	EPA 8151 A
133.220	004	2,4,5-T	EPA 8151 A
133.220	005	Dalapon	EPA 8151 A
133.220	006	Dicamba	EPA 8151 A
133.220	008	Dinoseb	EPA 8151 A
133.220	009	MCPA	EPA 8151 A
133.220	010	MCPP	EPA 8151 A
133.220	011	4-Nitrophenol	EPA 8151 A
133.220	012	Pentachlorophenol	EPA 8151 A
133.230	001	Acenaphthene	EPA 8270 C
133.230	002	Acenaphthylene	EPA 8270 C
133.230	003	Aniline	EPA 8270 C
133.230	004	Anthracene	EPA 8270 C
133.230	005	Benzidine	EPA 8270 C
133.230	006	Benzoic Acid	EPA 8270 C
133.230	007	Benzo(a)anthracene	EPA 8270 C
133.230	008	Benzo(b)fluoranthene	EPA 8270 C
133.230	009	Benzo(k)fluoranthene	EPA 8270 C
133.230	010	Benzo(g,h,i)perylene	EPA 8270 C
133.230	011	Benzo(a)pyrene	EPA 8270 C
133.230	012	Benzyl Alcohol	EPA 8270 C
133.230	013	Bis(2-chloroethoxy) Methane	EPA 8270 C
133.230	014	Bis(2-chloroethyl) Ether	EPA 8270 C
133.230	015	Bis(2-ethylhexyl)phthalate (Di(2-ethylhexyl) phthalate)	EPA 8270 C
133.230	016	Butyl Benzyl Phthalate	EPA 8270 C
133.230	017	Chrysene	EPA 8270 C
133.230	018	Dibenz(a,h)anthracene	EPA 8270 C
133.230	019	Dibenzofuran	EPA 8270 C
133.230	020	Di-n-butyl Phthalate	EPA 8270 C
133.230	021	Diethyl Phthalate	EPA 8270 C
133.230	022	Dimethyl Phthalate	EPA 8270 C
133.230	023	Di-n-octyl Phthalate	EPA 8270 C
133.230	024	Fluoranthene	EPA 8270 C

133.230	025	Fluorene	EPA 8270 C
133.230	026	Naphthalene	EPA 8270 C
133.230	027	Nitrobenzene	EPA 8270 C
133.230	028	Pentachlorobenzene	EPA 8270 C
133.230	029	Pentachlorophenol	EPA 8270 C
133.230	030	1-Chloronaphthalene	EPA 8270 C
133.230	031	1,2-Dichlorobenzene	EPA 8270 C
133.230	032	1,3-Dichlorobenzene	EPA 8270 C
133.230	033	1,4-Dichlorobenzene	EPA 8270 C
133.230	034	2-Chloronaphthalene	EPA 8270 C
133.230	035	2-Chlorophenol	EPA 8270 C
133.230	036	2,4-Dichlorophenol	EPA 8270 C
133.230	037	2,4-Dimethylphenol	EPA 8270 C
133.230	038	2,4-Dinitrophenol	EPA 8270 C
133.230	039	2,4-Dinitrotoluene	EPA 8270 C
133.230	040	2,6-Dichlorophenol	EPA 8270 C
133.230	041	2,6-Dinitrotoluene	EPA 8270 C
133.230	042	2-Nitroaniline	EPA 8270 C
133.230	043	2-Nitrophenol	EPA 8270 C
133.230	044	3-Nitroaniline	EPA 8270 C
133.230	045	3,3'-Dichlorobenzidine	EPA 8270 C
133.230	046	4-Chloroaniline	EPA 8270 C
133.230	047	4-Chloro-3-methylphenol	EPA 8270 C
133.230	048	4-Bromophenyl Phenyl Ether	EPA 8270 C
133.230	049	4-Chlorophenyl Phenyl Ether	EPA 8270 C
133.230	050	4-Nitroaniline	EPA 8270 C
133.230	051	4-Nitrophenol	EPA 8270 C
133.230	087	N-nitrosodiethylamine	EPA 8270 C
133.230	088	N-nitrosodimethylamine	EPA 8270 C
133.230	089	N-nitrosodiphenylamine	EPA 8270 C
133.230	090	N-nitroso-di-n-propylamine	EPA 8270 C
133.230	091	Indeno(1,2,3-c,d)pyrene	EPA 8270 C
133.230	092	Isophorone	EPA 8270 C
133.230	093	2-Methylnaphthalene	EPA 8270 C
133.230	094	Phenanthrene	EPA 8270 C
133.270	001	Acenaphthene	EPA 8310
133.270	002	Acenaphthylene	EPA 8310
133.270	003	Anthracene	EPA 8310
133.270	004	Benzo(a)anthracene	EPA 8310
133.270	005	Benzo(a)pyrene	EPA 8310
133.270	006	Benzo(b)fluoranthene	EPA 8310
133.270	007	Benzo(g,h,i)perylene	EPA 8310

133.270	008	Benzo(k)fluoranthene	EPA 8310
133.270	009	Chrysene	EPA 8310
133.270	010	Dibenz(a,h)anthracene	EPA 8310
133.270	011	Fluoranthene	EPA 8310
133.270	012	Fluorene	EPA 8310
133.270	013	Indeno(1,2,3-c,d)pyrene	EPA 8310
133.270	014	Naphthalene	EPA 8310
133.270	015	Phenanthrene	EPA 8310
133.270	016	Pyrene	EPA 8310
133.350	001	1,3,5-Trinitrobenzene	EPA 8330 A
133.350	002	1,3-Dinitrobenzene	EPA 8330 A
133.350	003	Nitrobenzene	EPA 8330 A
133.350	004	2,4,6-Trinitrotoluene	EPA 8330 A
133.350	005	2,4-Dinitrotoluene	EPA 8330 A
133.350	006	2,6-Dinitrotoluene	EPA 8330 A
133.350	007	2-Nitrotoluene	EPA 8330 A
133.350	008	3-Nitrotoluene	EPA 8330 A
133.350	009	4-Nitrotoluene	EPA 8330 A

APPENDIX G – Laboratory SOPs

Confidential SOPs Retracted

STANDARD OPERATING PROCEDURES

ALKALINITY

SOP No.: EMAX-2320B Revision No. 8 Effective Date: 06-Dec-22

Prepared By: Tina Huang Date: 12/6/22

Approved By: Farina Madamba Date: 12/6/22
QA Manager

Approved By: Caspar Pang Date: 12/6/22
Laboratory Director

Control Number: 2320B-08-

1.0 SCOPE AND APPLICATION

1.1. This method is used to measure alkalinity of aqueous samples by titration. This is applicable to drinking, surface, and saline waters, domestic and industrial wastes. It is suitable for all concentration ranges of alkalinity; however, appropriate aliquots should be used to avoid a titration volume greater than 50 ml.

1.2. Alkalinity of soil may also be determined by leaching the matrix with reagent water and analyzing the leachate for alkalinity.

1.3. This SOP is an adaptation of Method 2320B-2011, Standard Methods for the Examination of Water and Wastewater, 22nd Edition.

1.4. This SOP is also an adaptation of Method 2320B-1997, Standard Methods for the Examination of Water and Wastewater, 20th and 21st Editions. There is no significant difference between Methods 2320B-2011 and 2320B-1997.

2.0 SUMMARY OF METHOD

2.1. An unaltered amount of sample is titrated with standard acid titrant to an endpoint of pH 4.5.

2.2. Solid matrices are leached with reagent water prior to titration.

2.3. **Interferences**

2.3.1. Substances, such as salts of weak organic or inorganic acids present in large amounts, may cause interference in the electrometric measurements.

2.3.2. Oil and grease coating the pH electrode may cause sluggish response. For samples having high concentration of mineral acids, such as mine wastes and associated receiving waters, ASTM Method D-1067 may be used.

3.0 DETECTION LIMITS

3.1. **Detection Limit (DL) and Limit of Detection (LOD)**

3.1.1. DL and LOD are not applicable for this method.

3.2. **Limit of Quantitation (LOQ)**

3.2.1. Refer to EMAX-QA04 for generation, validation and verification of LOQ.

3.2.2. Established LOQ for this method is 5 mg/L.

4.0 DYNAMIC RANGE

4.1. The maximum amount of titrant used in a pre-determined amount of sample shall not exceed 50 ml. All samples analyzed above these range shall be considered estimate (over-range) and shall require a smaller amount of sample or higher titrant concentration to properly quantitate.

5.0 SAMPLE HOLDING TIME & PRESERVATION

5.1. **Preservation**

5.1.1. Collected water samples are maintained at ≤ 6°C with no chemical preservation.

5.1.2. Samples should not be filtered, diluted, concentrated or altered in any way.

5.1.3. Store all samples ≤ 6°C without freezing.

5.2. **Holding Time**

5.2.1. Analyze aqueous samples as soon as possible, not to exceed 14 days from sampling date.

5.2.2. Analyze all leachates within 24 hours from extraction.

6.0 ASSOCIATED SOPs

6.1.	EMAX-DM01	Data Flow and Review
6.2.	EMAX-QA04	Detection Limit
6.3.	EMAX-QA05	Training
6.4.	EMAX-QA08	Corrective Action
6.5.	EMAX-QC02	Analytical Standard Preparation
6.6.	EMAX-QC07	Labware Cleaning
6.7.	EMAX-SM03	Waste Disposal
6.8.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS for chemicals listed in this SOP.

7.2. Treat reagents, standards and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, gloves, at all times when performing this procedure.

7.3. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amounts of water. If irritations persist, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS AND REAGENTS

8.1. Instruments and Supplies

8.1.1. pH meter: Hach One Laboratory pH/ISE Meter or equivalent

8.1.2. Autotitrator: PC Titrate

8.1.3. Combination electrode

8.1.4. Burette: 50, 25 and 10 mL

8.1.5. Beaker: 50 mL

8.1.6. Volumetric flasks: 1 L and 2 L

8.1.7. Analytical balance (capable of weighing 0.01 gm)

8.2. Chemicals and Reagents

8.2.1. Reagent water: Type II

9.0 STANDARDS

9.1. Purchase all standards as certified solutions as listed below (or equivalent):

STANDARD	SOURCE	CONCENTRATION
pH 4.0	SCP Science	NA
pH 7.0	SCP Science	NA
pH 10.0	SCP Science	NA
pH 8.0	Spex Certiprep	NA
Alkalinity Std.	VWR/ERA	Certified concentration
HCl (Titrant)	VWR	0.02 N

9.2. Alternately, you may prepare alkalinity standard and HCl standard solutions as follows:

9.2.1. Alkalinity Standard - 0.05N Na_2CO_3

9.2.1.1. Oven dry Na_2CO_3 at 250°C for at least 4 hours and cooled in dessicator.

9.2.1.2. Accurately weigh 2.5 ± 0.2 g and dissolve it in 1 liter reagent water.

9.2.1.3. Provide 7 days expiration date for this standard.

9.2.2. Titrant (Standard Acid)

9.2.2.1. HCl stock solution; 1N: dilute 8.33 mL conc. HCl to 100 mL reagent water.

9.2.2.2. HCl standard solution; 0.02 N: dilute 20 mL of 1 N HCl to 1000 mL reagent water.

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Aqueous Samples

10.1.1.1. Allow sample(s) to equilibrate at room temperature.

10.1.1.2. Transfer an appropriate amount of sample into a properly labeled container (see 10.4). Use reagent water for method blank and a certified standard for LCS/LCSD. Prepare a sample duplicate (SD) for every preparative batch. MS/MSD may also be included in the preparative batch depending on the project requirements.

10.1.1.3. The samples are now ready for analysis.

10.1.2. Soil/Solid Samples

10.1.2.1. Weigh 50 g of sample and add 50 ml of reagent water. Check that the balance calibration has been verified on that day prior to use.

10.1.2.2. Place it in the shaker and agitate for 1 hour.

10.1.2.3. Centrifuge for 5 minutes.

10.1.2.4. Carefully, withdraw the leachate, and prepare them as described in Sec. 10.4.

10.2. Instrument Parameters

10.2.1. pH Meter

10.2.1.1. Electrode Channel - Channel 1

10.2.1.2. Resolution - 0.01 pH

10.2.2. Autotitrator

10.2.2.1. Electrode port - Port 1

10.3. Calibration

10.3.1. Manual Calibration

10.3.1.1. Transfer about 10 mL each of pH 4, 7 and 10 buffer solution into separate 20 mL vials and drop a piece of magnetic bar into each vials.

10.3.1.2. Rinse the pH meter electrode and shake off excess water.

10.3.1.3. Immerse electrode to the pH buffers and calibrate the pH meter, accordingly.

10.3.1.4. Record calibration readings in the analysis run log. Slope should be between 92- 102% to proceed to analysis.

10.3.2. Autotitration

10.3.2.1. Calibrations are performed by the autotitrator prior to sample analysis.

10.3.2.2. Transfer about 35 – 40 mL of pH 4, 7, 10 and 8 buffer solutions into separate 50 ml vials and load vials at locations 1, 2, 3 and 4 of sample tray, respectively.

10.3.2.3. After calibration is complete check if buffer solution 8 passes QC criteria of pH = 8 ± 0.05. If calibration fails to meet QC parameter, re-sequence and recalibrate.

10.4. **Analysis**

10.4.1. Standardization of Titrant

10.4.1.1. Prepare 7.5 mL 0.05 N Na_2CO_3 in a beaker.

10.4.1.2. Titrate with HCl titrant potentiometrically to about pH 5.

10.4.1.3. Lift out electrode, rinse into the same beaker and boil gently for 3 to 5 min under a watch glass cover.

10.4.1.4. Cool to room temperature, rinse cover glass into beaker and finish titrating to the pH inflection point.

10.4.1.5. Calculate the HCl titrant concentration using Eq.-10.5.1. Perform triplicate standardization. Use the average of triplicate measurements as the HCl titrant concentration.

10.4.1.6. If HCl titrant is purchased as certified solution, verify the concentration against result of the LCS. Standardize the certified titrant 30 days after first use and every 30 days thereafter.

10.4.1.7. If titrant is prepared in-house, standardize before use and every 30 days thereafter.

10.4.2. Manual Titration

10.4.2.1. **Initial pH Determination**

10.4.2.1.1. Place a clean magnetic stir bar in the sample. Position the sample container on the center of the magnetic stirrer. Switch the magnetic stirrer power on and gradually turn the speed knob until adequate mixing is obtained.

10.4.2.1.2. Rinse the calibrated pH probe with reagent water. Shake-off the excess water into a Kim wipes paper towel. Immerse the pH meter probe into the sample. Allow the meter readout to stabilize.

10.4.2.1.3. Record the pH reading on the initial pH column. Proceed to Sec. 10.4.2.2.

10.4.2.2. **Sample Titration**

10.4.2.2.1. Fill the burette with titrant up to the mark. Position the burette to the center of the flask.

10.4.2.2.2. Titrate an appropriate amount of sample to three pH points: pH = 8.3, pH = 4.5 and pH=4.2 (i.e., pH points at ± 0.04) using 0.02N HCl. Record the titrant volume used for each pH point.

10.4.2.2.3. Results for total, bicarbonate, carbonate and hydroxide alkalinity are automatically calculated by the template. Alkalinity relationships/calculations are shown in Section 10.5.

10.4.2.3. **Sample Titration for Low Alkalinity**

10.4.2.3.1. For alkalinity of < 20 mg/L, titrate 100 mL of sample using 10 mL microburette an 0.02N acid solution.

10.4.2.3.2. Stop titration at pH range 4.5 ± 0.04. Record volume and exact pH.

10.4.2.3.3. Carefully, add titrant to lower the pH to exactly 0.3 pH units and record the titrant volume.

10.4.2.3.4. Record the actual final pH at the final pH column.

10.4.3. Automatic Titraton

10.4.3.1. **Program Setup**

10.4.3.1.1. Turn-on PC and activate PC Titrator program.

10.4.3.1.2. Click on “Titrator” located at the menu bar and access “manual control”

10.4.3.1.2.1. Click on autosampler tab to load autosampler tray template and home sampler.

10.4.3.1.2.2. Next, click on the digital tab to rinse the syringe and titration cell using pumps 2, 3, and 4.

Note: Pump 2: Turns on/off syringe pump

Pump 3: Turns on/off drain

Pump 4: Turns on/off rinse pump

10.4.3.1.2.3. Check for air bubbles in the burette. If air bubbles are found, click on the serial devices tab and dispense a few ml of titrant to push the bubble out. Refill burette and repeat if necessary.

10.4.3.1.2.4. Return to the menu screen when finished.

10.4.3.1.3. From the menu screen, click on “Titrator” and access “Run titration”

10.4.3.1.3.1. Load template “Daily run no order #” and input analytical batch sequence.

Note: Remember to include a sample duplicate for every preparative batch. ICV/CCV/MS/MSD may also be included in the preparative batch depending on the project requirements.

10.4.3.1.3.2. Check sequence for accuracy and completeness. Print and retain a copy of the timetable for reference.

10.4.3.2. **Sample Titration**

10.4.3.2.1. Aliquot 40 mL of sample into 50 ml vials and load samples as listed on the sequence.

10.4.3.2.2. Click on the “Start” button after loading pH buffers and samples. If the sequence needs to be updated during the analysis, click “priority” on the right to pause. DO NOT CLICK STOP! Afterwards, make the required changes and click on resume to continue onto the next sample.

Note: Load 40 mL of pH buffer 7/KCl probe solution at tray location 122 before the analytical batch is complete.

10.4.3.2.3. Print the report that appears on the screen when the run is completed. Close the screen and click OK to return to the main menu.

10.4.3.2.4. Click on “Titrator” and “Examine calibrations”. Print the calibration record from the previous run by choosing “port 1” on the drop-down bar. Previous calibrations can also be checked by clicking the arrows at the bottom-left of the screen.

10.5. Calculations

10.5.1. Calculate for Titrant Concentration (Standardization)

$$N = \frac{A \text{ x } B}{53.00 \text{ x } C} \qquad \text{Eq.-10.5.1}$$

where:

N = Normality of titrant

A = Na_2CO_3 dissolved in 1 L solution, g

B = Na_2CO_3 solution titrated, mL

C = titrant used to inflection point, mL

10.5.2. Calculate for Alkalinity

10.5.2.1. **Phenolphtalein Alkalinity (P)**

$$P= \frac{A \, x \, C \, x \, 50000}{D} \qquad \text{Eq.-10.5.2.1}$$

10.5.2.2. ***Total Alkalinity (T)***

$$T= \frac{B \, x \, C \, x \, 50000}{D} \qquad \text{Eq.-10.5.3.1}$$

where:

A = volume of titrant added to reach pH 8.3, mL

B = volume of titrant added to reach pH 4.5 (or 4.2 for low alkalinity), mL

C = concentration of titrant, normality

D = volume of sample used, mL

Alkalinity Relationships/Calculations			
Result of Titration	Hydroxide (OH) Alkalinity as $CaCO_3$	Carbonate (CO_3) Alkalinity as $CaCO_3$	Bicarbonate (HCO_3) Alkalinity as $CaCO_3$
P = 0	0	0	T
P < ½ T	0	2P	T – 2P
P = ½ T	0	2P	0
P > ½ T	2P - T	2 (T-P)	0
P = T	T	0	0

where:

P = phenolphthalein alkalinity

T = total alkalinity

10.5.3. Calculate for Accuracy (Percent Recovery)

$$R = \left(\frac{C_f - C_s}{C_o}\right) \times 100 \qquad \text{Eq.-10.5.4}$$

where:

R = percent recovery

C_f = found concentration

C_s = sample concentration (for LCS, $C_s = 0$)

C_o = known spike concentration

10.5.4. Calculate for Precision (Relative Percent Difference)

$$\%RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100 \qquad \text{Eq.-10.5.5}$$

where:

RPD – Relative Percent Difference

C_1 – Measured concentration of the first sample aliquot

C_2 – Measured concentration of the second sample aliquot

10.6. **Data Reduction**

10.6.1. Make a copy of the analytical run log and sample preparation log (if applicable)

10.6.2. Print a copy of the raw data and the QC report.

10.6.3. Highlight reportable results for data processing.

10.7. **Report Generation**

10.7.1. Autotitration, after analysis, access “Reporting” from the main menu and click on “Print or prepare shazam reports”. Open report format “Water Analysis Historical Data Report.srw”. Double-click on the filters and input the run # found on the front of the report printout. Export the data in an ASCII delimited text format onto the desktop by clicking on “File” and then “Export” from the menu bar. Transfer the export data onto the network via a flash drive for reporting.

10.7.2. Copy exported file (YYe5M01.txt) to R:\[SDG]\[Method folder] (e.g., R:\YYMXXX\TALK)

10.7.3. For manual titration copy export file from X:\SAMPREP\SD\[ANALSYSIS BATCH] (e.g., YYALMXXX.TXT) to R:\[SDG]\[Method folder] (e.g., R:\YYMXXX\TALK)

10.7.4. Generate report forms F1 and F3 (LCS/LCSD, SD) using ALK00.exe.

10.7.5. Generate the case narrative using CN00.exe.

10.8. **Data Review**

10.8.1. Arrange the analysis package in sequence as detailed below. Attach all raw data to every form generated, to include re-analysis.

- Case Narrative
- Sample Results
- LCS/LCSD Summary
- Sample Duplicate Summary
- Analytical Run Log
- Raw Data
- Non-Conformance Report (If any)

10.8.2. Perform a 100% data review in accordance to EMAX-DM01 and the PSR.

10.8.3. Review the case narrative and check that it accurately describes what transpired in the analytical process. Edit as necessary to reflect essential issues not captured by the case narrative generator program.

10.8.4. Submit the analytical folder for secondary review.

10.9. **Preventive Maintenance**

10.9.1. The pH electrodes should be maintained clean and the probe returned to the probe handle after every use.

10.9.2. Instruments should receive routine preventive maintenance, which is reported in instrument-specific maintenance logs. Routine maintenance ensures that all equipment are operating under optimum condition, thus reducing the possibility of instrument malfunction that consequently affects sample results.

11.0 QUALITY CONTROL

11.1. Refer to Appendix 1 for all related Quality Control parameters, frequency, acceptance criteria and corrective action.

11.2. All labwares used in the sample preparation shall be properly treated as specified in EMAX-QC07.

11.3. All analytical standards are prepared fresh on the day of analysis. All analytical standard preparations shall follow the procedures described in EMAX-QC02 and shall be documented in the analytical standard preparation log.

11.4. Instrument parameters are checked and recorded in the instrument maintenance log prior to its use for the day.

11.5. A preparative batch shall include a MB, LCS, sample duplicate and a maximum of 20 field original samples unless otherwise specified by the project.

11.6. A valid LOQ must exist prior to sample analysis. Refer to EMAX-QA04 for details.

11.7. All analysts conducting this analysis must have an established Demonstration of Capability (DOC) as described in EMAX-QA05.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1.

12.2. QC Samples

12.2.1. Method Blank (MB). If MB is non-compliant, consider the following suggestions to analyze and possibly correct the problem:

- Investigate the source of the problem and institute resolution to correct, minimize or eliminate the problem.
- If the analyte found in the blank is not detected in any of the field samples, consult with the Supervisor and the PM if the result can be reported otherwise, re-extract and re-analyze the method blank with the associated samples.

12.2.2. Lab Control Sample(s). If LCS is non-compliant, consider the following suggestions to analyze and possibly correct the problem:

- Check for errors in calculation and concentration of the analyte solution.
- If recovery of LCS is bias-high and associated sample results are non-detect, then results can be reported. If associated samples show positive results or if recovery of LCS is bias-low, then acquire or prepare a new LCS standard and titrant and re-analyze with the associated samples.
- If recovery of LCS is still non-compliant after re-analysis, check the PSR for corrective action otherwise; discuss the issue in the case narrative.

12.3. If pH electrode response is erratic and/or sluggish, record sample description on the analytical log and inform the Supervisor for further advice.

12.4. For insufficiency of sample(s), inform the Supervisor immediately for further advice.

12.5. Other anomalies encountered during the analytical process not listed in Appendix 1 shall require a non-conformance report (NCR). Refer to EMAX-QA08.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of standards and reagents that may go to the wastewater drains.

13.2. Prepare all standards in fume hoods.

14.0 WASTE MANAGEMENT

14.1. No samples shall be dumped in the laboratory sink.

14.2. Separate and properly identify all unused expired analytical standards for proper disposal.

14.3. Place all waste generated during analytical process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired analytical standards and other wastes generated during the analytical process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. Based on the Methods Update Rule and Title 40 Code of Federal Regulations, Part 136, EPA Method 310.1 is no longer an approved method. However, since EPA Method 310.1 is equivalent to SM 2320B-1997 and SM 2320B-2011, where necessary, this SOP is also applicable to EPA Method 310.1.

15.2. **Definition of Terms**

15.2.1. Alkalinity of water – is its acid-neutralizing capacity. It is the sum of all titratable bases.

15.2.2. Phenolphthalein Alkalinity – is the alkalinity measured by titration to pH 8.3

15.2.3. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.2.3.1. **Preparation Batch** - is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.2.3.2. **Analytical batch -** is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices, preparation batches, and can exceed 20 samples.

15.2.4. Limit of Quantitation (LOQ) – The minimum levels, concentrations or quantities of target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

15.2.5. Material Safety Data Sheet (MSDS) – is where the physical data, toxicology and safety precaution of a certain substance is listed.

15.2.6. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.2.7. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.2.8. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.2.9. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.2.10. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.2.11. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.2.12. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.2.13. Matrix – is a component or form of a sample.

15.2.14. Re-analysis – is a repeated analysis from the same extract/leachate or sample, identified with the Lab Sample ID suffixed with “W”.

15.3. Application of EMAX QC Procedures

15.3.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing analysis for Alkalinity. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.4. Department of Defense (DoD) and Department of Energy (DOE) Projects

15.4.1. Samples from DoD sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client’s quality control directive. In the absence of QAPP, the DoD Quality Systems Manual (QSM), latest update, shall be applied.

16.0 REFERENCES

16.1. “Alkalinity by Titration”, Method 2320B-2011 and Method 2320B-1997, Standard Methods for the Examination of Water and Wastewater, 22nd edition.

16.2. Manual for the Certification of Laboratories Analyzing Drinking Water, 5th edition.

16.3. “Alkalinity by Titration”, EPA Method 310.1, Editorial Rev. 1978.

16.4. Title 40 Code of Federal Regulations Part 136, Guidelines Establishing Test Performance for Analysis of Pollutants, Clean Water Act Methods Update Rule, May 19, 2021.

16.5. EMAX Quality Systems Manual, as updated.

17.0 APPENDICES

17.1. Figures

17.1.1.	Figure 1	Typical Sample Result Summary
17.1.2.	Figure 2	Typical LCS/LCSD Summary
17.1.3.	Figure 3	Typical Sample Duplicate Summary
17.1.4.	Figure 4	Typical Case Narrative

17.2. Appendices

17.2.1.	Appendix 1	Summary of Quality Control Procedures
17.2.2.	Appendix 2	Demonstration of Capability

17.3. Forms

17.3.1.	2320BFA	Analytical Run Log
17.3.2.	2320BFM	Instrument Maintenance Log

Figure 1: TYPICAL SAMPLE RESULT SUMMARY

```
                                                              METHOD SM2320B

                                                             TOTAL ALKALINITY

=====================================================================================================================================================
    Client     : XYZ, INC.                                                                                                     Matrix        : WATER
    Project    : CLEAN PROJECT                                                                                                 InstrumentID  : E5
    Batch No.  : YYM001
======================================================================================================================================================
    CLIENT         EMAX       RESULTS   PREP. MOIST     LOD     LOQ    ANALYSIS    PREPARATION   DATA         CAL      PREP     COLLECTION    RECEIVED
    SAMPLE ID      SAMPLE ID    (mg/L)  FACTOR  (%)   (mg/L) (mg/L)    DATETIME    DATETIME      FILE ID      REF      BATCH     DATETIME     DATETIME
    ---------      ---------- --------- ------ ------ ------ ------ ------------- ------------- ----------  -------- --------  -------------  --------
    MBLK1W         ALM001WB         ND      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0103   YYE5M01   ALM001W        NA          NA
    LCS1W          ALM001WL       56.3      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0104   YYE5M01   ALM001W        NA          NA
    LCD1W          ALM001WC       60.3      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0105   YYE5M01   ALM001W        NA          NA
    ABCDEF-01      M001-01        34.4      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0106   YYE5M01   ALM001W  MM/DD/YYHH:MM  MM/DD/YY
    ABCDEF-02      M001-02        34.7      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0107   YYE5M01   ALM001W  MM/DD/YYHH:MM  MM/DD/YY
    ABCDEF-02DUP   M001-02D       34.6      1    NA       5      5  MM/DD/YYHH:MM      NA       YYE5M0108   YYE5M01   ALM001W  MM/DD/YYHH:MM  MM/DD/YY

   NOTES:
        Alkalinity concentration is reported as:
            Alkalinity to pH 4.5 for results ≥ 20 mg/L
            Alkalinity to pH 4.2 for results < 20 mg/L
```

Figure 2: TYPICAL LCS/LCSD SUMMARY

```
                                                            EMAX QUALITY CONTROL DATA
                                                           LAB CONTROL SAMPLE ANALYSIS

CLIENT         : XYZ, INC.
PROJECT        : CLEAN PROJECT
BATCH NO.      : YYM001
METHOD         : SM2320B
==========================================================================================================================

MATRIX         : WATER                                        % MOISTURE:   NA
DILUTION FACTOR: 1                 1              1
SAMPLE ID      : MBLK1W         LCS1W             LCD1W
LAB SAMPLE ID  : ALM001WB       ALM001WL          ALM001WC
LAB FILE ID    : YYE5M0103      YYE5M0104         YYE5M0105
DATE EXTRACTED : NA             NA                NA
DATE ANALYZED  : MM/DD/YYHH:MM  MM/DD/YYHH:MM     MM/DD/YYHH:MM
PREP BATCH     : ALM001W        ALM001W           ALM001W
CALIBRATION REF: YYE5M01        YYE5M01           YYE5M01

ACCESSION:

                         MB RESULT SPIKE AMT BS RESULT   BS REC  SPIKE AMT BSD RESULT BSD REC    RPD     QC LIMIT  MAX RPD
PARAMETER                 (mg/L)    (mg/L)    (mg/L)      (%)     (mg/L)     (mg/L)     (%)      (%)       (%)       (%)
---------                --------- --------- --------- --------- --------- --------- --------- --------- --------- -------
TOTAL ALKALINITY               ND       63.4      56.3      89        63.4      60.3      95        7       80-120     20
```

Figure 3: TYPICAL SAMPLE DUPLICATE SUMMARY

```
                                     EMAX QUALITY CONTROL DATA
                                     SAMPLE DUPLICATE ANALYSIS

CLIENT         : XYZ, INC.
PROJECT        : CLEAN PROJECT
BATCH NO.      : YYM001
METHOD         : SM2320B
=======================================================================================

MATRIX         : WATER
DILUTION FACTOR: 1                       1
SAMPLE ID      : ABCDEF-02               ABCDEF-02DUP
LAB SAMPLE ID  : M001-02                 M001-02D
LAB FILE ID    : YYE5M0107               YYE5M0108
DATE PREPARED  : NA                      NA
DATE ANALYZED  : MM/DD/YYHH:MM           MM/DD/YYHH:MM
PREP BATCH     : ALM001W                 ALM001W
CALIBRATION REF: YYE5M010                YYE5M010

ACCESSION:

                         PARENT RESULT  DUP RESULT      RPD      MAX RPD
PARAMETER                    (mg/L)      (mg/L)         (%)        (%)
----------               -------------  ---------      ------   ---------
TOTAL ALKALINITY                34.7       34.6          0.3        20
```

Figure 5: TYPICAL CASE NARRATIVE

CASE NARRATIVE

Client : XYZ, INC.

Project: CLEAN PROJECT

SDG : YYM001

METHOD SM2320B
ALKALINITY

A total of two (2) water samples were received on MM/DD/YY to be analyzed for Total Alkalinity in accordance with Method SM2320B and project specific requirements.

Holding Time
Samples were analyzed within the prescribed holding time.

Calibration
Calibration was performed as prescribed by the method and was verified using a secondary source (ICV). All calibration requirements were within acceptance criteria.

Method Blank
Method blank was prepared and analyzed at the frequency required by the project. For this SDG, one (1) method blank was analyzed. Total Alkalinity was not detected in ALM001WB. Refer to sample result summary form for details.

Lab Control Sample
Lab control sample was prepared and analyzed at a frequency required by the project. For this SDG, one (1) set of LCS/LCD was analyzed. ALM001WL/ALM001WC were within LCS limits. Refer to LCS summary form for details.

Matrix QC Sample
Sample duplicate was analyzed and RPD was within expected value.

Sample Analysis
Samples were analyzed according to prescribed analytical procedures. Results were evaluated in accordance to project requirements. For this SDG, all quality control requirements were met.

Appendix 1: SUMMARY OF QUALITY CONTROL PROCEDURES

QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	1st Rvw	2nd Rvw
Instrument Calibration	Daily prior to sample analysis	± 0.05 pH units	Correct the problem and re-calibrate prior to sample analysis		
Method Blank	One method blank per preparation batch	Result ≤ LOQ	If sample results are non-detect, no corrective action is needed, otherwise correct the problem and re-analyze all associated samples.		
Method Reporting Limit (MRL) ***only for drinking water***	One MRL every analysis day	% Recovery: 80 - 120%	Correct the problem and re-analyze all associated samples.		
LCS	One LCS per preparation batch	% Recovery: 80 – 120%	Correct the problem and re-analyze all associated samples.		
Sample Duplicate	One sample duplicate per preparation batch	RPD ≤ 20%	Discuss in the case narrative		
Comments: Refer to PSR for flagging criteria. 22nd / 21st Edition			Reviewed By:		
			Date:		

Appendix 2: DEMONSTRATION OF CAPABILITY

DEMONSTRATION OF CAPABILITY

METHOD 2320B

Unit: mg/L
Sample Amount(ml): 25

PARAMETER	ALM001WL	ALM001WC	ALM001WX	ALM001WY	TV	Ave Conc.	Ave %Rec	SD	RSD (%)	Accuracy Acceptance Limits (% Rec)	RSD (%) Criteria	Comments
	YYE5M0104	YYE5M0105	YYE5M0106	YYEMC0107								
Alkalinity	86.9	88.1	87.0	87.5	86.4	87.4	101	0.529	0.6	80 - 120	≤ 20	Passed

REFERENCE:

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2320BFA (Page 1): ANALYTICAL RUN LOG

Data File Name	Lab Sample ID	Sample Amount (mL)	Sample pH	Analysis Date mm:dd:yy	Analysis Time hh:mm:ss	Volume of Acid Titrant (A) mL pH = 8.3	Analysis Date mm:dd:yy	Analysis Time hh:mm:ss	Volume of Acid Titrant (B) mL pH = 4.5	Analysis Date mm:dd:yy	Analysis Time hh:mm:ss	Volume of Acid Titrant (C) mL pH = 4.2	Analysis Date mm:dd:yy	Analysis Time hh:mm:ss	Final pH	Analysis Date mm:dd:yy	Analysis Time hh:mm:ss	Phenolphtalein Alkalinity (P) mg/L	Total Alkalinity (T) mg/L	Bicarbonate Alkalinity (HCO_3) mg/L	Carbonate Alkalinity (CO_3) mg/L	Hydroxide Alkalinity (OH) mg/L	Notes

Comments:

Standard / Reagent ID	Description	Conc.	Exp. Date
	ICV		
	LCS (mg/L)		
	MS (mg/L)		
	Acid Titrant, HCl (N)		
	pH Strip		
	pH 4		
	pH 7		
	pH 10		
	pH 8 (Check)		

pH Meter Calibration

Instrument ID:		53
Buffer 4		
Buffer 7		
Buffer 10		
pH Check Buffer (8)		

Snapseal Lot:			

Micropipette ID: ____________________

☐ Titriation end point: pH 4.5 ± 0.04

☐ Low alkalinity: pH 4.2 ± 0.04

SOP

☐ EMAX-2320B Rev.

LOQ (mg/L) __________
LOD (mg/L) __________

MS EV Aliquot (mL) __________
MS EV Final Vol (mL) __________

HCL Standardization

Concentration of HCl Titrant (N) = A x B / C x 53.00

Na_2CO_3 (g)	Na_2CO_3 Soln vol used (mL)	HCl used			Conctration of HCl Titrant (N)	Date
		TO pH 5	TO pH 4.5	Total (mL)		
Average of Triplicate Standrization:						

A = Na_2CO_3 (g)
B = Na_2CO_3 Soln vol used (mL)
C = Total (mL)

Note: HCl is standardized against 7.5 mL 0.05N Na_2CO_3 solution

☐ Date of Standardization:

Reagent	Reagent ID	Expiration
Na_2CO_3		
HCl		
Reagent H_2O		

Analyzed By: ____________________
Reviewed By: ____________________
Date:

2320BFA (Page 2): ANALYTICAL RUN LOG

LAB QC CHECK

DataFileID	LabSampleID	Result	Expected Value	QC Result

MS CHECK

DataFileID	LabSampleID	Result	Expected Value	QC Result

DUP CHECK

DataFileID	LabSampleID	Result	Expected Value	QC Result

2320BFA: ANALYTICAL RUN LOG

EMAX LABORATORIES, INC.

ANALYSIS RUN LOG
for
ALKALINITY

Page 1

Note: For samples and relevent QCs/Standards analyzed, refer to attached analytical sequence.

☐ Titration end point: pH 4.5 ± 0.04

☐ Low alkalinity: pH 4.2 ± 0.04

Micropipette ID:

MS/MSD amount of spike:

Reagent Water:

Comments:

Book#: AAL-XXX

Instrument No.: ☐ 53 ☐ E5

Analytical Batch:

Analytical Sequence:

SOP #	Rev. #
☐ EMAX-2320B	
☐ EMAX-	

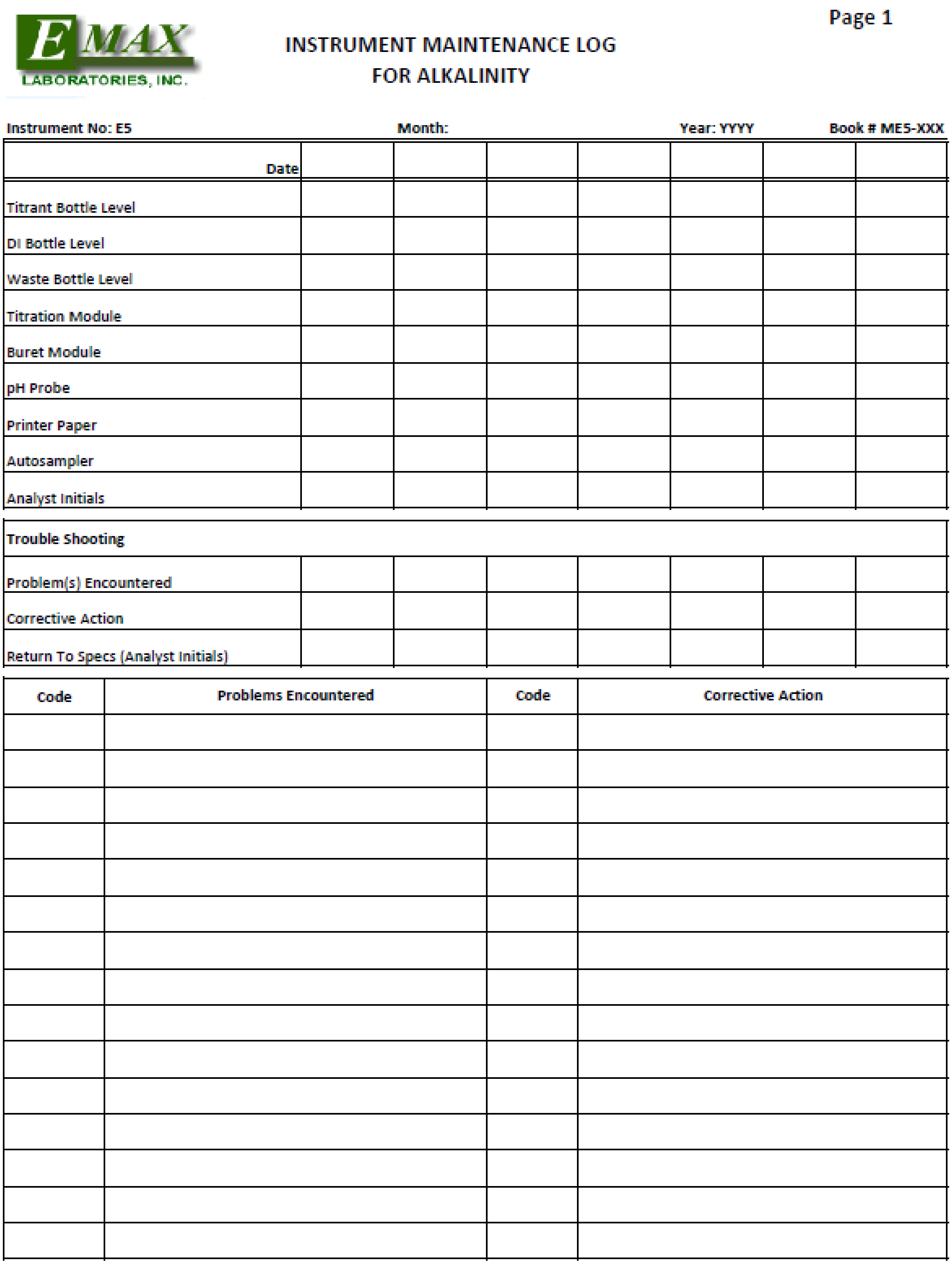
STANDARDS ID	Conc. (mg/L)
0.02N HCL	
LCS	
MS/MSD	
ICV	

pH Buffer	ID
pH 4	
pH 7	
pH 10	
pH 8.0 (Check)	
pH Strip	

Analyzed By:

Date:

2320BFM: INSTRUMENT MAINTENANCE LOG



EMAX LABORATORIES, INC.

Page 1

INSTRUMENT MAINTENANCE LOG
FOR ALKALINITY

Instrument No: E5 Month: Year: YYYY Book # ME5-XXX

Date							
Titrant Bottle Level							
DI Bottle Level							
Waste Bottle Level							
Titration Module							
Buret Module							
pH Probe							
Printer Paper							
Autosampler							
Analyst Initials							

Trouble Shooting							
Problem(s) Encountered							
Corrective Action							
Return To Specs (Analyst Initials)							

Code	Problems Encountered	Code	Corrective Action

SOP REVIEW FORM

ALKALINITY

SOP#: **EMAX-2320B** **Rev** **8** **Effective Date:** **06-Dec-22**

COMMENTS	**Reviewed By**	**Review Date**
No update needed per DRF by T. Kosaka dated 1/8/2024		1/8/2024

TOC QCP

STANDARD OPERATING PROCEDURES

HARDNESS, TOTAL

SOP No.: EMAX-2340C Revision No. 6 Effective Date: 12-Sep-22

Prepared By: Tina Huang Date: 9/12/22

Approved By: Farina Madamba Date: 9/12/22
QA Manager

Approved By: Caspar Pang Date: 9/12/22
Laboratory Director

Control Number: 2340C-06

1.0 SCOPE AND APPLICATION

1.1. This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes. It is suitable for all concentration ranges of hardness.

1.2. This SOP is an adaptation of Methods 2340C-1997 and 2340C-2011, Standard Methods for the Examination of Water and Wastewater, 21st and 22nd Editions.

2.0 SUMMARY OF METHOD

2.1. Calcium and magnesium ions in the sample are sequestered upon the addition of disodium ethylenediamine tetraacetate (Na_2EDTA). The endpoint of the reaction is detected by means of Eriochrome Black T indicator, which has a red color in the presence of calcium and magnesium and a blue color when the cations are sequestered.

2.2. Interferences

2.2.1. Excessive amounts of heavy metals can interfere. This is usually overcome by complexing metal ions with cyanide.

2.2.1.1. Routine addition of sodium cyanide solution to prevent potential metallic interference is recommended.

3.0 DETECTION LIMITS

3.1. Detection Limit (DL), Limit of Detection (LOD)

3.1.1. DL and LOD are not applicable for this method.

3.2. Limit of Quantitation (LOQ)

3.2.1. Refer to EMAX-QA04 for generation, validation and verification of LOQ.

3.2.2. Established LOQ for this method is 10 mg/L.

4.0 DYNAMIC RANGE

4.1. Dynamic range of this method is 10 mg/L – 600 mg/L.

4.2. The highest quantifiable range requiring no dilution is equal to the concentration of the sample titrated with < 15 mL of titrant within 5 minute of titration. All samples analyzed above this range are considered "over-range" and requires a larger volume of sample for proper quantitation.

4.3. The lowest quantifiable range on a given sample amount is equal to a concentration above LOQ. All samples analyzed lower than the standard sample amount (25 mL) whose concentration is ≤ LOQ are considered as “under-range” and requires a higher sample amount for proper quantitation.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. Holding Time

5.1.1. Analyze samples within six months.

5.2. Preservation

5.2.1. Preserve the samples received with HNO_3 to pH < 2 to prevent degradation.

5.2.2. Store samples at ≤ 6°C without freezing.

6.0 ASSOCIATED SOPs

6.1.	EMAX-DM01	Data Flow and Review
6.2.	EMAX-QA04	Detection Limit (DL)
6.3.	EMAX-QA05	Training
6.4.	EMAX-QA08	Corrective Action
6.5.	EMAX-QC01	Quality Control for Chemicals
6.6.	EMAX-QC02	Analytical Standard Preparation
6.7.	EMAX-QC06	Volumetric Labware & Micropipette Verification
6.8.	EMAX-QC07	Labware Cleaning
6.9.	EMAX-SM03	Waste Disposal
6.10.	EMAX-SM04	Analytical and QC Labeling

7.0 SAFETY

7.1. Read all SDS for chemicals listed in this SOP.

Caution: Sodium Cyanide (NaCN) is extremely poisonous.

7.2. Perform all reagent preparations under a properly operating fume hood.

7.3. Treat all reagents, standards, and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, and gloves, at all times when performing this procedure.

7.4. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with tap water. If irritations persist inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS AND REAGENTS

8.1. Instruments and Supplies

8.1.1. Class "A" buret – 25 mL

8.1.2. Magnetic stirrer

8.1.3. Micropipettes

8.1.4. Volumetric flasks

8.1.5. Erlenmeyer flasks

8.2. Chemicals and Reagents

8.2.1. Purchase reagent-grade or better, whenever possible.

8.2.2. Buffer Solution

8.2.2.1. Purchase commercially available "odorless buffers" or prepare buffer solutions as described below:

Magnesium EDTA	Dissolve 16.9 g NH_4Cl in 143 mL concentrated NH_4OH in a 250 mL volumetric flask, add 1.25 g of magnesium salt in EDTA and dilute to the mark with reagent water.
Disodium EDTA	Dissolve 1.179 g disodium EDTA (analytical reagent grade) and 780 mg $MgSO_4 \bullet 7\,H_2O$ in 50 mL reagent water. Add this solution to a 250 mL volumetric flask containing 16.9 g NH_4Cl and 143 mL concentrated NH_4OH with mixing and dilute to the mark with reagent water.

8.2.2.2. Store in a tightly stoppered plastic bottle. This solution is stable for one month. Discard when 1 or 2 mL added to sample fails to produce a pH of 10.0 ± 0.1 at endpoint of titration.

8.2.3. Inhibitors

8.2.3.1. For most waters, inhibitors are not necessary. If interfering ions are present use one of the following:

Inhibitor I	NaCN powder. Basify solutions or sample containing this and place in CN waste container. Make sure no acids are present which might liberate HCN gas.
Inhibitor II	Dissolve 5.0 g $Na_2S \bullet 9H_2O$ or 3.7 g $Na_2S \bullet 5H_2O$ in 100 mL reagent water. Exclude air with tightly fitted rubber stopper. This gives sulfide precipitates, which may obscure the endpoint if large quantities of heavy metals are present. This deteriorates rapidly through air oxidation.
Inhibitor III	Dissolve 4.5 g hydroxylamine hydrochloride in 100 mL of 95% ethanol or isopropanol.

8.2.4. Indicator

8.2.4.1. Use a commercially available indicator or one of the formulations described below:

Eriochrome Black T	Mix 0.5 g Eriochrome Black T with 4.5 g hydroxylamine hydrochloride. Dissolve in 100 mL of 95% ethanol or isopropanol. Or Dissolve 0.5 to 1.0(g) Eriochrome Black T in an appropriate solvent such as triethanolamine or 2-methoxyethanol. This solution is stable for approximately one week. Or Mix together 0.5 g Eriochrome Black T and 100 g NaCl.
Calmagite, 1-(1-hydroxy-4-methyl-2-phenylazo)-2-naphthol-4-sulfonic-acid	Dissolve 0.10 g calmagite in reagent water in 100 mL volumetric flask and dilute to mark. Use 1 mL per 50 mL solution to be titrated.
Methyl red indicator	Dissolve 0.10 g methyl red in reagent water in 100 mL volumetric flask and dilute to mark.

8.2.5. Ammonium hydroxide solution, 3 N: Dilute 210 mL of concentrated NH_4OH to 1 L with reagent water.

8.2.6. Ammonium hydroxide solution, 1 N: Dilute 70 mL of concentrated NH_4OH to 1 L with reagent water.

8.2.7. HCl acid 1+1: Using a clean 500 ml flask, measure and transfer 100 ml of reagent water. Slowly add 100 ml of concentrated HCL while swirling the flask to obtain adequate mixing

9.0 STANDARDS

9.1. Refer to EMAX-QC02 for proper preparation of analytical standards.

9.2. Store standards at room temperature.

9.3. Purchase all standards/titrants as certified solutions as listed below:

STANDARD	SOURCE	CONCENTRATION
EDTA Solution	Ricca or equivalent	0.02N (equals to 0.01M)
LCS	ERA or equivalent	Based on Certified Concentration

9.4. Alternately, you may prepare the above solution as follows:

9.4.1. Standard EDTA titrant at 0.02N

9.4.1.1. Place 3.723 g analytical reagent grade disodium EDTA dehydrate ($Na_2H_2C_{10}H_{12}O_8N_2{\bullet}2H_2O$) in a 1000 mL volumetric flask and dilute to the mark with reagent water.

9.4.2. Standard Calcium Carbonate Solution at 0.02 N

9.4.2.1. Place 1.000 g anhydrous calcium carbonate (primary standard low in metals) in a 500 mL flask. Add droplets of 1+1 HCl until all of the $CaCO_3$ has dissolved.

9.4.2.2. Add 200 mL reagent water. Boil for a few minutes to expel CO_2. Allow solution to cool down.

9.4.2.3. Add a few drops of methyl red indicator and adjust to intermediate orange color by adding 3N NH_4OH or 1+1 HCl as required.

9.4.2.4. Quantitatively transfer to a 1000 mL volumetric flask and dilute to mark with reagent water.

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Allow the samples to equilibrate with room temperature.

10.1.2. Prepare the analytical batch not to exceed 20 field samples with a sample duplicate, Method Blank (MB) and Lab Control Sample (LCS). Neutralize the sample with 1N NH_4OH and dilute to 50 mL reagent water.

10.1.3. Measure 25 mL of sample in titration vessels. Use reagent water for MB and use LCS standard for LCS. Samples are now ready for titration.

10.1.4. For wastewater and highly polluted waters, the sample(s) must be digested. Refer to EMAX-3010 SOP for details.

10.2. Instrument Parameters

10.2.1. Burette used for titration should read a 0.10mL graduation.

10.3. Standardization of EDTA Titrant

10.3.1. If EDTA titrant is purchased as a standard solution, standardize it 30 days after purchase and every 30 days thereafter.

10.3.2. If EDTA titrant is prepared in-house, standardize before use and every 30 days thereafter.

10.3.3. Standardize the EDTA titrant in triplicate against 0.02N $CaCO_3$ Solution. Calculate the EDTA concentration in molarity as shown in Eq.-10.5.1 and 10.5.1a.

10.3.4. Record the standardization in the Total Hardness template (TH.xls) and update the Standardization Date.

10.4. Analysis

10.4.1. Titration

10.4.1.1. Conduct titrations at or near normal room temperature. Note that the color change becomes impractically slow as the sample approaches freezing temperature. Indicator decomposition becomes a problem in hot water.

10.4.1.2. Set the timer to alarm after 5 minutes.

10.4.1.3. Add 1 to 2 mL of buffer solution to sample (prepared in Sec. 10.1.3). This amount is usually sufficient to give a pH of 10.0 to 10.1.

10.4.1.4. Turn on the timer.

10.4.1.5. Add 1 to 2 drops indicator solution or one scoop of dry indicator. Expect the solution to turn to reddish pink.

10.4.1.6. Using EDTA titrant, titrate slowly with continuous stirring until the color changes to distinct blue. If color is not distinct blue, e.g. purple or reddish violet, add inhibitor. If titration endpoint is reached, the solution will turn to distinct blue. This color transition determines the endpoint.

10.4.1.7. If any of the conditions below occur the sample is considered to be "over-range". Reduce the sample amount and repeat the process. [*Note that sample result is expected to be > LOQ, otherwise sample amount is insufficient.*]

- The color does not turn to distinct blue after addition of inhibitor.
- If titrant amount is more than the volume of EDTA used in the standardization.
- If titration took more than 5 minutes after addition of buffer.

10.4.2. Sample Result Evaluation

10.4.2.1. Check the QC data as soon as available. Refer to Appendix 1 for acceptance criteria.

- ✓ Check the method blank and make sure that it meets the project requirement.
- ✓ Check the LCS and make sure it meets the recovery limit.
- ✓ Check the sample duplicate(s) that it meets the acceptance criteria. If not, matrix interference is possible. Note this in the run log.
- ✓ Check that all samples are analyzed within the dynamic range.

10.5. Calculations

10.5.1. Calculate for Titrant Molarity by Standardization

$$E_c = \frac{(C_c)(C_v)}{E_v} \qquad \text{Eq.-10.5.1}$$

where:

E_c – molarity of EDTA titrant

E_v – volume of EDTA titrant in mL

C_c – molarity of calcium carbonate

C_v – volume of calcium carbonate in mL

Calculate the average of the triplicate measurements

$$E = \frac{\sum E_c}{n}$$ Eq.-10.5.1a

where:

E – average of triplicate molarity results of EDTA titrant

ΣE_c – summation of triplicate molarity results of EDTA titrant

N – number of measurements (3 for triplicate measurements)

10.5.2. Calculate for Sample Result

$$H = \frac{(T)(E)100{,}000}{S}$$ Eq.-10.5.2

where:

H – hardness as $CaCO_3$ (mg/L)

T – Titrant volume in mL

E – average EDTA concentration in molarity (M)

S – sample amount (mL)

10.5.3. Calculate for Accuracy (Percent Recovery)

$$\% Recovery = \frac{C_f - C}{C_s} \times 100$$ Eq.-10.5.4

where:

C_f – Concentration Found

C – Concentration of sample (use 0 for LCS)

C_s – Concentration of spike

10.5.4. Calculate for Precision (Relative Percent Difference)

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$ Eq.-

10.5.3

where:

RPD – Relative Percent Difference

C_1 – Measured concentration of the first sample aliquot

C_2 – Measured concentration of the second sample aliquot

10.6. **Data Reduction**

10.6.1. Print a copy of the run log.

10.6.2. Highlight reportable results for data processing.

10.6.3. Keep all other data generated with the analytical folder marked with “For record only”.

10.7. Report Generation

10.7.1. Generate the method .txt file, sample results and QC summaries using TITRI.exe.

10.7.2. Generate the case narrative using CN00.exe.

10.7.3. Arrange the analysis package in sequence as detailed below:

10.7.3.1. Case Narrative

10.7.3.2. Sample Results

10.7.3.3. LCS/LCSD Summary

10.7.3.4. Sample Duplicate Result Summary

10.7.3.5. Run Log

10.7.3.6. Non-Conformance Report (if any)

10.8. Data Review

10.8.1. Perform a 100% data review in accordance to EMAX-DM01 and the PSR.

- Check that MB is compliant to PSR.
- Check LCS/LCSD recoveries against project specific criteria (PSR). In the absence of the PSR, default to in-house QC limits.
- Check concentration of sample results that all are within dynamic range.
- If any of the above check point is non-compliant, re-analysis is required.

10.8.2. Check the generated reports against the run log. Check that the analytical data generated indicating positive results are qualitatively and quantitatively correct.

10.8.3. Review the case narrative and check that it accurately describes what transpired in the analytical process. Edit as necessary to reflect essential issues not captured by the case narrative generator program.

10.8.4. Submit the analytical folder for secondary review.

11.0 QUALITY CONTROL

11.1. Acceptance criteria for each quality control procedure are summarized in Appendix 1.

11.2. Analytical Batch QC

11.2.1. calibration must be verified daily prior to its use. Refer to EMAX-QC06 for details.

11.2.2. Reagents are subjected to QC check prior to its use. Refer to EMAX-QC01 for details.

11.3. Preparation Batch QC

11.3.1. The maximum number of original field samples in a prep batch is twenty (20) unless otherwise specified by the project.

11.3.2. Prepare method blank and LCS in every prep batch, unless otherwise specified by the project.

11.3.3. Prepare a sample duplicate per preparation batch.

11.3.4. Properly treat all lab wares used in the sample preparation as specified in EMAX-QC07.

11.4. **Method QC**

11.4.1. A valid LOQ must exist prior to sample analysis. LOQ must be verified quarterly. Refer to EMAX-QA04 for details.

11.4.2. All analysts conducting this analysis must have an established Demonstration of Capability (DOC) as described in EMAX-QA05.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control Procedure is summarized in Appendix 1.

12.2. **Preparation Batch QC**

12.2.1. When method blank is non-compliant, investigate the source of the problem and institute resolution to correct, minimize or eliminate the problem.

12.2.2. If LCS is non-compliant, investigate the source of the problem to institute resolution to correct the problem.

12.3. **Sample Analysis QC**

12.3.1. For insufficient amount of sample(s), inform the supervisor immediately for further action.

12.3.2. If sample duplicate is non-compliant, discuss in case narrative.

12.4. A Non-Conformance Report (NCR) is required when the following circumstances occur.

- Anomaly other than specified in Appendix 1 is observed.
- Sample is out of technical holding time.

12.4.1. Refer to EMAX-QA08 for NCR details.

13.0 POLLUTION PREVENTION

13.1. NaCN is extremely poisonous. Observe all necessary precautions to avoid spillage of reagents that may go to the wastewater drains.

13.2. Prepare all standards in the fume hood.

14.0 WASTE MANAGEMENT

14.1. No samples shall be dumped on the laboratory sink.

14.2. Separate and properly identify all unused and expired analytical standards for proper disposal.

14.3. Place all waste generated during analytical process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired analytical standards and other waste generated during the analytical process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. According to the Method Update Rule (MUR) and Title 40 Code of Federal Regulation, Part 136, EPA Method 130.2 is not an approved method. If a client requires Method 130.2, EMAX shall perform analysis using Method 2340C-1997/2011 to comply with the MUR and client shall be duly informed.

15.2. **Definition of Terms**

15.2.1. Total Hardness – is the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per liter.

15.2.2. Titration – A procedure for carrying out a chemical reaction between two solutions by the controlled addition of a solution of known concentration called titrant into an unknown. Reaching a certain pH either measured by pH meter or a color change completes the reaction.

15.2.3. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.2.3.1. **Preparation Batch** - is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.2.3.2. **Analytical batch** - is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices, preparation batches, and can exceed 20 samples.

15.2.4. Limit of Quantitation (LOQ) - is at the lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard.

15.2.5. Safety Data Sheet (SDS) – is where the physical data, toxicology and safety precaution of a certain substance is listed.

15.2.6. Buffered solutions or buffers - Are solutions which resist a change in pH when small amounts of acid or base are added.

15.2.7. Indicators – A certain chemical has a special property that changes its color at different pH levels. When a few drops of indicator are added to a solution, the color of the solution serves as an indication of its pH.

15.2.8. Method Blank (MB) – A target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.2.9. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.2.10. Lab Control Sample Duplicate (LCSD) – is a replicate of LCS analyzed to monitor precision in the absence of MS/MSD sample.

15.2.11. Sample – A specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.2.12. Sub-sample – An aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.2.13. Sample Duplicate – A replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.2.14. Matrix – A component or form of a sample.

15.2.15. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.3. **Application of EMAX QC Procedures**

15.3.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing Total Hardness. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.4. **Department of Defense (DoD) and Department of Energy (DoE) Projects**

15.4.1. Samples from DoD and DoE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD and DoE Consolidated Quality Systems Manual (QSM), latest update, is applied.

15.5. Note that this SOP was revised on the merit of updating according to 40 CFR Methods Update Rule. There is no significant analytical changes made from that of the previous version.

16.0 REFERENCES

16.1. "Hardness – EDTA Titrimetric Method", Methods 2340C-1997 and 2340C-2011, Standard Methods For the Examination Of Water and Wastewater, 21st and 22nd Editions.

16.2. Title 40 Code of Federal Regulations Part 136, Guidelines Establishing Test Performance for Analysis of Pollutants, Clean Water Act Methods Update Rule, May 19, 2021.

16.3. EMAX Quality Systems Manual, as updated.

17.0 APPENDICES

17.1. **Figures**

17.1.1. Figure 1 Typical Sample Result Summary

17.1.2. Figure 2 Typical LCS/LCSD Summary

17.1.3. Figure 3 Typical Sample Duplicate Result Summary

17.1.4. Figure 4 Typical Case Narrative

17.2. **Appendices**

17.2.1. Appendix 1 Summary of Quality Control Procedures

17.2.2. Appendix 2 Demonstration of Capability

17.3. **Forms**

17.3.1. 2340CFA Analytical Run Log

Figure 1: TYPICAL SAMPLE RESULT SUMMARY

```
                                                                METHOD SM2340C
                                                                   HARDNESS

===================================================================================================================================================
Client      : XYZ, INC.                                                                                                  Matrix          : WATER
Project     : CLEAN PROJECT                                                                                              InstrumentID    : NA
Batch No.   : YYMXXX
===================================================================================================================================================

CLIENT        EMAX     RESULTS   PREP. MOIST  LOQ      DL    LOD   ANALYSIS     PREPARATION    DATA       CAL     PREP    COLLECTION    RECEIVED
SAMPLE ID   SAMPLE ID   (mg/L)  FACTOR  (%) (mg/L)  (mg/L) (mg/L)  DATETIME      DATETIME     FILE ID     REF     BATCH    DATETIME     DATETIME
---------   ---------- -------- ------ ----- ------ ------ ------ ------------ ------------- ---------- ------- -------- ------------- --------
MBLK1W      THM001WB        ND       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00101 YYTHM001 THM001W       NA          NA
LCS1W       THM001WL       186       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00102 YYTHM001 THM001W       NA          NA
LCD1W       THM001WC       188       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00103 YYTHM001 THM001W       NA          NA
ABCDEF-1    MXXX-01        392       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00104 YYTHM001 THM001W  MM/DD/YYHH:MM MM/DD/YY
ABCDEF-1DUP MXXX-01D       394       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00105 YYTHM001 THM001W  MM/DD/YYHH:MM MM/DD/YY
ABCDEF-2    MXXX-02        342       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00106 YYTHM001 THM001W  MM/DD/YYHH:MM MM/DD/YY
ABCDEF-3    MXXX-03         ND       1    NA     10     10     10 MM/DD/YYHH:MM       NA     YYTHM00107 YYTHM001 THM001W  MM/DD/YYHH:MM MM/DD/YY
```

Figure 2: TYPICAL LCS/LCSD SUMMARY

```
                                           EMAX QUALITY CONTROL DATA
                                         LAB CONTROL SAMPLE ANALYSIS

CLIENT         : XYZ, INC.
PROJECT        : CLEAN PROJECT
BATCH NO.      : YYMXXX
METHOD         : METHOD SM2340C
==========================================================================================================================

MATRIX         : WATER                                        % MOISTURE:  NA
DILUTION FACTOR: 1              1                 1
SAMPLE ID      : MBLK1W         LCS1W             LCD1W
LAB SAMPLE ID  : THM001WB       THM001WL          THM001WC
LAB FILE ID    : YYTHM00101     YYTHM00102        YYTHM00103
DATE EXTRACTED : NA             NA                NA
DATE ANALYZED  : MM/DD/YYHH:MM  MM/DD/YYHH:MM     MM/DD/YYHH:MM
PREP BATCH     : THM001W        THM001W           THM001W
CALIBRATION REF:

ACCESSION:

                         MB RESULT SPIKE AMT BS RESULT   BS REC  SPIKE AMT BSD RESULT BSD REC    RPD     QC LIMIT  MAX RPD
PARAMETER                 (mg/L)    (mg/L)    (mg/L)      (%)     (mg/L)     (mg/L)     (%)      (%)       (%)       (%)
---------                ---------  --------- --------- --------- --------- --------- --------- --------- --------- -------
HARDNESS                       ND       177       186      105       177       188      106       1       80-120     20
```

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Figure 3: TYPICAL SAMPLE DUPLICATE RESULT SUMMARY

```
                                    EMAX QUALITY CONTROL DATA
                                    SAMPLE DUPLICATE ANALYSIS

CLIENT         : XYZ, INC.
PROJECT        : CLEAN PROJECT
BATCH NO.      : YYMXXX
METHOD         : METHOD SM2340C
=======================================================================================

MATRIX         : WATER
DILUTION FACTOR: 1                      1
SAMPLE ID      : ABCDEF-1               ABCDEF-1DUP
LAB SAMPLE ID  : MXXX-01                MXXX-01D
LAB FILE ID    : YYTHM00104             YYTHM00105
DATE PREPARED  : NA                     NA
DATE ANALYZED  : MM/DD/YYHH:MM          MM/DD/YYHH:MM
PREP BATCH     : THM001W                THM001W
CALIBRATION REF: YYTHM001               YYTHM001

ACCESSION:

                         PARENT RESULT  DUP RESULT      RPD      MAX RPD
PARAMETER                    (mg/L)      (mg/L)         (%)        (%)
---------                -------------  ---------      ------    ---------
HARDNESS                          392        394          1        20
```

Figure 4: TYPICAL CASE NARRATIVE

CASE NARRATIVE

Client : XYZ, INC.

Project: CLEAN PROJECT

SDG : YYMXXX

METHOD SM2340C
HARDNESS

A total of three (3) water samples were received on MM/DD/YY to be analyzed for Hardness in accordance with Method SM2340C and project specific requirements.

Holding Time
Samples were analyzed within the prescribed holding time.

Calibration
Calibration was performed as prescribed by the method and was verified using a secondary source (ICV). All calibration requirements were within acceptance criteria.

Method Blank
Method blank was prepared and analyzed at the frequency required by the project. For this SDG, one (1) method blank was analyzed. Hardness was not detected in THM001WB. Refer to sample result summary form for details.

Lab Control Sample
Lab control sample was prepared and analyzed at a frequency required by the project. For this SDG, one (1) set of LCS/LCD was analyzed. THM001WL/THM001WC were within LCS limits. Refer to LCS summary form for details.

Matrix QC Sample
Sample duplicate was analyzed and RPD was within expected value.

Sample Analysis
Samples were analyzed according to prescribed analytical procedures. Results were evaluated in accordance to project requirements. For this SDG, all quality control requirements were met.

Appendix 1: SUMMARY OF QUALITY CONTROL PROCEDURES

QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	1st Rvw	2nd Rvw
Method Blank	One blank per preparation batch	No analytes detected ≥ ½ LOQ	Re-prepare and re-analyze method blank and all samples processed with the contaminated blank.		
LCS	One LCS per preparation batch	Recovery : 80-120%	Correct the problem and re-analyze LCS prior to sample analysis.		
Duplicate Sample	One Dup per preparation batch	RPD ≤ 20%	Check PSR and discuss in case narrative		

Comments: Refer to PSR for flagging criteria. 21st and/or 22nd Editions	Reviewed By:		
	Date:		

Appendix 2: DEMONSTRATION OF CAPABILITY

DEMONSTRATION OF CAPABILITY

METHOD 2340C

Conc Unit: mg/L
Sample Amount(ml): 25

PARAMETER	THM002W THM00202	THM002WC THM00203	THM002WX THM00204	THM002WY THM00205	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Acceptance	RSD (%) Criteria	COMMENTS
HARDNESS	235	239	231	243	232	237	102	5.16	2	80 - 120	≤ 20	Passed

REFERENCE:
22THC002W

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2340CFA: ANALYSIS RUN LOG

PrepBatchID	LabSampleID	Aliquot (ml)	pHAdj	Buffer Added	EDTA (ml)	AnalysisDateTime	Found Conc.	Hardness	Unit	Notes

Calibration of pH Meter		InstrumentID:	53
BufferID	Value	Reading	DateTime
	4		
	7		
	12.45		
	CalVer 8		
STANDARDIZATION			
Vol. 0.02N CaCO3(ml)	Vol. EDTA(ml)	Molarity EDTA Titrant	DATE
		Average EDTA (M)=	

Standard/Reagent ID	Description	Concentration	Exp.Date
	EDTA (M)		
	LCS (mg/L)		
	NH_4OH(N)		
	Eriochrome Black T		
	Inhibitor III		
	pH strip		
	Buffer Solution		

Micropipette ID:

QC Check	Result	ExpectedVal	QC Check
		0	

Snapseal Lot 1.5oz: Snapseal Lot 1.5oz:

Analyzed By:

☐ EMAX-2340C Rev.

Checked By:

Hardness=EDTA (M)xEDTA (ml)x100000/Aliquot (ml)

Date:

☐ Titrant is certified standard

☐ Standardization Date:

PRINT DRF

When printed valid only until 12/7/22 EOB.

SOP REVIEW FORM

HARDNESS, TOTAL

SOP#: **EMAX-2340C** **Rev** **6** **Effective Date:** **12-Sep-22**

COMMENTS	**Reviewed By**	**Review Date**
No update needed per DRF by TKosaka dated 09/15/23		09/15/23

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STANDARD OPERATING PROCEDURES

ACID DIGESTION, TOTAL METALS FOR AQUEOUS

SOP No.: EMAX-3010 Revision No. 8 Effective Date: 09-Jun-22

Prepared By: Tina Huang Date: 6/9/2022

Approved By: Farina Madamba Date: 6/9/22
QA Manager

Approved By: Caspar Pang Date: 6/9/2022
Laboratory Director

Control Number: 3010-08-

1.0 SCOPE AND APPLICATION

1.1. This method describes the acid digestion for total metals from surface and ground water, leachates and other related substances that are aqueous in nature, in preparation for metals analysis by ICP analytical technique.

1.2. This SOP is an adaptation of SW846 Methods 3010A.

2.0 SUMMARY OF METHOD

2.1. Metal analytes are acid digested from a pre-measured sample. Nitric acid and hydrochloric acid are added to the sample and heated without boiling until the volume is substantially reduced. The digestate is diluted back to its original sample volume using reagent water.

2.2. Interference

2.2.1. The analyst should be cautioned that this digestion procedure may not be vigorous to destroy some metal complexes.

2.2.2. Precipitation will cause lowering of the silver concentration.

2.2.3. Cross-contamination and contamination of the sample can be a major source of error. The sample preparation work area should be kept scrupulously clean. All glassware should be cleaned as directed in EMAX-QC07.

3.0 DETECTION LIMITS

3.1. Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

3.1.1. Refer to applicable analytical procedure.

4.0 DYNAMIC RANGE

4.1. Refer to applicable analytical procedure.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. Holding Time

5.1.1. All samples shall be digested within 180 days from sampling date.

5.2. Preservation

5.2.1. All samples received shall have a pH value of < 2 and container should indicate that they are preserved with HNO_3.

5.2.2. Store all samples at the condition as received in the lab, unless otherwise specified by the project. If samples are received cooled at $\leq$ 6°C without freezing, they shall be stored at that condition.

6.0 ASSOCIATED SOPS

6.1.	EMAX-QA04	Detection Limit (DL)
6.2.	EMAX-QA08	Corrective Action
6.3.	EMAX-QC04	Balance Calibration
6.4.	EMAX-QC05	Calibration of Thermometers
6.5.	EMAX-QC06	Volumetric Labware and Micropipette Verification
6.6.	EMAX-QC07	Glassware Cleaning
6.7.	EMAX-SM03	Waste Disposal
6.8.	EMAX-SM04	Analytical and QC Sample Labeling
6.9.	EMAX-6010	Inductive Coupled Plasma Emission Spectrometric Method for Trace Metal Analyses
6.10.	EMAX-6010C	Inductive Coupled Plasma Emission Spectrometric Method for Trace Metal Analyses

7.0 SAFETY

7.1. Read the SDS of all chemicals listed in this SOP.

7.2. All reagents, standards and samples shall be treated as potential hazard. Observe the standard laboratory safety procedures. Protective gear, i.e., lab coat, safety glasses, gloves, shall be worn at all times when performing this procedure. Perform all sample and standard handling in the fume hood.

7.3. If for any reason, acid and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amount of tap water. If irritations or any other discomfort related to the incident persist, inform your supervisor immediately, so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS & REAGENTS

8.1. Instruments & Supplies

8.1.1.	Digestion vessel	50 ml graduated round bottles corning or equivalent
8.1.2.	Micropipette	Eppendorf or equivalent
8.1.3.	Digestor	Environmental Express Hot Block or equivalent
8.1.4.	Thermometer	Range 0 – 110°C or equivalent
8.1.5.	Watch Glass	Disposable Conical Watch glass or equivalent
8.1.6.	Filter	Whatman #41 or equivalent

8.2. Chemicals & Reagents

8.2.1. All reagents are reagent-grade or better.

8.2.2. Reagent water: ASTM Type II or equivalent

8.2.3. Nitric Acid

8.2.4. Hydrochloric Acid

9.0 STANDARD

9.1. ICP Matrix Spike Solutions

EMAX MIX 4

ANALYTE					CONCENTRATION (mg/L)
Arsenic	Barium	Beryllium	Cadmium	Chromium	100
Cobalt	Copper	Lead	Manganese	Nickel	
Selenium	Silver	Thallium	Vanadium	Zinc	
Aluminum	Iron				1000

EMAX MIX 5A

ANALYTE					CONCENTRATION (mg/L)
Antimony					500
Boron	Molybdenum	Tin	Strontium	Titanium	100

EMAX MIX 5B

ANALYTE				CONCENTRATION (mg/L)
Calcium	Magnesium	Potassium	Sodium	5000

SINGLE STANDARD (as needed by project)

ANALYTE	CONCENTRATION (mg/L)
Lithium	1000

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Based on the work order, determine samples for a preparative batch (not to exceed 20 samples per preparative batch). Withdraw the sample(s) from the sample control room and bring them to the preparation area. Allow the samples to equilibrate at room temperature.

10.1.2. Shake the sample container. Pour a small amount of sample into the sample cap and trickle just enough to wet the pH indicator strip. Compare the color of the wet strip to the indicator chart displayed in the pH indicator box. Record the pH in the digestion log.

- If the pH value is <2, proceed to Sec. 10.1.3.

- If the pH value is >2, check if special instruction is written on the analysis folder or in the COC. Otherwise, inform the supervisor immediately. DO NOT PROCEED WITH THE DIGESTION. WAIT FOR FURTHER INSTRUCTION.

10.1.3. Line up the samples chronologically.

10.1.4. Check the lot number of the digestion vessels to confirm that it has been verified for bias and precision. Record the lot # of the digestion vessels.

10.1.5. Take digestion vessels and label each one corresponding to the samples withdrawn and place them in front of each sample making sure that their labels agree. Take four more vessels and label them as preparation blank, LCS, matrix spike and matrix spike duplicate.

Note: EPA 3010A requires MS and sample duplicate. However, the analytical methods EPA 6010B and 6010C require MS/MSD. To satisfy both preparation and analytical methods, MSD is prepared because it can be regarded as duplicate sample as well.

10.1.6. Mix the sample thoroughly to achieve homogeneity. Fill each digestion vessel up to the 50 ml mark.

10.1.7. Record the sample volume in the digestion log. Use reagent water for blank and LCS.

10.1.8. Take another digestion vessel, fill it with tap water to 50-ml mark and let it sit in the digestion block. Place a thermometer in the water. Turn the thermostat to a pre-determined mark to deliver heat at 90°C – 95°C.

10.1.9. Standard Addition

10.1.9.1. Call for a witness for standard addition. Have the witness verify the setting of the micropippette and the expiration dates of the spike standards.

10.1.9.2. Add 0.25 ml of each from EMAX Mix 4 and 5A, 0.5 ml of EMAX Mix 5B and 0.025 ml Lithium (see Sec. 9.1) spike solutions to matrix spike samples and LCS.

10.1.10. Acid Digestion

10.1.10.1. Add 1.5 ml of concentrated HNO_3 to each of the digestion vessels. Cap the vessels with conical watch glass.

10.1.10.2. Check that the temperature of the digestion block is 90°C, adjust the thermostat if necessary. Wait until temperature reaches 90-95°C. Once the desired temperature is reached, record the temperature reading in the digestion log.

10.1.10.3. Place the digestion vessels on the digestion block for two hours without boiling.

10.1.10.4. Remove the digestion vessels from the digestion block and allow the vessels to cool down.

10.1.10.5. Lift the conical watch glass and add another 1.5 ml of HNO_3. Place the watch glass back before working on the next vessel. Return the vessels on the digestion block and continue heating without boiling for another two hours.

10.1.10.6. Observe the color of the digestate. If, at this point, the color of the digestate is clear or light, proceed to Sec. 10.1.10.7. Otherwise, continue refluxing adding 1.5 ml portions of HNO_3 until no evidence of change in the digestate consistency is observed. Record each addition of 1.5 ml portions of HNO3 in the digestion log.

10.1.10.7. Add 2.5 ml of HCl and reflux for additional 15 minutes.

10.1.10.8. Remove the digestion vessels from the digestion block and allow the vessels to cool down.

10.1.10.9. Using a reagent water wash bottle, rinse the watch glass collecting the rinsate on the same digestion vessel that it covered. Add 2.5 ml concentrated HCl for matrix matching.

10.1.10.10. Dilute the digestate with reagent water to the 50 ml mark of the digestion vessel. Seal the vessel and shake. If the digestate appears to be turbid, pass it through Whatman #41 filter and collect it in a new polyethylene container.

10.2. Instrument Parameters

10.2.1. The digestion block shall be monitored by putting a thermometer inside a digestion vessel with tap water, placed on the digestion block together with the samples being digested. The temperature shall be checked from time to time to ensure that it delivers heat at about 90°C (+ 5°C).

10.3. Calibration

10.3.1. Micropipette verification shall be carried out as described in EMAX-QC06.

10.3.2. Digestion vessels shall be verified for accuracy as described in EMAX-QC06.

10.3.3. Thermometer calibration shall be carried out as described in EMAX-QC05.

10.4. Analysis

10.4.1. Refer to EMAX-6010 or EMAX-6010C.

10.5. Data Reduction

10.5.1. Refer to EMAX-6010 or EMAX-6010C.

10.6. Calculations

10.6.1. Refer to EMAX-6010 or EMAX-6010C.

10.7. Report Generation

10.7.1. Refer to EMAX-6010 or EMAX-6010C. .

10.8. Data Review

10.8.1. Refer to EMAX-6010 or EMAX-6010C.

10.9. Preventive Maintenance

10.9.1. The digestion area shall be maintained clean at all times to prevent contamination.

11.0 QUALITY CONTROL

11.1. The maximum number of original field samples in an analytical batch shall be 20 unless otherwise specified by the project.

11.2. Matrix spike samples shall be taken from a specified matrix spike field sample. In the absence of a specified matrix spike field sample, the analyst performing the extraction shall choose from any of the samples within the preparation batch.

11.3. A method blank, LCS, and MS/MSD shall be prepared in every preparation batch, unless otherwise specified by the project. They shall be subjected to the same process that the field samples undergo as described in Section 10.

11.4. In the event of sample insufficiency for MS/MSD, a LCS duplicate shall be prepared to demonstrate precision.

11.5. All reagents and standards shall undergo quality control acceptance prior to its use.

11.6. Micropipettes used for spiking must be verified daily prior to use.

11.7. To ensure that the desired heat (indicated by the required temperature) is delivered throughout the digestor, move the monitoring thermometer from one sample well to another daily. Record the thermometer location (i.e., sample well ID) during digestion batch.

11.8. All labwares to be used in the sample preparation shall be properly treated as specified in EMAX-QC07.

11.9. Whenever non-volumetric labware is used to measure extract or digestate volume, the non-volumetric labware must be verified by lot before use according to EMAX-QC06 Non-Volumetric Labware Verification.

11.10. Every lot of volumetric digestion vessels shall be checked for bias and precision prior to its use. Refer to EMAX-QC06.

11.11. Demonstration of proficiency is required prior to performing this procedure.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1 of the analytical method.

12.2. Whenever any of the following circumstances occur, undertake corrective action as advised below:

12.2.1. Breakage of sample container. Identify the sample and check for sample spare. If a spare is found, replace the broken sample. If not, inform the supervisor immediately for further action.

12.2.2. Sample insufficiency. Inform the supervisor immediately for further advice.

12.2.3. Insufficient preservation of sample. If sample pH is ≥ 2, and no special instruction is provided by the analysis folder, inform your supervisor immediately for further action.

12.2.4. Sample overflow due to excessive effervescence. Identify the sample and check for sample spare. If a spare is found, re-digest the sample. If there is no spare sample, inform your supervisor immediately for further action.

12.2.5. Breakage of digestate container or when sample is spilled prior to dilution to final volume. Identify the digestate. If it is a method blank or LCS, re-digest the entire preparation batch. If it is a sample, re-digest the sample with a method blank and LCS. If re-extraction is not possible, inform your supervisor for further action.

12.3. A Non-Conformance Report (NCR) is required when any of the following circumstances occur:

- Anomalies, other than those mentioned above and specified in the analytical QCP, are observed.
- Sample is out of holding time.

12.3.1. Refer to EMAX-QA08 for details.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to wastewater drains.

13.2. Handle solvents and extracts and preparation of standards under the fume hoods.

13.3. Keep digestion area clean to prevent contamination of sample.

14.0 WASTE MANAGEMENT

14.1. No sample shall be dumped in the laboratory sink.

14.2. Separate and properly identify all unused expired standards for proper disposal.

14.3. Place all wastes generated during the digestion process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired standards and other wastes generated during the process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. **Definition of Terms**

15.1.1. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.1.1.1. **Preparation batch** – is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.1.1.2. **Analytical batch** – is compose of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices; preparation batches, and can exceed 20 samples.

15.1.2. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.1.3. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.1.4. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.1.5. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying chain of custody (COC). Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.1.6. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.1.7. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.1.8. Matrix – is a component or form of a sample.

15.1.9. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method's recovery efficiency.

15.1.10. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.1.11. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.2. Application of EMAX QC Procedures

15.2.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing this acid digestion of aqueous samples for total metals analysis. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.3. Department of Defense (DoD) and Department of Energy (DOE) Projects

15.3.1. Samples from DoD and/or DOE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD and DOE Consolidated Quality Systems Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, US EPA SW-846, Method 3010A, Rev. 1, July 1992.

16.2. Inductively Coupled Plasma-Atomic Emission Spectrometry, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, US EPA SW-846, Methods 6010B Rev.2, Dec. 1996 and 6010C Rev. 3, Feb. 2007.

16.3. EMAX Quality Systems Manual, as updated.

17.0 APPENDICES

17.1. Figures

17.1.1. Figure 1 Process Flowchart

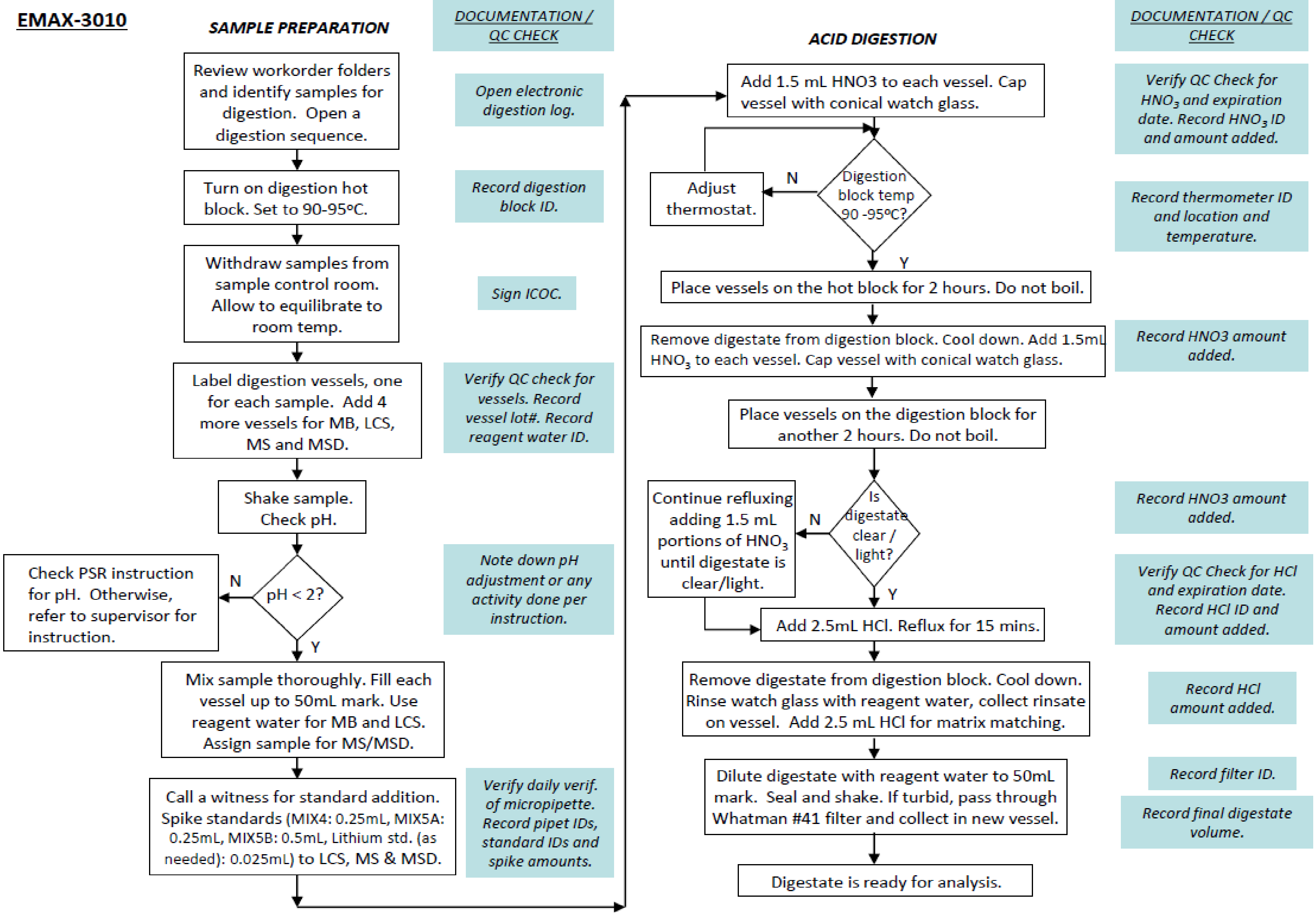
17.2. Appendices

17.2.1. Appendix 1 Demonstration of Capability

17.3. Forms

17.3.1. 3010FS Sample Preparation Log

Figure 1: **PROCESS FLOWCHART**



EMAX-3010

SAMPLE PREPARATION

Review workorder folders and identify samples for digestion. Open a digestion sequence.

Turn on digestion hot block. Set to 90-95ºC.

Withdraw samples from sample control room. Allow to equilibrate to room temp.

Label digestion vessels, one for each sample. Add 4 more vessels for MB, LCS, MS and MSD.

Shake sample. Check pH.

pH < 2?

Check PSR instruction for pH. Otherwise, refer to supervisor for instruction.

Mix sample thoroughly. Fill each vessel up to 50mL mark. Use reagent water for MB and LCS. Assign sample for MS/MSD.

Call a witness for standard addition. Spike standards (MIX4: 0.25mL, MIX5A: 0.25mL, MIX5B: 0.5mL, Lithium std. (as needed): 0.025mL) to LCS, MS & MSD.

DOCUMENTATION / QC CHECK

Open electronic digestion log.

Record digestion block ID.

Sign ICOC.

Verify QC check for vessels. Record vessel lot#. Record reagent water ID.

Note down pH adjustment or any activity done per instruction.

Verify daily verif. of micropipette. Record pipet IDs, standard IDs and spike amounts.

ACID DIGESTION

Add 1.5 mL HNO3 to each vessel. Cap vessel with conical watch glass.

Digestion block temp 90 -95ºC?

Adjust thermostat.

Place vessels on the hot block for 2 hours. Do not boil.

Remove digestate from digestion block. Cool down. Add 1.5mL HNO_3 to each vessel. Cap vessel with conical watch glass.

Place vessels on the digestion block for another 2 hours. Do not boil.

Is digestate clear / light?

Continue refluxing adding 1.5 mL portions of HNO_3 until digestate is clear/light.

Add 2.5mL HCl. Reflux for 15 mins.

Remove digestate from digestion block. Cool down. Rinse watch glass with reagent water, collect rinsate on vessel. Add 2.5 mL HCl for matrix matching.

Dilute digestate with reagent water to 50mL mark. Seal and shake. If turbid, pass through Whatman #41 filter and collect in new vessel.

Digestate is ready for analysis.

DOCUMENTATION / QC CHECK

Verify QC Check for HNO_3 and expiration date. Record HNO_3 ID and amount added.

Record thermometer ID and location and temperature.

Record HNO3 amount added.

Record HNO3 amount added.

Verify QC Check for HCl and expiration date. Record HCl ID and amount added.

Record HCl amount added.

Record filter ID.

Record final digestate volume.

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Appendix 1: DEMONSTRATION OF CAPABILITY

Conc Unit: mg/L
Sample Amt(ml): 50

PARAMETER	ID8M017028	ID8M017029	ID8M017030	ID8M017031	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Criteria (% Rec)	Precision Criteria (%RSD)	COMMENTS
	IPM026WL	IPM026WC	IPM026WX	IPM026WY								
Aluminum	5.63	5.58	5.69	5.76	5	5.67	113	0.0759	1	80 - 120	≤ 20	PASSED
Antimony	2.58	2.58	2.64	2.64	2.5	2.61	104	0.0339	1	80 - 120	≤ 20	PASSED
Arsenic	0.509	0.506	0.527	0.517	0.5	0.515	103	0.00958	2	80 - 120	≤ 20	PASSED
Barium	0.512	0.505	0.511	0.517	0.5	0.511	102	0.00500	1	80 - 120	≤ 20	PASSED
Beryllium	0.488	0.483	0.491	0.498	0.5	0.490	98	0.00594	1	80 - 120	≤ 20	PASSED
Boron	0.470	0.465	0.474	0.479	0.5	0.472	94	0.00602	1	80 - 120	≤ 20	PASSED
Cadmium	0.488	0.484	0.505	0.496	0.5	0.493	99	0.00945	2	80 - 120	≤ 20	PASSED
Calcium	52.4	51.9	53.8	54.5	50	53.1	106	1.22	2	80 - 120	≤ 20	PASSED
Chromium	0.489	0.486	0.503	0.500	0.5	0.495	99	0.00809	2	80 - 120	≤ 20	PASSED
Cobalt	0.493	0.489	0.491	0.501	0.5	0.494	99	0.00498	1	80 - 120	≤ 20	PASSED
Copper	0.513	0.510	0.513	0.525	0.5	0.515	103	0.00634	1	80 - 120	≤ 20	PASSED
Iron	4.95	4.90	5.12	5.03	5	5.00	100	0.0973	2	80 - 120	≤ 20	PASSED
Lead	0.489	0.487	0.493	0.499	0.5	0.492	98	0.00498	1	80 - 120	≤ 20	PASSED
Lithium	0.522	0.513	0.508	0.514	0.5	0.514	103	0.00582	1	80 - 120	≤ 20	PASSED
Magnesium	47.4	46.9	48.6	49.6	50	48.1	96	1.19	2	80 - 120	≤ 20	PASSED
Manganese	0.468	0.462	0.472	0.479	0.5	0.470	94	0.00688	1	80 - 120	≤ 20	PASSED
Molybdenum	0.492	0.487	0.484	0.500	0.5	0.491	98	0.00703	1	80 - 120	≤ 20	PASSED
Nickel	0.508	0.503	0.505	0.515	0.5	0.508	102	0.00559	1	80 - 120	≤ 20	PASSED
Potassium	52.1	51.6	52.7	53.5	50	52.5	105	0.826	2	80 - 120	≤ 20	PASSED
Selenium	0.494	0.489	0.504	0.498	0.5	0.496	99	0.00636	1	80 - 120	≤ 20	PASSED
Silver	0.518	0.515	0.527	0.528	0.5	0.522	104	0.00662	1	80 - 120	≤ 20	PASSED
Sodium	50.9	50.2	50.8	51.9	50	50.9	102	0.701	1	80 - 120	≤ 20	PASSED
Strontium	0.467	0.458	0.458	0.472	0.5	0.464	93	0.00682	1	80 - 120	≤ 20	PASSED
Thallium	0.473	0.469	0.486	0.480	0.5	0.477	95	0.00764	2	80 - 120	≤ 20	PASSED
Tin	0.503	0.495	0.500	0.513	0.5	0.503	101	0.00762	2	80 - 120	≤ 20	PASSED
Titanium	0.505	0.497	0.508	0.514	0.5	0.506	101	0.00700	1	80 - 120	≤ 20	PASSED
Vanadium	0.512	0.506	0.523	0.518	0.5	0.515	103	0.00734	1	80 - 120	≤ 20	PASSED
Zinc	0.509	0.502	0.516	0.521	0.5	0.512	102	0.00816	2	80 - 120	≤ 20	PASSED

3010FS: **SAMPLE PREPARATION LOG (Page 1)**

EMAX
LABORATORIES, INC.

DIGESTION LOG
for
ICP METALS

Page 1

Note: For samples, relevant QCs/Standards digested, refer to attached digestion sequence.

Comments:

Digestion Vessel Lot #

Filter Lot #

Book #: EIP-139
Batch:
Matrix:
Digestor ID:

SOP #	Rev. #
☐ EMAX-3010	
☐ EMAX-3050	
☐ EMAX-200.7	
☐ EMAX-	

Start	Temp	End	Temp
	°C		°C

Standards	ID	Amount Added (ml/g)
LCS-1		
LCS-2		
LCS-3		
MS		
Blank Soil (Bead)		
Reagent	**Lot# / ID**	**Amount Added (ml)**
HNO_3		
HCl		
H_2O_2		
HNO_3(1:1)		
pH Strip (0-14)		

Digestate Location	
Extract Location	

☐ Reagent Water ID:
☐ Thermometer ID:
☐ Pipette ID:
☐ Pipette ID:
☐ Pipette ID:
☐ HNO_3 dispenser checked @ 5.0 ml with Class A volumetric flask
☐ HCl dispenser checked @ 5.0 ml with Class A volumetric flask

Prepared By:
Standard Added By: Witnessed By:
Extract Rcvd By: Checked By:

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3010FS: SAMPLE PREPARATION LOG (Page 2)

PrepBatchID	LabSampleID	Aliquot	Unit	DateTime	Vd(ml)	ExpAmt	ExpVd(ml)	PrepFctr	Comments

Vd=digestate volume

PrepFctr=)ExpAmt/Aliquot)*(Vd/ExpVd)

☐ Digestion Started @

Prepared By:

PRINT DRF

☐ Digestion Ended @

Checked By:

Comments:

Date

SOP REVIEW FORM

ACID DIGESTION, TOTAL METALS FOR AQUEOUS

SOP#: EMAX-3010 **Rev** 8 **Effective Date:** 09-Jun-22

COMMENTS	Reviewed By	Review Date
No update needed per DRF by THuang dated 09/20/23		09/20/23

TOC

STANDARD OPERATING PROCEDURES

ACID DIGESTION, TOTAL METALS FOR SOLIDS

SOP No.: EMAX-3050 Revision No. 9 Effective Date: 04-Jan-23

Prepared By: Tina Huang Date: 1/4/2023

Approved By: Farina Madamba Date: 1/4/2023
QA Manager

Approved By: Caspar Pang Date: 1/4/2023
Laboratory Director

Control Number: 3050-09-

1.0 SCOPE AND APPLICATION

1.1. This method describes the acid digestion for soils, sludge, sediments and other related substances that are solid in nature, in preparation for metals analysis by ICP analytical technique.

1.2. This SOP adopts the same acid strength as SW846 Method 3050B.

1.3. A comparative study of this modified procedure vis-à-vis the reference method shows better recoveries for some elements particularly antimony.

2.0 SUMMARY OF METHOD

2.1. Metal analytes are acid digested from a pre-measured sample. Hydrochloric acid is added to the sample and heated to initialize digestion. Nitric acid is added to the digestate and is further oxidized with 30% peroxide. Hydrochloric acid is again added to complete acid digestion.

2.2. **Interferences**

2.2.1. Sludge samples can contain diverse matrix types, which may present analytical challenge.

2.2.2. Samples having high concentrations may cause memory effect on the digestion vessels. Treating the vessels with 1:1 v/v of HCL and HNO3 will decontaminate the digestion vessels.

3.0 DETECTION LIMITS

3.1. **Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation**

3.1.1. Refer to EMAX-QA04 for generation, validation and verification of DL, LOD & LOQ.

3.2. **Reporting Limit**

3.2.1. Refer to applicable analytical procedure.

4.0 DYNAMIC RANGE

4.1. Refer to applicable analytical procedure.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. **Holding Time**

5.1.1. All samples shall be digested within 180 days from sampling date.

5.2. **Preservation**

5.2.1. All samples shall be stored at the condition specified by the project.

6.0 ASSOCIATED SOPS

6.1.	EMAX-QA04	Detection Limit (DL)
6.2.	EMAX-QA08	Corrective Action
6.3.	EMAX-QC04	Balance Calibration
6.4.	EMAX-QC05	Calibration of Thermometers
6.5.	EMAX-QC06	Volumetric Labware and Micropipette Verification
6.6.	EMAX-QC07	Glassware Cleaning
6.7.	EMAX-SM03	Waste Disposal
6.8.	EMAX-SM04	Analytical and QC Sample Labeling
6.9.	EMAX-6010	Inductive Coupled Plasma Emission Spectrometric Method for Trace Metal Analyses
6.10.	EMAX-6010C	Inductive Coupled Plasma Emission Spectrometric Method for Trace Metal Analyses

7.0 SAFETY

7.1. Read the SDS of all chemicals listed in this SOP.

7.2. All reagents, standards and samples shall be treated as potential hazard. Observe the standard laboratory safety procedures. Protective gear, i.e., lab coat, safety glasses, gloves, shall be worn at all times when performing this procedure. Perform all sample and standard handling in the fume hood.

7.3. If for any reason, acid and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amount of tap water. If irritations or any other discomfort related to the incident persist, inform your supervisor immediately, so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS & REAGENTS

8.1. **Instruments & Supplies**

8.1.1.	Balance	Sartorius LC 620 S or equivalent
8.1.2.	Spatula	Disposable or equivalent
8.1.3.	Digestion vessel	125 mL digestion vessel or equivalent
8.1.4.	Micropipette	Eppendorf or equivalent
8.1.5.	Digestion block	CPI Block Digestor or equivalent
8.1.6.	Thermometer	Range 0 – 110°C
8.1.7.	Watch Glass	Disposable Conical Watch glass or equivalent
8.1.8.	Filter	Whatman #41 or equivalent

8.2. **Chemicals & Reagents**

8.2.1. All reagents are reagent-grade or better.

8.2.2. Solid Matrix (Blank): Resin Pellet Solid Matrix or equivalent

8.2.3. Reagent Water: BDH Water ASTM Type II or equivalent

8.2.4. Nitric Acid

8.2.5. Hydrochloric Acid

8.2.6. Hydrogen Peroxide

9.0 STANDARD

9.1. **ICP Matrix Spike Solutions**

EMAX MIX 4

ANALYTE					CONCENTRATION (mg/L)
Arsenic	Barium	Beryllium	Cadmium	Chromium	100
Cobalt	Copper	Lead	Manganese	Nickel	
Selenium	Silver	Thallium	Vanadium	Zinc	
Aluminum	Iron				1000

EMAX MIX 5A

ANALYTE					CONCENTRATION (mg/L)
Antimony					500
Boron	Molybdenum	Tin	Strontium	Titanium	100

EMAX MIX 5B

ANALYTE				CONCENTRATION (mg/L)
Calcium	Magnesium	Potassium	Sodium	5000

SINGLE STANDARD (as needed by project)

ANALYTE	CONCENTRATION (mg/L)
Lithium	1000

10.0 PROCEDURES

10.1. **Sample Preparation**

10.1.1. Sample Handling

10.1.1.1. Based from the work order, determine the samples to form a preparative batch (not to exceed 20 field samples). Withdraw the sample(s) from the sample control room designated for metals analysis (passing # 10 sieve) and bring them to the weighing area. Allow the samples to equilibrate at room temperature.

Note: ***Sample homogeneity is crucial in metals analysis. If no sample was designated for metals analysis, and it is apparent that sample particles contain > #10 sieve, inform the Supervisor for further instruction.***

10.1.1.2. Take digestion vessels and label each one corresponding to the samples withdrawn. Take four more vessels and label them as preparation blank, LCS, matrix spike and matrix spike duplicate.

10.1.1.3. Follow sub-sampling procedure described in EMAX-SM01 Section 5.14. Check project sub-sampling requirement. If multi-incremental sub-sampling (MIS) is required, refer to EMAX-SM01 for details.

10.1.1.4. Scoop 1-1.5 g sub-sample and transfer into a properly labeled digestion vessel. Record the weight to the nearest 0.01 g.

10.1.2. Pre-heating the Digestion Block

10.1.2.1. Place a digestion vessel with reagent water and a temperature monitoring thermometer on the digestion block.

10.1.2.2. Turn the digestion block on and set the thermostat to ~95°C or to a predetermined temperature to obtain approximately 95°C once the digestion vessel is covered with a watch glass.

10.1.2.3. When the temperature reading is about 95°C ± 5°C, the digestion block is now ready for digestion.

10.1.3. Standard Addition

10.1.3.1. Call for a witness for standard addition. Have the witness verify the setting of the micropipette and the expiration dates of the spike standards.

10.1.3.2. Add 0.5 mL of each from EMAX Mix 4 and 5A, 1.0 mL of EMAX Mix 5B and 0.05 mL of Lithium spike standard.

10.1.4. Acid Digestion

10.1.4.1. Add 10 mL of regent water and 5 mL of concentrated HCL[1] into each vessel, swirl the vessel to mix the acid and the sample. Add same amount of acid into a clean and empty vessel and designate it as blank. Insert the vessels in the digestion block(s). Cap the vessels with conical watch glass.

10.1.4.2. Check the temperature of the digestion block (95°C ± 5°C), adjust if necessary. If temperature happens to be ≥ 100°C, adjust the thermostat and wait until temperature is within 95°C ± 5°C. Record the temperature reading in the digestion log.

10.1.4.3. Place the digestion vessels on the digestion block and reflux for 15 minutes without boiling.

10.1.4.4. Transfer the vessels into unheated digestion block and allow the vessels to cool down for at least 5 minutes. Lift the watch glass and add 10 mL of concentrated HNO_3. Place the watch glass back before working on the next vessel.

10.1.4.5. Return the vessels to the digestion block and reflux for another 15 minutes.

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[1] Addition of 5 mL HCl is a modification from Method 3050B to enhance recovery of antimony. Refer to Appendix 2 for the comparative study done on ICP.

10.1.4.6. Transfer the vessels into unheated digestion blocks and allow the vessels to cool down for at least 5 minutes. Lift the water glass and add 10 mL 1:1 HNO3. Place the water glass back before working on the next vessel.

10.1.4.7. Return the vessels to the digestion block and reflux for another 15 minutes.

10.1.4.8. Transfer the vessels into unheated digestion blocks and allow the vessels to cool down for at least 5 minutes.

10.1.4.9. Add 2 mL of reagent water. Then add 3 mL of 30% hydrogen peroxide (H_2O_2) to each vessel, swirling each one of them after every addition to initiate peroxide reaction. Continue to add H_2O_2 until the amount added reaches 10 mL.

10.1.4.10. Return the vessels to the heated digestion block. Care must be taken to ensure that losses do not occur due to excessive effervescence.

10.1.4.11. Continue to reflux the mixture at 95°C ± 5°C for 15 minutes. Remove the digestion vessels from the digestion block.

10.1.4.12. Lift the watch glass, add 5 mL of concentrated HCl. Swirl the vessel until added reagents are properly mixed with the solution. Place the watch glass before working on the next vessel. Return the vessels into the heated digestion block. Reflux for additional 15 minutes. Subsequently, remove the digestion vessels from the digestion block and allow the vessels to cool down and dilute to 100 mL final volume with reagent water.

10.1.4.13. Let the digestate settle overnight or centrifuge if analysis has to be performed on the same day.

10.1.4.14. Take an aliquot of the liquid portion of digestate for analysis.

10.2. Instrument Parameters

10.2.1. Take a digestion vessel filled halfway with tap water and insert a thermometer to serve as a temperature monitoring vessel. Place the temperature monitoring vessel on the digestion block together with the samples being digested. Check the temperature reading from time to time to ensure that it delivers heat at about 95°C ± 5°C.

10.3. Calibration

10.3.1. Balance calibration shall be carried out as described by EMAX-QC04.

10.3.2. Thermometer calibration shall be carried out as described by EMAX-QC05.

10.3.3. Micropipette verification shall be carried out as described by EMAX-QC06.

10.3.4. Digestion vessels shall be verified for accuracy as described in EMAX-QC06.

10.4. Analysis

10.4.1. For ICP analytical method, refer to EMAX-6010 or EMAX-6010C.

10.5. Data Reduction

10.5.1. For ICP analytical method, refer to EMAX-6010 or EMAX-6010C.

10.6. Calculations

10.6.1. For ICP analytical method, refer to EMAX-6010 or EMAX-6010C.

10.7. **Report Generation**

10.7.1. For ICP analytical method, refer to EMAX-6010 or EMAX-6010C.

10.8. **Data Review**

10.8.1. For ICP analytical method, refer to EMAX-6010 or EMAX-6010C.

10.9. **Preventive Maintenance**

10.9.1. The digestion area shall be maintained clean at all times to prevent contamination

11.0 QUALITY CONTROL

11.1. The maximum number of original field samples in an analytical batch shall be 20 unless otherwise specified by the project.

11.2. Matrix spike samples shall be taken from a specified matrix spike field sample. In the absence of a specified matrix spike field sample, the analyst performing the extraction shall choose from any of the samples within the preparation batch.

11.3. A method blank, LCS, and MS/MSD shall be prepared in every preparation batch, unless otherwise specified by the project. They shall be subjected to the same process that the field samples undergo as described in Section 10.

11.4. In the event of sample insufficiency for MS/MSD, a LCS duplicate shall be prepared to demonstrate precision.

11.5. Balance calibration check must be performed daily prior to use.

11.6. All reagents and standards shall undergo quality control acceptance prior to its use.

11.7. To ensure that the desired heat (indicated by the required temperature) is delivered throughout the digestor, move the monitoring thermometer from one sample well to another daily. Record the thermometer location (i.e., sample well ID) during digestion batch.

11.8. All labwares to be used in the sample preparation shall be properly treated as specified in EMAX-QC07.

11.9. Micropipettes used for spiking must be verified daily prior to use.

11.10. Whenever non-volumetric labware is used to measure extract or digestate volume, the non-volumetric labware must be verified by lot before use according to EMAX-QC06 Non-Volumetric Labware Verification.

11.11. Every lot of volumetric digestion vessels shall be checked for bias and precision prior to its use. Refer to EMAX-QC06.

11.12. Demonstration of proficiency is required prior to performing this procedure.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1 of the analytical method.

12.2. Whenever any of the following circumstances occur, undertake corrective action as advised below:

12.2.1. Breakage of sample container. Identify the sample and check for sample spare. If a spare is found, replace the broken sample. If not, inform the supervisor immediately for further action.

12.2.2. Sample insufficiency. Inform the supervisor immediately for further advice.

12.2.3. Insufficient preservation of sample. If sample pH is ≥ 2, and no special instruction is provided by the analysis folder, inform your supervisor immediately for further action.

12.2.4. Sample overflow due to excessive effervescence. Identify the sample and check for sample spare. If a spare is found, re-digest the sample. If there is no spare sample, inform your supervisor immediately for further action.

12.2.5. Breakage of digestate container or when sample is spilled prior to dilution to final volume. Identify the digestate. If it is a method blank or LCS, re-digest the entire preparation batch. If it is a sample, re-digest the sample with a method blank and LCS. If re-extraction is not possible, inform your supervisor for further action.

12.3. A Non-Conformance Report (NCR) is required when any of the following circumstances occur:

- Anomalies, other than those mentioned above and specified in the analytical QCP, are observed.
- Sample is out of holding time.

12.3.1. Refer to EMAX-QA08 for details.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to wastewater drains.

13.2. Handle solvents and extracts and preparation of standards under the fume hoods.

13.3. Keep digestion area clean to prevent contamination of sample.

14.0 WASTE MANAGEMENT

14.1. No sample shall be dumped in the laboratory sink.

14.2. Separate and properly identify all unused expired standards for proper disposal.

14.3. Place all wastes generated during the digestion process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired standards and other wastes generated during the process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. Method Modification

15.1.1. This SOP is a modification of Method 3050B to enhance the recovery of antimony. The modification includes the addition of 5 mL HCl.

15.1.2. In addition, a modification has been made decreasing the reflux time. In the modified method, a 30 minute acid reflux and peroxide reflux is performed instead of two hours.

15.1.3. Appendix 2 provides the comparative study done on ICP analysis. The technical report of this study shall be retained as reference.

15.1.4. The modification of Method 3050B was first documented in EMAX-3050 Rev. 4.

15.2. Definition of Terms

15.2.1. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.2.1.1. **Preparation batch** – is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.2.1.2. **Analytical batch** – is compose of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices; preparation batches, and can exceed 20 samples.

15.2.2. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.2.3. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.2.4. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.2.5. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying chain of custody (COC). Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.2.6. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.2.7. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.2.8. Matrix – is a component or form of a sample.

15.2.9. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method’s recovery efficiency.

15.2.10. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.2.11. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.3. Application of EMAX QC Procedures

15.3.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing acid digestion of soil, sludge, and sediment samples for metals analysis. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.4. Department of Defense (DoD) and Department of Energy (DOE) Projects

15.4.1. Samples from DoD and/or DOE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client’s quality control directive. In the absence of

QAPP, the DoD and DOE Consolidated Quality Systems Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. Acid Digestion of Sediments, Sludges and Soils, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, US EPA SW-846, Method 3050B, Rev. 2, December 1996.

16.2. Inductively Coupled Plasma-Atomic Emission Spectrometry, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, US EPA SW-846, Methods 6010B Rev.2, Dec. 1996 and 6010C Rev. 3, Feb. 2007.

16.3. EMAX Quality Systems Manual, as updated.

17.0 APPENDICES

17.1. **Figures**

17.1.1.	Figure 1	Process Flowchart

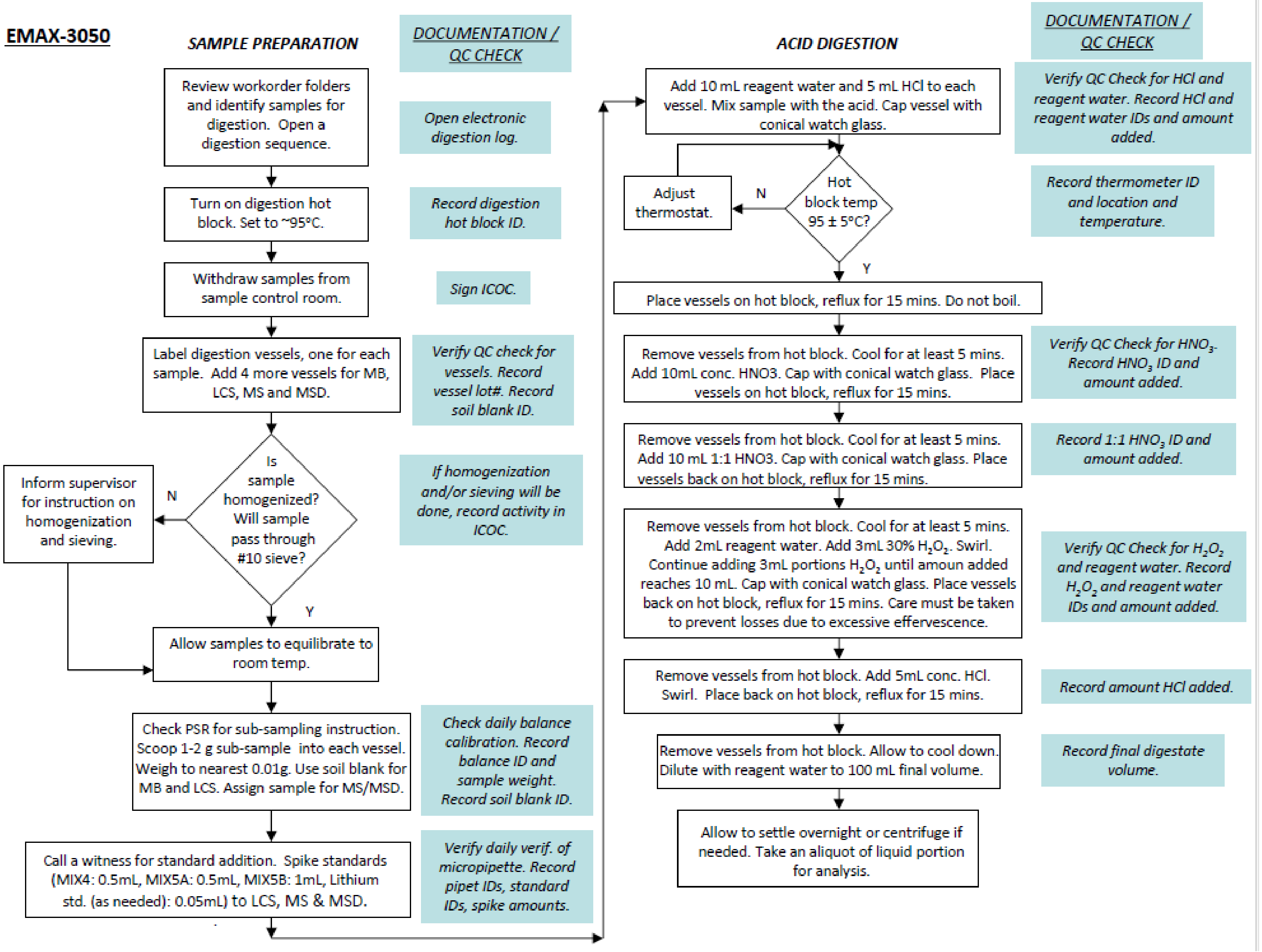
17.2. **Appendices**

17.2.1.	Appendix 1	Demonstration of Capability
17.2.2.	Appendix 2	Comparative Study of Modified 3050B

17.3. **Forms**

17.3.1.	3050FS	Sample Preparation Log

Figure 1: PROCESS FLOWCHART



SAMPLE PREPARATION

Review workorder folders and identify samples for digestion. Open a digestion sequence. — *Open electronic digestion log.*

Turn on digestion hot block. Set to ~95°C. — *Record digestion hot block ID.*

Withdraw samples from sample control room. — *Sign ICOC.*

Label digestion vessels, one for each sample. Add 4 more vessels for MB, LCS, MS and MSD. — *Verify QC check for vessels. Record vessel lot#. Record soil blank ID.*

Is sample homogenized? Will sample pass through #10 sieve? — *If homogenization and/or sieving will be done, record activity in ICOC.*

N: Inform supervisor for instruction on homogenization and sieving.

Y: Allow samples to equilibrate to room temp.

Check PSR for sub-sampling instruction. Scoop 1-2 g sub-sample into each vessel. Weigh to nearest 0.01g. Use soil blank for MB and LCS. Assign sample for MS/MSD. — *Check daily balance calibration. Record balance ID and sample weight. Record soil blank ID.*

Call a witness for standard addition. Spike standards (MIX4: 0.5mL, MIX5A: 0.5mL, MIX5B: 1mL, Lithium std. (as needed): 0.05mL) to LCS, MS & MSD. — *Verify daily verif. of micropipette. Record pipet IDs, standard IDs, spike amounts.*

ACID DIGESTION

Add 10 mL reagent water and 5 mL HCl to each vessel. Mix sample with the acid. Cap vessel with conical watch glass. — *Verify QC Check for HCl and reagent water. Record HCl and reagent water IDs and amount added.*

Hot block temp 95 ± 5°C? — *Record thermometer ID and location and temperature.*

N: Adjust thermostat.

Y: Place vessels on hot block, reflux for 15 mins. Do not boil.

Remove vessels from hot block. Cool for at least 5 mins. Add 10mL conc. HNO3. Cap with conical watch glass. Place vessels on hot block, reflux for 15 mins. — *Verify QC Check for HNO_3. Record HNO_3 ID and amount added.*

Remove vessels from hot block. Cool for at least 5 mins. Add 10 mL 1:1 HNO3. Cap with conical watch glass. Place vessels back on hot block, reflux for 15 mins. — *Record 1:1 HNO_3 ID and amount added.*

Remove vessels from hot block. Cool for at least 5 mins. Add 2mL reagent water. Add 3mL 30% H_2O_2. Swirl. Continue adding 3mL portions H_2O_2 until amoun added reaches 10 mL. Cap with conical watch glass. Place vessels back on hot block, reflux for 15 mins. Care must be taken to prevent losses due to excessive effervescence. — *Verify QC Check for H_2O_2 and reagent water. Record H_2O_2 and reagent water IDs and amount added.*

Remove vessels from hot block. Add 5mL conc. HCl. Swirl. Place back on hot block, reflux for 15 mins. — *Record amount HCl added.*

Remove vessels from hot block. Allow to cool down. Dilute with reagent water to 100 mL final volume. — *Record final digestate volume.*

Allow to settle overnight or centrifuge if needed. Take an aliquot of liquid portion for analysis.

Appendix 1: DEMONSTRATION OF CAPABILITY

Conc Unit: mg/Kg
Sample Amt(g): 1

PARAMETER	ID8M017023	ID8M017024	ID8M017025	ID8M017026	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Acceptance Limits (%	RSD (%) Criteria	COMMENTS
	IPM023SL	IPM023SC	IPM023SX	IPM023SY								
Aluminum	515	499	506	511	500	508	102	6.66	1	80 - 120	≤ 20	Passed
Antimony	243	237	239	243	250	240	96	3.10	1	80 - 120	≤ 20	Passed
Arsenic	48.1	47.0	47.3	47.8	50	47.5	95	0.490	1	80 - 120	≤ 20	Passed
Barium	50.0	47.7	48.3	49.5	50	48.9	98	1.07	2	80 - 120	≤ 20	Passed
Beryllium	47.2	45.4	46.1	46.7	50	46.3	93	0.772	2	80 - 120	≤ 20	Passed
Boron	42.2	41.0	41.5	42.0	50	41.7	83	0.545	1	80 - 120	≤ 20	Passed
Cadmium	47.2	46.8	46.4	47.1	50	46.9	94	0.366	1	80 - 120	≤ 20	Passed
Calcium	5138	5038	5029	5121	5000	5082	102	56.3	1	80 - 120	≤ 20	Passed
Chromium	47.9	47.0	47.4	47.9	50	47.5	95	0.426	1	80 - 120	≤ 20	Passed
Cobalt	49.2	46.9	48.4	49.0	50	48.4	97	1.07	2	80 - 120	≤ 20	Passed
Copper	48.8	46.8	48.1	48.6	50	48.1	96	0.893	2	80 - 120	≤ 20	Passed
Iron	480	473	468	477	500	475	95	5.08	1	80 - 120	≤ 20	Passed
Lead	47.9	45.9	47.2	47.7	50	47.2	94	0.892	2	80 - 120	≤ 20	Passed
Lithium	48.9	46.7	47.4	48.3	50	47.8	96	0.983	2	80 - 120	≤ 20	Passed
Magnesium	4734	4644	4606	4675	5000	4665	93	54.2	1	80 - 120	≤ 20	Passed
Manganese	46.2	44.6	44.9	45.6	50	45.3	91	0.731	2	80 - 120	≤ 20	Passed
Molybdenum	50.2	47.5	49.2	49.9	50	49.2	98	1.20	2	80 - 120	≤ 20	Passed
Nickel	50.8	48.4	50.0	50.6	50	50.0	100	1.08	2	80 - 120	≤ 20	Passed
Potassium	5056	4898	4964	5038	5000	4989	100	72.7	1	80 - 120	≤ 20	Passed
Selenium	45.9	44.8	45.1	45.8	50	45.4	91	0.553	1	80 - 120	≤ 20	Passed
Silver	48.5	47.2	47.4	48.3	50	47.9	96	0.642	1	80 - 120	≤ 20	Passed
Sodium	4951	4765	4846	4896	5000	4865	97	78.9	2	80 - 120	≤ 20	Passed
Strontium	46.2	43.8	44.6	45.2	50	44.9	90	1.03	2	80 - 120	≤ 20	Passed
Thallium	44.1	43.6	43.4	44.2	50	43.8	88	0.388	1	80 - 120	≤ 20	Passed
Tin	54.0	51.9	53.4	53.9	50	53.3	107	0.948	2	80 - 120	≤ 20	Passed
Titanium	49.8	47.7	48.0	49.2	50	48.7	97	0.997	2	80 - 120	≤ 20	Passed
Vanadium	50.2	49.0	48.9	49.9	50	49.5	99	0.653	1	80 - 120	≤ 20	Passed
Zinc	51.2	49.8	50.6	51.0	50	50.7	101	0.601	1	80 - 120	≤ 20	Passed

Appendix 2: COMPARATIVE STUDY OF MODIFIED 3050B

ANALYTICAL METHOD:	SW 6010C		
PREPARATION BATCH:	IPG052S - Modified Method 3050B	**Preparation Date:**	7/27/2010
	IPG053S - Reference Method 3050B	**Extracted by:**	M. Mendoza
ANALYTICAL BATCH:	D8G025	**Analytical Run Date:**	7/28/2010
QC STANDARD:	09G281-02	**Analyzed by:**	T. Hoang

COMPOUND	TRUE VALUES (mg/Kg)	ACCEPTANCE LIMITS (mg/Kg)	RECOVERY LIMITS (%)	REFERENCE METHOD 3050B				MODIFIED METHOD 3050B			
				Concentration (mg/Kg)		Recovery		Concentration (mg/Kg)		Recovery	
				D8G025063 G281-02	D8G025064 G281-02D	D8G025063 G281-02	D8G025064 G281-02D	D8G025054 G281-02	D8G025055 G281-02D	D8G025054 G281-02	D8G025055 G281-02D
Aluminum	7320	4940 - 16400	67.5 - 224	13900	13800	190%	189%	12600	12600	172%	172%
Antimony	110	11.0 - 121	10.0 - 110	22.4	20.4	20%	19%	71.5	76.7	65%	70%
Arsenic	84.2	42.8 - 92.7	50.8 - 110	67.5	68.1	80%	81%	70.1	71.7	83%	85%
Barium	247	186 - 318	75.3 - 129	246	248	100%	100%	266	261	108%	106%
Beryllium	49.0	29.0 - 53.9	59.2 - 110	39.7	39.4	81%	80%	43.8	42.5	89%	87%
Boron	130	61.8 - 149	47.5 - 115	99.8	99.8	77%	77%	108	105	83%	81%
Cadmium	76.5	48.7 - 84.4	63.7 - 110	70.6	71.6	92%	94%	77.5	76.8	101%	100%
Calcium	10200	7860 - 12900	77.1 - 126	10400	11500	102%	113%	11200	11200	110%	110%
Chromium	116	74.8 - 140	64.5 - 121	108	108	93%	93%	117	119	101%	103%
Cobalt	64.6	47.2 - 79.7	73.1 - 123	64.5	64.2	100%	99%	70	69	108%	107%
Copper	143	99.7 - 166	69.7 - 116	134	135	94%	94%	143	144	100%	101%
Iron	23300	11500 - 36200	49.4 - 155	25400	24700	109%	106%	25500	25700	109%	110%
Lead	82.0	41.9 - 90.2	51.1 - 110	62.5	63.6	76%	78%	66.4	66.2	81%	81%
Magnesium	7400	5300 - 9060	71.6 - 122	7080	7140	96%	96%	7330	7330	99%	99%
Manganese	475	428 - 724	90.1 - 152	566	581	119%	122%	618	597	130%	126%
Molybdenum	66.1	36.0 - 72.7	54.5 - 110	55.4	53.9	84%	82%	63.5	62.8	96%	95%
Nickel	144	88.8 - 158	61.7 - 110	129	131	90%	91%	142	141	99%	98%
Potassium	3740	2360 - 4990	63.1 - 133	4080	3970	109%	106%	4110	3920	110%	105%
Selenium	189	97.2 - 208	51.4 - 110	151	155	80%	82%	157	162	83%	86%
Silver	40.6	21.2 - 44.6	52.2 - 110	33.3	34.7	82%	85%	35.3	35.9	87%	88%
Sodium	200	31.4 - 324	15.7 - 162	223	214	112%	107%	199	202	100%	101%
Strontium	135	88.1 - 162	65.3 - 120	121	118	90%	87%	128	125	95%	93%
Thallium	127	73.2 - 144	57.6 - 113	108	114	85%	90%	116	110	91%	87%
Tin	250	39.5 - 275	15.8 - 110	72.1	73.5	29%	29%	85.3	86	34%	34%
Titanium	609	426 - 792	70.0 - 130	725	731	119%	120%	765	746	126%	122%
Vanadium	61.8	55.6 - 123	90.0 - 199	97.4	95.8	158%	155%	99.6	99.3	161%	161%
Zinc	208	145 - 270	69.7 - 130	227	228	109%	110%	258	244	124%	117%

** Note: Modified 3050B procedure is specified in EMAX-3050 Rev. 4*

3010FS: **SAMPLE PREPARATION LOG (Page 1)**

EMAX
LABORATORIES, INC.

DIGESTION LOG
for
ICP-MS METALS

Page 1

Note: For samples, relevant QCs/Standards digested, refer to attached digestion sequence.

Comments:

Digestion Vessel Lot #

Book #: EIM-073
Batch:
Matrix:
Digestor ID:

SOP #	Rev. #
☐ EMAX-200.8	
☐ EMAX-6020	
☐ EMAX-	

Start	Temp	End	Temp
	°C		°C

Standards	ID	Amount Added (ml/g)
LCS-1		
LCS-2		
MS		
Blank Soil (Bead)		
Reagent	**Lot# / ID**	**Amount Added (ml)**
HNO_3		
HCl		
H_2O_2		
HNO_3(1:1)		
pH Strip (0-14)		

Digestate Location	
Extract Location	

☐ Reagent Water ID:
☐ Thermometer ID:
☐ Pipette ID:
☐ Pipette ID:
☐ Pipette ID:
☐ HNO_3 dispenser checked @ 5.0 ml with Class A volumetric flask
☐ HCl dispenser checked @ 5.0 ml with Class A volumetric flask

Prepared By:
Standard Added By: Witnessed By:
Extract Rcvd By: Checked By:

TOC

3010FS: SAMPLE PREPARATION LOG (Page 2)

PrepBatchID	LabSampleID	Aliquot	Unit	DateTime	Vd(ml)	ExpAmt	ExpVd(ml)	PrepFctr	Comments

Vd=digestate volume

PrepFctr=(ExpAmt/Aliquot)*(Vd/ExpVd)

☐ Digestion Started @

Prepared By:

☐ Digestion Ended @

Checked By:

Comments:

Date

PRINT DRF

SOP REVIEW FORM

ACID DIGESTION, TOTAL METALS SOLIDS

SOP#: EMAX-3050 **Rev** 9 **Effective Date:** 04-Jan-23

COMMENTS	**Reviewed By**	**Review Date**

TOC

STANDARD OPERATING PROCEDURES

PURGE AND TRAP

SOP No.:	EMAX-5030	Revision No.	5	Date:	19-Jul-22
Prepared By:	Oanh Dinh			Date:	07/19/22
Approved By:	Farina Madamba QA Manager			Date:	7/19/22
Approved By:	Caspar Pang Laboratory Director			Date:	7/19/22
		Control Number:	5030-05-		

1.0 SCOPE AND APPLICATION

1.1. This method describes a purge-and-trap procedure for the analysis of volatile organic compounds (VOCs) in aqueous samples and water miscible liquid samples. It also describes the analysis of high concentration sample. This method is applicable for all determinative methods requiring purge and trap for above mentioned matrices.

1.2. This method can be used for volatile organic compounds listed in the volatile determinative SOPs. Other compounds maybe determined upon successful demonstration of capability.

1.3. This SOP is an adaptation of SW846 Methods 5030B and 5030C.

2.0 SUMMARY OF METHOD

2.1. Aqueous Samples. Helium gas is bubbled through an aqueous solution or suspension at a predetermined flow rate, and volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where volatiles are absorbed. After purging is completed, the sorbent column is heated and back flushed with helium to desorb the components onto a GC column.

2.2. High Concentration samples are extracted with methanol. An aliquot of the methanol extract is combined with organic free reagent water in the purging chamber. It is then analyzed by purge and trap GC or GC/MS following the normal aqueous method.

2.3. Interferences

2.3.1. Impurities in the purge gas and from organic compounds out-gassing from the plumbing ahead of the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination by running method blanks. The use of non-polytetrafluoroethylene (non-PTFE) plastic coating, non-PTFE thread sealant, or flow controllers with rubber components in the purging device must be avoided. These compounds will result in interferences or false positives in the determinative step.

2.3.2. Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) during shipment or storage. A trip blank prepared from organic-free reagent water and carried through sampling and handling serves as a check on such contamination.

2.3.3. Contamination by carryover can occur whenever high-concentration and low-concentration samples are analyzed in sequence. Where practical, samples with unusually high concentrations of analytes should be followed by an analysis of organic-free reagent water to check for cross-contamination.

2.3.4. Special pre-cautions must be taken to determine methylene chloride. The volatile area should be isolated from all atmospheric sources of methylene chloride; otherwise random background levels will result.

3.0 DETECTION LIMITS

3.1. Refer to applicable analytical SOP.

4.0 DYNAMIC RANGE

4.1. Refer to applicable analytical SOP.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. Holding Time

5.1.1. Analyze preserved samples within 14 days from sampling date.

5.1.2. Analyze samples with pH > 2 within 7 days from sampling date.

5.2. Preservation

5.2.1. Keep both soil and aqueous samples cool at ≤ 6°C without freezing.

5.2.2. Preserve aqueous samples with hydrochloric acid to pH < 2. The acid preservation of the aqueous samples must be done in the field; the laboratory will only confirm the acid preservation at the time of analysis.

6.0 ASSOCIATED SOPs

6.1.	EMAX-8015G	Gasoline Range Organics
6.2.	EMAX-8260	Volatile Organics by GC/MS
6.3.	EMAX-8260C	Volatile Organics by GC/MS
6.4.	EMAX-8260SIM	Volatile Organics by GC/MS SIM
6.5.	EMAX-M8260SIM	1-4,Dioxane by GC/MS SIM
6.6.	EMAX-TCPSIM	1,2,3-Trichloropropane by GC/MS SIM
6.7.	EMAX-QA05	Training
6.8.	EMAX-QA08	Corrective Action
6.9.	EMAX-QC01	Quality Control for Chemicals
6.10.	EMAX-QC07	Glassware Cleaning
6.11.	EMAX-SM03	Waste Disposal
6.12.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS for chemicals listed in this SOP.

7.2. Treat reagents, standards, and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, and gloves at all times when performing this procedure. Perform all sample and standard handling in the fume hood.

7.3. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amounts of tap water. If irritations or any other discomfort related to the incident persist, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS AND REAGENTS

8.1. Instruments and Supplies

8.1.1. Automatic Sample Purger: Tekmar ALS 2016 or OI MPM-.6; Archon; DynaSoil

8.1.2. Trap: VOCARB 4000 (Supelco) or equivalent

8.1.3. Concentrator: O.I. 4560, 4460 or Tekmar LCS 2000; DynaSoil or equivalent

8.1.4. Syringe: 5 mL, 25 mL, gas-tight with Luerlok tip

8.1.5. Microsyringe: 2, 10, 25, 50, 100 µl (Hamilton 702N or equivalent)

8.1.6. Sparging Vessel: 40 mL , 20 mL test tubes

8.1.7. Balance: Sartorius, Model LC620, top loading, capable of weighing 100 g ± 0.01 g

8.2. Chemicals and Reagents

8.2.1. Reagents: Organic free reagent water, generated from active charcoal column

8.2.2. Ultra-high purity methanol

9.0 STANDARDS

9.1. Preparation of standard is outlined in Section 9.0 of applicable analytical SOP.

9.2. Spiking Standard Solution

9.2.1. Refer to applicable analytical SOP.

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Water Samples

10.1.1.1. Label sample vials to include the following:

- Method Blank (MB)
- Lab Control Sample/Lab Control Sample Duplicate (LCS/LCD)

- Matrix Spike/Matrix Spike Duplicate (MS/MSD)[1]
- Field Samples according to lab sample ID.

10.1.1.2. Pull out samples from the sample control room and record samples withdrawn in the internal chain of custody (ICOC).

10.1.1.3. Line up field samples corresponding to the labeled sample vials.

10.1.1.4. Using a 10 mL or 25 mL syringe, remove the plunger, close the syringe hub and fill the syringe barrel. Insert the syringe plunger back and measure the appropriate sample amount needed for analysis. Use organic free water for MB, LCS and LCD.

10.1.1.5. Add the surrogate and internal standard to all samples. Add LCS standard to LCS and LCD, MS and MSD (if required). Inject spiking solution through the syringe hub.

As a precaution, consider separating LCS, LCD, MS and MSD samples from the rest of the samples to prevent spiking the sample that is not intended for positive QC sample.

10.1.1.6. Transfer the measured sample into the corresponding labeled vial. Careful delivery must be considered to prevent air leak. Invert the sample source vial to indicate that subsampling is completed for that sample.

10.1.1.7. Samples are now ready to be placed on the purge and trap autosampler.

10.1.1.8. When only one vial of sample is available, samples must be analyzed following a passing DCC and associated QC. A 5X and 25X dilutions (or per priori knowledge) shall be prepared simultaneously, in case dilution is needed. These extra steps, is expected to minimize occurrences of un-reportable results.

10.1.1.9. Check sample pH if it is ≤ 2 (when preserved) and presence of residual chlorine if it is ≤ 5 mg/L. Record sample pH and residual chlorine observations on the analysis log.

In the event that sample pH is > 2 and it is beyond the sample holding time (7 days) or residual chlorine is > 5mg/L, inform the supervisor immediately.

10.1.2. High Level

10.1.2.1. Weigh 5 ± 0.1 g of sample into a 20 mL vial. Using a 5 mL syringe, add 5 mL of methanol and mix thoroughly for 5 minutes. Allow the mixture to stand so that the sediment can settle.

10.1.2.2. Prepare 5 mL of organic free water solution with internal standard and surrogate. Withdraw up to 100 µl of methanol extract using an appropriate microsyringe.

10.1.2.3. Add the methanol extract to the 5 mL syringe through the Luerlok tip and pull the plunger slowly to make room for the extract, taking into consideration that no air is introduce into the syringe.

10.1.2.4. Samples are now ready to be placed on the purge and trap autosampler.

10.2. **Instrument Parameters**

10.2.1. Refer to applicable analytical method.

10.3. **Calibration**

10.3.1. Refer to applicable analytical method.

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[1] Adhere to PSR, some projects requires MS/MSD only on designated matrix QC field sample(s).

10.4. **Analysis**

10.4.1. Refer to applicable analytical method

10.5. **Calculations**

10.5.1. Dilution factor (DF)

10.5.1.1. **Low Level**

$$DF = \frac{V}{S} \qquad \text{Eq.-10.5.1.1}$$

where:

V – Purge volume

S – Sample amount

10.5.1.2. **High Level**

$$DF = \frac{V}{E} \times \frac{EV}{S} \qquad \text{Eq.-10.5.1.2}$$

where:

V – Purge volume

E – Extract amount

EV – Extract volume

S – Sample amount

10.5.2. Refer to applicable analytical SOP.

10.6. **Data Reduction**

10.6.1. Refer to applicable analytical SOP.

10.7. **Report Generation**

10.7.1. Refer to applicable analytical SOP.

10.8. **Data Review**

10.8.1. Refer to applicable analytical SOP.

10.9. **Preventive Maintenance**

10.9.1. Refer to applicable analytical SOP.

11.0 QUALITY CONTROL

11.1. The sequence of runs and quality control acceptance criteria are specified in the individual analytical SOP. They include method blank, calibrations, lab control samples, and matrix spike/matrix spike duplicate.

11.2. Reagents and standards must undergo quality control check prior to use. Refer to EMAX-QC01 for details.

11.3. Properly treat all lab wares used in the sample preparation as specified in EMAX-QC07.

11.4. Syringes must be purchased with a certificate of bias and precision. Discard the syringe when deterioration is observed.

11.5. All analysts conducting this method must demonstrate capability (IDOC/DOC) as described in EMAX-QA05.

12.0 CORRECTIVE ACTION

12.1. Refer to applicable analytical SOP.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to wastewater drains.

13.2. Handle solvents and extracts and preparations of standards under the fume hood.

13.3. Keep extraction area clean to prevent contamination of sample.

14.0 WASTE MANAGEMENT

14.1. No samples may be dumped on the laboratory sink.

14.2. Separate and properly identify all unused expired standards for proper disposal.

14.3. Place all wastes generated during the process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired standards and other waste generated during the process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. **Definition of Terms**

15.1.1. Analyte – the specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family, and which are analyzed together.

15.1.2. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.1.2.1. **Preparation batch** – is composed of one to 20 field samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate (if required).

15.1.2.2. **Analytical batch** – is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices; preparation batches, and may exceed 20 samples.

15.1.3. Safety Data Sheet (SDS) – is a written information concerning a chemical physical properties, toxicity, health hazards, fire hazard and reactivity data including storage, spill and handling precautions.

15.1.4. Calibration - is a determinant measured from a standard to obtain the correct value of an instrument output.

15.1.5. Calibration Blank – is a target-analyte-free solvent subjected to the entire analytical process to establish zero baseline or background value.

15.1.6. Calibration Check Compounds (CCC) - evaluate the integrity of the system. Variability of these compounds may indicate system leak or reactive sites in the column.

15.1.7. Instrument Method - is a file generated to contain the instrument calibration and instrument parameter settings for a particular analysis.

15.1.8. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.1.9. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.1.10. Lab Control Sample Duplicate (LCSD) – is a replicate of LCS analyzed to monitor precision in the absence of MS/MSD sample.

15.1.11. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.1.12. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.1.13. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.1.14. Matrix – is a component or form of a sample.

15.1.15. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method’s recovery efficiency.

15.1.16. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.1.17. Response Factor - is the ratio of the peak area of the target compound in the sample or sample extract.

15.1.18. Surrogate – are compounds added to every blank, sample, matrix spike, matrix spike duplicate and standard; used to evaluate analytical efficiency by measuring recovery. Compounds not expected to be detected in environmental media.

15.1.19. System Performance Check Compounds (SPCC) - are compounds that are used to check compound stability and to check for degradation caused by contaminated lines or active sites in the system.

15.1.20. Reagent Water – is purified water free from any target analyte or any other substances that may interfere with the analytical process.

15.2. Application of EMAX QC Procedures

15.2.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing purgeable volatile analyses. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.3. Department of Defense (DoD) and Department of Energy (DoE) Projects

15.3.1. Samples from DoD and DoE sponsored projects follow the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD Quality System Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. "Purge-and-Trap for Aqueous Samples", USEPA SW 846 Method 5030B, Rev. 2, Dec. 1996 and Method 5030C, Rev. 3, May 2003

16.2. EMAX Quality Systems Manual, as updated

17.0 APPENDICES

17.1. Appendices

17.1.1. Appendix 1 Demonstration of Capability for 8260

17.1.2. Appendix 2 Demonstration of Capability for 8015

17.2. Forms

17.2.1. 5030FAA Analytical Log for 8260

17.2.2. 5030FAB Analytical Run Log for 8015

Appendix 1: DEMONSTRATION OF CAPABILITY FOR 8260

DEMONSTRATION OF CAPABILTY

METHOD 5030/8260

Unit: µg/L
Sample Amount(ml): 25
Sample Purge(ml): 25

PARAMETER	RMY229 VOF5M14L	RMY230 VOF5M14C	RMY231 VOF5M15L	RMY232 VOF5M15C	True Value	Ave. Conc.	Ave. % Rec.	SD	RSD (%)	Accuracy Acceptance Limits (% Rec)	Precision Criteria (RSD%)	Comments
Acetone	48.0	46.6	47.6	49.1	50	47.8	96	1.03	2	60 - 140	≤ 30	Passed
Acrolein	44.4	42.5	43.5	44.6	50	43.8	88	0.961	2	50 - 130	≤ 30	Passed
Acrylonitrile	49.2	48.0	48.7	50.0	50	49.0	98	0.842	2	60 - 130	≤ 30	Passed
Benzene	9.39	9.48	9.59	9.53	10	9.50	95	0.0846	1	70 - 130	≤ 30	Passed
Bromobenzene	9.71	9.74	9.71	9.88	10	9.76	98	0.0812	1	70 - 130	≤ 30	Passed
Bromochloromethane	9.83	9.59	9.87	9.87	10	9.79	98	0.135	1	70 - 130	≤ 30	Passed
Bromodichloromethane	9.51	9.59	9.60	9.66	10	9.59	96	0.0616	1	70 - 130	≤ 30	Passed
Bromoform	9.63	9.62	9.72	9.98	10	9.74	97	0.168	2	70 - 140	≤ 30	Passed
Bromomethane	9.18	9.41	9.72	9.73	10	9.51	95	0.265	3	60 - 130	≤ 30	Passed
tert-Butyl alcohol	252	245	251	254	250	251	100	3.87	2	60 - 140	≤ 30	Passed
2-Butanone (MEK)	50.7	49.5	50.8	53.0	50	51.0	102	1.46	3	70 - 130	≤ 30	Passed
n-Butylbenzene	9.86	10.3	10.1	10.2	10	10.1	101	0.189	2	70 - 130	≤ 30	Passed
sec-Butylbenzene	9.69	10.1	10.0	10.0	10	9.95	100	0.178	2	70 - 130	≤ 30	Passed
tert-Butylbenzene	9.60	10.1	9.77	10.0	10	9.87	99	0.226	2	70 - 130	≤ 30	Passed
Carbon disulfide	8.22	7.97	8.99	8.66	10	8.46	85	0.454	5	60 - 130	≤ 30	Passed
Carbon tetrachloride	9.43	9.47	9.51	9.60	10	9.50	95	0.0727	1	70 - 130	≤ 30	Passed
Chlorobenzene	9.47	9.48	9.65	9.57	10	9.54	95	0.0846	1	70 - 130	≤ 30	Passed
2-Chloroethyl vinyl ether	9.32	9.18	8.95	9.40	10	9.21	92	0.197	2	60 - 140	≤ 30	Passed
Chloroethane	9.23	9.53	9.65	9.77	10	9.55	96	0.232	2	60 - 140	≤ 30	Passed
Chloroform	9.33	9.46	9.57	9.56	10	9.48	95	0.112	1	70 - 130	≤ 30	Passed
1-Chlorohexane	9.75	10.0	10.0	9.76	10	9.88	99	0.142	1	70 - 130	≤ 30	Passed
Chloromethane	9.23	9.48	9.70	9.72	10	9.53	95	0.229	2	60 - 140	≤ 30	Passed
2-Chlorotoluene	9.33	9.56	9.29	9.56	10	9.44	94	0.145	2	70 - 130	≤ 30	Passed
4-Chlorotoluene	9.45	9.71	10.1	9.75	10	9.75	98	0.267	3	70 - 130	≤ 30	Passed
Dibromochloromethane	9.61	9.66	10.0	9.8	10	9.76	98	0.166	2	70 - 130	≤ 30	Passed
1,2-Dibromo-3-chloropropane	9.71	9.84	9.39	9.56	10	9.63	96	0.194	2	70 - 130	≤ 30	Passed
1,2-Dibromoethane	9.79	9.84	9.92	10.0	10	9.88	99	0.0804	1	70 - 130	≤ 30	Passed
Dibromomethane	9.62	9.30	9.57	10.7	10	9.80	98	0.618	6	70 - 130	≤ 30	Passed
1,1-Dichloroethane	9.18	9.09	9.24	9.20	10	9.18	92	0.0634	1	70 - 130	≤ 30	Passed
1,2-Dichloroethane	9.68	9.61	9.86	9.93	10	9.77	98	0.150	2	70 - 130	≤ 30	Passed
1,2-Dichlorobenzene	9.34	9.38	9.42	9.49	10	9.41	94	0.0640	1	70 - 130	≤ 30	Passed
1,3-Dichlorobenzene	9.54	9.68	9.58	9.74	10	9.64	96	0.0915	1	70 - 130	≤ 30	Passed
trans-1,4-Dichloro-2-Butene	9.42	9.69	9.55	9.73	10	9.60	96	0.141	1	70 - 140	≤ 30	Passed
1,4-Dichlorobenzene	9.56	9.88	9.65	9.68	10	9.69	97	0.135	1	70 - 130	≤ 30	Passed
Dichlorodifluoromethane	8.85	9.23	9.52	9.34	10	9.24	92	0.283	3	40 - 140	≤ 30	Passed
1,1-Dichloroethene	8.72	8.92	8.97	8.88	10	8.87	89	0.108	1	70 - 130	≤ 30	Passed
cis-1,2-Dichloroethene	9.60	9.63	9.91	9.81	10	9.74	97	0.148	2	70 - 130	≤ 30	Passed
trans-1,2-Dichloroethene	9.15	9.13	9.35	9.27	10	9.23	92	0.104	1	70 - 130	≤ 30	Passed
Dichlorofluoromethane	9.25	9.39	9.45	9.41	10	9.38	94	0.0870	1	30 - 160	≤ 30	Passed
1,1-Dichloropropene	9.50	9.27	9.50	9.27	10	9.39	94	0.133	1	70 - 130	≤ 30	Passed
1,2-Dichloropropane	9.16	9.09	9.28	9.29	10	9.21	92	0.0968	1	70 - 130	≤ 30	Passed
1,3-Dichloropropane	9.66	9.63	9.88	9.65	10	9.71	97	0.117	1	70 - 130	≤ 30	Passed
2,2-Dichloropropane	9.18	9.49	9.56	9.31	10	9.39	94	0.173	2	70 - 130	≤ 30	Passed
cis-1,3-Dichloropropene	9.93	10.0	10.1	10.1	10	10.0	100	0.0830	1	70 - 130	≤ 30	Passed
trans-1,3-Dichloropropene	10.3	10.1	10.3	10.2	10	10.2	102	0.0957	1	70 - 130	≤ 30	Passed

Appendix 1 (Cont.): DEMONSTRATION OF CAPABILITY FOR 8260

DEMONSTRATION OF CAPABILTY

METHOD 5030/8260

	RMY229	RMY230	RMY231	RMY232								
PARAMETER	VOF5M14L	VOF5M14C	VOF5M15L	VOF5M15C	True Value	Ave. Conc.	Ave. % Rec.	SD	RSD (%)	Accuracy Acceptance Limits (% Rec)	Precision Criteria (RSD%)	Comments
tert-Butyl ethyl ether (ETB	9.61	9.59	9.83	9.84	10	9.72	97	0.136	1	70 - 130	≤ 30	Passed
Ethyl Methacrylate	10.4	10.3	10.4	10.2	10	10.3	103	0.0957	1	70 - 140	≤ 30	Passed
Ethylbenzene	9.38	9.55	9.67	9.37	10	9.49	95	0.144	2	70 - 130	≤ 30	Passed
2-Hexanone (MBK)	53.7	51.8	52.7	53.6	50	53.0	106	0.889	2	70 - 130	≤ 30	Passed
Hexachlorobutadiene	9.60	10.2	10.0	10.1	10	10.0	100	0.263	3	70 - 130	≤ 30	Passed
Iodomethane	9.19	9.25	9.43	9.39	10	9.32	93	0.114	1	70 - 140	≤ 30	Passed
Isopropyl ether (DIPE)	9.56	9.58	9.72	9.81	10	9.67	97	0.119	1	70 - 130	≤ 30	Passed
Isopropylbenzene	10.3	10.4	10.5	10.1	10	10.3	103	0.171	2	70 - 130	≤ 30	Passed
p-Isopropyltoluene	9.70	10.1	10.1	9.97	10	9.97	100	0.189	2	70 - 130	≤ 30	Passed
Methyl acetate	8.45	8.08	8.66	8.83	10	8.51	85	0.323	4	60 - 130	≤ 30	Passed
Methylene Chloride	8.61	8.70	8.84	8.82	10	8.74	87	0.108	1	70 - 130	≤ 30	Passed
4-Methyl-2-pentanone (MIBK)	52.6	51.4	51.7	53.3	50	52.3	105	0.866	2	70 - 130	≤ 30	Passed
tert-Butyl methyl ether	9.79	9.76	9.95	10.1	10	9.90	99	0.157	2	70 - 130	≤ 30	Passed
Naphthalene	9.80	10.0	9.94	10.2	10	9.99	100	0.166	2	70 - 130	≤ 30	Passed
n-Propylbenzene	9.48	9.80	9.81	9.79	10	9.72	97	0.160	2	70 - 130	≤ 30	Passed
Styrene	10.2	10.4	10.5	10.2	10	10.30	103	0.150	1	70 - 130	≤ 30	Passed
tert-Amyl methyl ether (TAME)	9.99	10.0	10.1	10.2	10	10.1	101	0.0984	1	70 - 130	≤ 30	Passed
1,1,1,2-Tetrachloroethane	9.66	9.69	9.77	9.69	10	9.70	97	0.0472	0.5	70 - 130	≤ 30	Passed
1,1,2,2-Tetrachloroethane	9.17	9.30	9.20	9.27	10	9.24	92	0.0603	1	70 - 130	≤ 30	Passed
Tetrachloroethene	9.36	9.57	9.63	9.45	10	9.50	95	0.121	1	70 - 130	≤ 30	Passed
Toluene	9.59	9.58	9.77	9.62	10	9.64	96	0.0883	1	70 - 130	≤ 30	Passed
1,1,1-Trichloroethane	9.37	9.53	9.72	9.46	10	9.52	95	0.149	2	70 - 130	≤ 30	Passed
1,1,2-Trichloroethane	9.75	9.85	10.0	10.2	10	10.0	100	0.196	2	70 - 130	≤ 30	Passed
1,2,3-Trichlorobenzene	9.77	10.2	9.86	10.2	10	10.0	100	0.225	2	70 - 130	≤ 30	Passed
1,2,4-Trichlorobenzene	9.54	10.0	9.84	10.1	10	9.87	99	0.245	2	70 - 130	≤ 30	Passed
Trichloroethene	9.19	9.56	9.63	9.55	10	9.48	95	0.198	2	70 - 130	≤ 30	Passed
Trichlorofluoromethane	9.38	9.87	10.2	10.0	10	9.85	99	0.344	3	70 - 140	≤ 30	Passed
1,2,3-Trichloropropane	9.76	9.82	10.1	10.6	10	10.1	101	0.383	4	70 - 130	≤ 30	Passed
1,1,2-Trichloro1,2,2-trifluoroethane	9.36	9.62	9.57	9.47	10	9.51	95	0.115	1	60 - 130	≤ 30	Passed
1,2,4-Trimethylbenzene	9.73	10.1	9.97	9.93	10	9.93	99	0.153	2	70 - 130	≤ 30	Passed
1,3,5-Trimethylbenzene	9.62	9.82	9.77	9.88	10	9.77	98	0.111	1	70 - 130	≤ 30	Passed
Vinyl Acetate	9.41	9.92	9.8	10.1	10	9.81	98	0.292	3	70 - 140	≤ 30	Passed
Vinyl Chloride	9.25	9.67	10.0	9.81	10	9.68	97	0.318	3	60 - 140	≤ 30	Passed
m-Xylene & p-xylene	19.2	19.5	19.6	19.4	20	19.4	97	0.171	1	70 - 130	≤ 30	Passed
o-Xylene	10.2	10.2	10.3	10.2	10	10.2	102	0.0500	0.5	70 - 130	≤ 30	Passed
1,4-Dioxane	201	184	195	185	200	191	96	8.18	4	70 - 130	≤ 30	Passed
Cyclohexane	9.33	9.79	9.99	9.67	10	9.70	97	0.277	3	60 - 140	≤ 30	Passed
Methylcyclohexane	9.18	9.54	9.90	9.50	10	9.53	95	0.295	3	60 - 140	≤ 30	Passed
Tetrahydrofuran	10.4	9.90	9.94	10.4	10	10.2	102	0.278	3	70 - 130	≤ 30	Passed
1,2,3-Trimethylbenzene	0.00	0.00	0.00	0.00	10	0	0	0.000	###	30 - 160	≤ 31	#DIV/0!
2,2,4-Trimethylpentane	10.3	9.6	10.0	9.8	10	9.93	99	0.293	3	30 - 160	≤ 33	Passed
1,2-Dichloroethane-d4	10.0	9.95	10.1	9.97	10	10.0	100	0.0666	1	70 - 130	≤ 30	Passed
Toluene-d8	10.4	10.4	10.4	10.3	10	10.4	104	0.0500	0.5	70 - 130	≤ 30	Passed
4-Bromofluorobenzene	10.3	10.4	10.4	10.5	10	10.4	104	0.0816	1	70 - 130	≤ 30	Passed
Dibromofluoromethane	10.2	9.96	10.0	10.2	10	10.1	101	0.128	1	70 - 130	≤ 30	Passed

REFERENCE:

AF5-024, Page 47

Appendix 2: DEMONSTRATION OF CAPABILITY FOR 8015

DEMONSTRATION OF CAPABILITY

METHOD 5030/8015

Conc Unit: µg/L
Sample Amount(ml): 5

PARAMETER	EM04005A	EM04006A	EM04007A	EM04008A	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Acceptance Limits (% Rec)	RSD (%) Criteria	COMMENTS
	VG39M02L	VG39M02C	VG39M02X	VG39M02Y								
Gasoline(TOTAL)	473	498	483	519	500	493	99	20.3	4	70 - 130	≤ 30	Passed
GRO(C6-C10)	512	532	518	567	500	532	106	24.5	5	70 - 130	≤ 30	Passed
GRO(2MP-124TMB)	482	500	487	520	500	497	99	17.2	3	70 - 130	≤ 30	Passed
GRO(C5-C12)	486	511	497	531	500	506	101	19.2	4	70 - 130	≤ 30	Passed
Bromofluorobenzene	43.0	44.1	42.9	44.6	40	43.6	109	0.827	2	70 - 130	≤ 30	Passed
1,1,1-Trifluorotoluene	39.4	39.5	39.0	39.9	40	39.4	99	0.380	1	70 - 130	≤ 30	Passed

REFERENCE:

A39-076, Page 18

5030FAA: ANALYTICAL LOG FOR 8260

EMAX
LABORATORIES, INC.

Page 1

ANALYSIS LOG FOR VOLATILES

SOP ☐ EMAX-8260 Rev.No. __ ☐ EMAX-8260C Rev. No. __ ☐ EMAX-8260SIM Rev.No. __ ☐ EMAX-M8260SIM Rev.No. __ ☐ EMAX-TCPSIM Rev.No. __ ☐ EMAX-624 Rev.No. 5 ☐ EMAX-624.1 Rev.No. 0

Start Date: ☐ 5-mL Purge ☐ 10-mL Purge ☐ 25-mL Purge **Book #:** **AF5-XXX**

	Sample Prep ID	Data File Name	Lab Sample ID	Sample Amount	DF	Matrix			Notes
						W		S	
						pH <2	Cl_2 <5ppm		
BATCH	01								
	02								
	03								
	04								
	05								
	06								
	07								
	08								
	09								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								
	26								
	27								
	28								
	29								
	30								

		Instrument No.	**F5**
INITIAL CALIBRATION REFERENCE			
DATE			
ICAL ID			
STANDARDS			
NAME	ID	Amount (µl)	Conc. (mg/L)
DCC			
DCC			
DCC			
DCC			
BFB			
IS/SURR.			
ICV/LCS			
ICV/LCS			
ICV/LCS			
ICV/LCS			
Data File Folder			
	LOT #	Syringe Lot #	
pH strip			
Chlorine strip			
Methanol			
$NaHSO_4$			
Reagent Water			
Sand			
Electronic Data Archival Location		Date	
HPCHEM_VOA/TOF5			

Comments:

☐ Refer to sample weight log

Analyzed By:

Date Disposed: Disposed By:

TOC

5030FAB: ANALYTICAL RUN LOG FOR 8015

EMAX
LABORATORIES, INC.

ANALYSIS RUN LOG
for
PURGEABLE TPH

Page 1

Note: For samples and relevant QCs/Standards analyzed, refer to attached analytical sequence.

Comments:

Purge Volume = 5 ml

Soil Extract Amount Analyzed (1x) = 100 µL

Book #: A39-XXX

Instrument No.: 39

Analytical Sequence:

Method File:
☐
☐
☐

Analytical Batch:

SOP #	**Rev. #**
☐ EMAX-5030B	
☐ EMAX-8015G	
☐ EMAX-AK101	
☐ EMAX-	

STANDARDS ID	Amt Added (µL)	Conc. (mg/L)
ICAL		
ICV		
DCC GAS		
DCC		
BFB/TFT (Sample)		
Surrogate (DCC)		
LCS/LCSD		
MS/MSD		
GRO (HC-Chain)		

Solvent	**ID/Lot #**
Methanol	
Reagent Water	
	Lot #
pH strip	

SYRINGES
☐ 5 mL - MSF-02-01-19
☐ 5 mL - MSF-01-03-06
☐ 1 mL - MSF-01-02-11
☐ 1 mL - MSF-01-02-08
☐ 1 mL - MSF-01-01-20
☐ 500 µL - MSF-01-02-12
☐ 500 µL - MSF-01-03-13
☐ 250 µL - MSF-01-03-19
☐ 100 µL - MSF-02-01-10
☐ 100 µL - MSF-02-01-17
☐ 50 µL - MSF-01-01-17
☐ 25 µL - MSF-01-03-11
☐ 10 µL - MSF-02-01-07
☐ 10 µL - MSF-02-01-08
☐ 1 µL - MSF-01-03-12
☐ 0.5 µL - MSF-01-03-23
☐

ELECTRONIC DATA ARCHIVAL	
Location	Date
☐ EZC-3-BTEX	

Analyzed By:

Date:

PRINT DRF

SOP REVIEW FORM

PURGE & TRAP

SOP#: **EMAX-5030** **Rev** **5** **Effective Date:** **19-Jul-22**

COMMENTS	**Reviewed By**	**Review Date**
Reviewed.		7/27/23

TOC

STANDARD OPERATING PROCEDURES

CLOSED SYSTEM PURGE AND TRAP

SOP No.: EMAX-5035 Revision No. 5 Date: 19-Jul-22

Prepared By: Oanh Dinh Date: 07/19/22

Approved By: Farina Madamba, QA Manager Date: 7/19/22

Approved By: Caspar Pang, Laboratory Director Date: 7/19/22

Control Number: 5035-05-

1.0 SCOPE AND APPLICATION

1.1. This method describes a closed-system purge and trap process for the sample preparation and extraction for the analysis of volatile organics in a solid matrix. It applies to the gas chromatographic determination of volatile organics in sediment, soil, and waste. The low soil method (0.5 to 200 µg/kg) utilizes a hermetically-sealed sample vial, the seal of which is never broken from the time of sampling to the time of sample preservation.

1.2. Procedures are also included for preparing high concentration sample for purging by Method 5030B or 5030C.

1.3. This SOP is an adaptation of SW846 Methods 5035 and 5035A.

2.0 SUMMARY OF METHOD

2.1. **Low Concentration Soil Samples (0.5 - 200 µg/Kg)**

2.1.1. Samples collected in EnCore^{R} tube are preserved within 48 hours of sample collection by directly transferring its contents into a 40 mL vial containing sodium bisulfate as preservative, 5 mL of reagent water and a stir bar. Samples are extracted in a purge and trap closed system interfaced to a GC instrument equipped with a detector appropriate for the determinative method.

2.1.2. The purge and trap closed system is equipped with an autosampler. The vial containing the sample is simultaneously analyzed and heated. A duplicate sample is prepared in case re-analysis is needed.

2.2. High Concentration Soil Samples or Encore tube/Terra Core are extracted with 5 mL methanol in case sample dilution is necessary.

2.3. **Interferences**

2.3.1. Impurities in the purge gas and organic compounds in the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination by running method blanks. The use of non-polytetrafluoroethylene (non-PTFE) plastic coating, non-PTFE thread sealant, or flow controllers with rubber components in the purging device must be avoided. These compounds will result in interferences or false positives in the determinative step.

2.3.2. Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) during shipment or storage. A trip blank prepared from organic-free reagent water and carried through sampling and handling serves as a check on such contamination.

2.3.3. Contamination by carryover can occur whenever high-concentration and low-concentration samples are analyzed in sequence. Where practical, samples with unusually high concentrations of analytes should be followed by an analysis of organic-free reagent water to check for cross-contamination.

2.3.4. The volatile lab should be free of solvents and contamination. Special precautions must be taken to determine methylene chloride. The volatile area should be isolated from all atmospheric sources of methylene chloride, otherwise random background levels will result.

3.0 DETECTION LIMITS

3.1. Refer to applicable analytical SOP.

4.0 DYNAMIC RANGE

4.1. Refer to applicable analytical SOP.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. Holding Time

5.1.1. Analyze preserved samples within 14 days from sampling date.

5.1.2. Analyzed extracts within 14 days from extraction date.

5.2. Preservation

5.2.1. Samples received in glass jars or brass tubes must be stored at ≤ 6°C without freezing. Samples must be analyzed within 14 days from sampling date.

5.2.2. Samples received in encore tubes or terra core are frozen, preserved with sodium bisulfate or extracted with methanol prior to analysis.

- Frozen encore tubes/terra core must be analyzed within 14 days from sampling date.
- Samples preserved with sodium bisulfate within 48 hours from sampling date must be analyzed within 14 days from sampling date.
- Methanol extracts must be analyzed within 14 days from sampling date.
- Preserved samples and extracts must be stored at ≤ 6°C without freezing.

6.0 ASSOCIATED SOPs

6.1.	EMAX-8015G	Gasoline Range Organics
6.2.	EMAX-8260	Volatile Organics by GC/MS
6.3.	EMAX-8260C	Volatile Organics by GC/MS
6.4.	EMAX-8260SIM	Volatile Organics by GC/MS SIM
6.5.	EMAX-M8260SIM	1,4-Dioxane by GC/MS SIM
6.6.	EMAX-QA05	Training
6.7.	EMAX-QA08	Corrective Action
6.8.	EMAX-QC01	Quality Control for Chemicals

6.9.	EMAX-QC07	Labware Cleaning
6.10.	EMAX-SM03	Waste Disposal
6.11.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS of chemicals listed in this SOP.

7.2. Treat reagents, standards, and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, and gloves at all times when performing this procedure. Perform sample and standard handling in the fume hood.

7.3. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amounts of tap water. If irritations or any other discomfort related to the incident persists, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS AND REAGENTS

8.1. Instruments and Supplies

8.1.1. Purge and Trap Autosampler – Archon/Centurion or equivalent

8.1.2. Trap – VOCARB 4000 (Supelco) or equivalent

8.1.3. Syringe – 5 mL, gas-tight with Luerlok tip

8.1.4. Microsyringes – 1, 5, 10, 25, 50, 100 µL (Hamilton 702N or equivalent)

8.1.5. Sparging Vessel – 40 mL vials with screw cap and Teflon-lined septum

8.1.6. Stir bars – Teflon- lined

8.1.7. Archon Soil Method Program (If applicable to the method) – Internal Standard solution is added automatically by the instrument to the initial calibration standards containing all analytes of interest and surrogates, in the same fashion as used for the samples.

8.2. Chemicals and Reagents

8.2.1. Reagent Water – Organic-free water, generated from active charcoal column

8.2.2. Reagent Soil – Silica sand baked at 200°C overnight

8.2.3. Preservative – Sodium Bisulfate, reagent-grade

8.2.4. Extraction Solvent – Methanol, ultrapure

9.0 STANDARDS

9.1. Preparation of standards is outlined in Sec. 9.0 of applicable analytical SOP.

9.2. Spiking Standard Solution

9.2.1. Refer to applicable analytical SOP.

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Decontamination of Re-usable Lab wares

10.1.1.1. Stir bars – Wash recycled stir bars with tap water until no solids are visible. Rinse with methanol and final rinse with copious amount of reagent water. Bake for a minimum of 2 hours at 120°C and allow cooling before re-use.

10.1.2. Purifying Reagent Soil

10.1.2.1. Fill a clean 1 L wide mouth glass jar with silica sand. Label the jar with the silica sand lot number for traceability purposes and bake it at 200°C overnight.

10.1.2.2. Analyze a 5 g sample to verify that the reagent soil is organic free.

10.1.2.3. Sample result must be ≤ ½ LOQ for all target analytes, otherwise, the lot will be discarded.

10.1.2.4. Submit result to the QA Department.

10.1.3. Low Level Sample

10.1.3.1. Weigh 1 - 5 g of sample (depending on determinative method requirement) into a 40 mL vial. Note and record the actual weight to the nearest 0.1 g.

10.1.3.2. Add 5 mL organic free water using verified volumetric dispenser.[1]

10.1.4. High Level Sample

10.1.4.1. Weigh 1 - 5 g of sample (depending on determinative method requirement) into a 40 mL vial. Note and record the actual weight to the nearest 0.1 g. Add 5 mL methanol using volumetric dispenser and mix thoroughly for 5 minutes. Allow the mixture to stand so that the sediment can settle.

10.1.4.2. Prepare 5 mL of organic free water solution. Withdraw up to 100 µL of methanol extract using an appropriate microsyringe.

10.1.4.3. Add the methanol extract to the 5 mL syringe through the Luerlok tip and pull the plunger slowly to make room for the extract. Take care not to introduce any air into the syringe.

10.1.5. EnCore

10.1.5.1. **Low Level Sample Preservation (< 200 µg/Kg)**

10.1.5.1.1. Remove EnCore tubes from freezer and let them warm up to room temperature. Line them up chronologically according to the sample IDs.

10.1.5.1.2. Label the vials and line them up in the same order as the EnCore tubes. Prepare at least one extra vial for preparation blank.

10.1.5.1.3. Add 1 g of sodium bisulfate, 5 mL of organics free water and a clean stirring bar to each of the vials. Re-cap the vial and gently mix the content.

10.1.5.1.4. List the samples into the preparation log in the same order as the samples are lined up.

---

[1] Volumetric dispenser is verified prior to use, using Class "A" volumetric flask noted in preparation log.

10.1.5.1.5. Weigh the first vial and record the weight to the nearest 0.01 g as W_1. Open the EnCore Tube envelope corresponding to the first vial and take out one tub and re-seal the envelope.

10.1.5.1.6. Using the EnCore tube sample extruder, remove the tube seal and quickly extrude the entire content of the EnCore tube into the vial and seal the vial with the screw cap. Record the weight to the nearest 0.01 g as W_2.

Note: Due to the nature of volatile compounds, minimum sample exposure must be observed during the sample transfer from the EnCore tube to the vial.

10.1.5.1.7. Repeat the same procedure for the rest of the samples.

10.1.5.1.8. Duplicate the entire process suffixing the sample IDs with "R" to be used in case re-analysis is needed.

10.1.5.1.9. Extract another set of samples as described in Sec. 10.1.4 in case sample concentration(s) is > 200 µg/kg. Prepare another preparation blank for each preparation batch.

10.1.5.2. **Medium Level Samples (> 200 µg/Kg)**

10.1.5.2.1. Remove EnCore tubes from sample storage and let them warm up to room temperature. Line them up chronologically according to the sample IDs.

10.1.5.2.2. Label the vials and line up in the same order as the EnCore tubes. Prepare one extra vial for the extraction blank.

10.1.5.2.3. Add 5 mL of methanol containing 2.5 µg/mL of surrogate. Re-cap each vial after methanol addition.

10.1.5.2.4. List the samples into the extraction log in the same order as the samples are lined up.

10.1.5.2.5. Weigh the first vial and record the weight to the nearest 0.01 g as W_1. Open the EnCore Tube envelope correponding to the first vial, and take out one tube.

10.1.5.2.6. Using the EnCore tube sample extruder, remove the tube seal and quickly extrude the entire content of the EnCore tube into the vial and seal the vial. Record the weight to the nearest 0.01 g as W_2.Use 5 g of reagent soil for the extraction blank.

Note: Due to the nature of volatile compounds, minimum sample exposure must be observed during the sample transfer from the EnCore tube to the vial.

10.1.5.2.7. Repeat the same procedure for the rest of the samples.

10.1.5.2.8. Store extracts at ≤ 6°C without freezing.

10.1.6. Terra Core

10.1.6.1. Weigh each sample as received. Record the initial weight as indicated in each sample label.

10.1.6.2. Samples are expected to be in either reagent water preserved with or without sodium bisulfate or Methanol.

10.2. Instrument Parameters

10.2.1. Refer to applicable analytical SOP.

10.3. Calibration

10.3.1. Refer to applicable analytical SOP.

10.4. Analysis

10.4.1. Refer to applicable analytical SOP.

10.5. Calculations

10.5.1. Refer to applicable analytical SOP.

10.6. Data Reduction

10.6.1. Refer to applicable analytical SOP.

10.7. Report Generation

10.7.1. Refer to applicable analytical SOP.

10.8. Data Review

10.8.1. Refer to applicable analytical SOP.

10.9. Preventive Maintenance

10.9.1. Refer to applicable analytical SOP.

11.0 QUALITY CONTROL

11.1. The sequence of runs and quality control acceptance criteria are specified in the individual analytical SOP. They include method blank, calibrations, lab control sample, and matrix spike/matrix spike duplicate.

11.2. Properly treat all lab wares used in the sample preparation as specified in EMAX-QC07.

11.3. Reagents and standards must undergo quality control check prior to use. Refer to EMAX-QC01 for details.

11.4. Balance must be verified daily before use as described in EMAX-QC04.

11.5. Syringes must be purchased with a certificate of bias and precision. Discard the syringe when deterioration is observed.

11.6. All analysts conducting this method must demonstrate capability (IDOC/DOC) as described in EMAX-QA05.

12.0 CORRECTIVE ACTIONS

12.1. Refer to applicable analytical SOP.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to wastewater drains.

13.2. Handle solvents and extracts and preparation of standards under the fume hood.

13.3. Keep extraction area clean to prevent contamination of sample.

14.0 WASTE MANAGEMENT

14.1. No sample may be dumped on the laboratory sink.

14.2. Separate and properly identify all unused expired standards for proper disposal.

14.3. Place all wastes generated during the process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired standards and other waste generated during the process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. When the low concentration samples are strongly alkaline or highly calcareous in nature, the sodium bisulfate solution may not be strong enough to reduce the pH of the sample to below 2. Additional steps may be required to preserve the samples. Such steps include: addition of large amount of sodium bisulfate solution, storage of the samples at -10°C, or significantly reducing the maximum holding time for low concentration samples. Whichever steps are employed, they should be clearly described in the case narrative.

15.2. Soil samples that contain carbonate minerals may effervescence upon contact with the acidic preservative solution in low concentration sampling vial. Therefore, when samples are known or suspected to contain high levels of carbonate, sodium bisulfate should be replaced with organic free reagent water and samples should be analyzed within 48 hours of sampling.

15.3. **Definition of Terms**

15.3.1. Analyte – the specific chemicals or components for which a sample is analyzed; may be a group pf chemicals that belongs to the same chemical family, and which are analyzed together.

15.3.2. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.3.2.1. **Preparation batch** – is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.3.2.2. **Analytical batch** – is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices; preparation batches, and can exceed 20 samples.

15.3.3. Safety Data Sheet (SDS) – is written information concerning a chemical physical properties, toxicity, health hazards, fire hazard and reactivity data including storage, spill and handling pre-cautions.

15.3.4. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.3.5. Calibration Blank – is a target-analyte-free solvent subjected to the entire analytical process to establish zero baseline or background value.

15.3.6. Calibration Check Compounds (CCC) – evaluate the integrity of the system. Variability of these compounds may indicate system leak or reactive sites in the column.

15.3.7. Instrument Method – is a file generated to contain the instrument calibration and instrument parameter settings for a particular analysis.

15.3.8. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical monitor contamination.

15.3.9. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.3.10. Lab Control Sample Duplicate (LCSD) – is a replicate of LCS analyzed to monitor precision in the absence of MS/MSD sample.

15.3.11. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.3.12. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.3.13. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.3.14. Matrix – is a component or form of a sample.

15.3.15. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method's recovery efficiency.

15.3.16. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.3.17. Response Factor – is the ratio of the peak area of the target compound in the sample or sample extract.

15.3.18. Surrogate – are compounds added to every blank, sample, matrix spike duplicate and standard; used to evaluate analytical efficiency by measuring recovery. Compounds not expected to be detected in environmental media.

15.3.19. System Performance Check Compounds (SPCC) – are compounds that are used to check compounds stability and to check for degradation caused by contaminated lines or active sites in the system.

15.3.20. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.3.21. Reagent Soil – organic-free Ottawa sand or equivalent.

15.4. Application of EMAX QC Procedures

15.4.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing purgeable volatile analyses. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.5. Department of Defense (DoD) and Department of Energy (DoE) Projects

15.5.1. Samples from DoD and DoE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client’s quality control directive. In the absence of QAPP, the DoD Quality System Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. “Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples”, USEPA SW-846 Method 5035, Rev. 0, December 1996 and Method 5035A, Rev. 1, July 2002..

16.2. EMAX Quality Systems Manual, as updated

17.0 APPENDICES

17.1. Appendices

17.1.1.	Appendix 1	Demonstration of Capability for 8260
17.1.2.	Appendix 2	Demonstration of Capability for 8015G

17.2. Forms

17.2.1.	5035FSA1	Sample Preparation Log for 8260
17.2.2.	5035FSA2	Extraction Log for 8260
17.2.3.	5030FSB1	Sample Preparation Log for 8015
17.2.4.	5030FSB2	Sample Preservation Log for 8015

TOC

Appendix 1: DEMONSTRATION OF CAPABILITY FOR 8260

DEMONSTRATION OF CAPABILITY

METHOD 5035/8260

Unit: µg/Kg
Sample Amount(g): 5
Sample Purge(ml): 5

PARAMETER	RAN020	RAN021	RAN022	RAN023	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	Accuracy Acceptance Limits (% Rec)	RSD (%) Criteria	Comments
	VSF4A03L	VSF4A03C	VSF4A04L	VSF4A04C								
Acetone	230	260	234	245	250	242	97	13.4	6	60 - 130	≤ 30	Passed
Acetonitrile	489	505	461	486	500	485	97	18.2	4	60 - 160	≤ 30	Passed
Acrolein	244	271	244	261	250	255	102	13.3	5	60 - 140	≤ 30	Passed
Acrylonitrile	240	267	245	256	250	252	101	12.0	5	70 - 130	≤ 30	Passed
Benzene	51.0	50.0	49.5	50.6	50	50.3	101	0.660	1	70 - 130	≤ 30	Passed
Bromobenzene	52.2	51.8	48.9	51.2	50	51.0	102	1.48	3	70 - 130	≤ 30	Passed
Bromochloromethane	51.4	50.7	49.3	51.4	50	50.7	101	0.990	2	70 - 130	≤ 30	Passed
Bromodichloromethane	50.3	51.2	50.4	50.5	50	50.6	101	0.408	1	70 - 130	≤ 30	Passed
Bromoform	53.6	53.4	50.1	53.2	50	52.6	105	1.66	3	70 - 130	≤ 30	Passed
Bromomethane	47.2	45.1	41.1	47.1	50	45.1	90	2.85	6	70 - 130	≤ 30	Passed
tert-Butyl alcohol	510	559	492	518	500	520	104	28.3	5	60 - 140	≤ 30	Passed
2-Butanone (MEK)	251	292	253	270	250	267	107	19.0	7	70 - 130	≤ 30	Passed
n-Butylbenzene	53.0	53.6	50.1	52.0	50	52.2	104	1.53	3	70 - 130	≤ 30	Passed
sec-Butylbenzene	52.6	53.0	49.1	51.4	50	51.5	103	1.75	3	70 - 130	≤ 30	Passed
tert-Butylbenzene	52.7	53.5	49.1	51.4	50	51.7	103	1.92	4	70 - 130	≤ 30	Passed
Carbon disulfide	49.7	50.2	47.2	44.5	50	47.9	96	2.62	5	70 - 130	≤ 30	Passed
Carbon tetrachloride	49.9	50.4	48.5	49.6	50	49.6	99	0.804	2	70 - 130	≤ 30	Passed
Chlorobenzene	51.3	50.7	48.5	50.4	50	50.2	100	1.21	2	70 - 130	≤ 30	Passed
2-Chloroethyl vinyl ether	55.3	57.7	58.1	57.2	50	57.1	114	1.24	2	70 - 130	≤ 30	Passed
Chloroethane	46.7	44.4	39.7	46.9	50	44.4	89	3.35	8	70 - 130	≤ 30	Passed
Chloroform	48.9	48.6	47.9	49.1	50	48.6	97	0.525	1	70 - 130	≤ 30	Passed
1-Chlorohexane	54.3	53.3	51.3	52.8	50	52.9	106	1.25	2	30 - 160	≤ 30	Passed
Chloromethane	44.4	43.1	38.8	44.9	50	42.8	86	2.77	6	60 - 130	≤ 30	Passed
2-Chlorotoluene	52.1	52.4	49.2	51.2	50	51.2	102	1.44	3	70 - 130	≤ 30	Passed
4-Chlorotoluene	52.7	52.8	49.0	51.4	50	51.5	103	1.77	3	70 - 130	≤ 30	Passed
Dibromochloromethane	51.8	48.9	49.5	51.4	50	50.4	101	1.42	3	70 - 130	≤ 30	Passed
1,2-Dibromo-3-chloropropane	54.3	58.3	51.0	54.2	50	54.5	109	2.99	5	70 - 130	≤ 30	Passed
1,2-Dibromoethane	52.3	49.7	49.4	52.0	50	50.9	102	1.51	3	70 - 130	≤ 30	Passed
Dibromomethane	51.1	51.3	50.8	51.0	50	51.1	102	0.208	0.4	70 - 130	≤ 30	Passed
1,1-Dichloroethane	50.0	49.3	48.2	49.7	50	49.3	99	0.787	2	70 - 130	≤ 30	Passed
1,2-Dichloroethane	49.7	48.4	48.5	50.0	50	49.2	98	0.819	2	70 - 130	≤ 30	Passed
1,2-Dichlorobenzene	51.3	50.7	48.8	50.8	50	50.4	101	1.10	2	70 - 130	≤ 30	Passed
1,3-Dichlorobenzene	51.8	51.6	48.6	50.9	50	50.7	101	1.47	3	70 - 130	≤ 30	Passed
trans-1,4-Dichloro-2-Butene	53.5	55.4	49.8	52.6	50	52.8	106	2.33	4	70 - 140	≤ 30	Passed
1,4-Dichlorobenzene	52.0	52.2	48.8	51.0	50	51.0	102	1.56	3	70 - 130	≤ 30	Passed
Dichlorodifluoromethane	45.0	43.4	38.6	45.5	50	43.1	86	3.15	7	60 - 130	≤ 30	Passed
1,1-Dichloroethene	49.6	49.7	48.0	49.7	50	49.3	99	0.835	2	60 - 130	≤ 30	Passed
cis-1,2-Dichloroethene	51.2	52.2	48.9	50.9	50	50.8	102	1.38	3	70 - 130	≤ 30	Passed
trans-1,2-Dichloroethene	50.9	49.9	48.5	50.3	50	49.9	100	1.02	2	70 - 130	≤ 30	Passed
Dichlorofluoromethane	49.3	48.6	47.2	48.8	50	48.5	97	0.900	2	30 - 160	≤ 30	Passed
1,1-Dichloropropene	52.1	53.1	50.3	51.8	50	51.8	104	1.16	2	70 - 130	≤ 30	Passed
1,2-Dichloropropane	51.5	52.3	52.3	51.2	50	51.8	104	0.562	1	70 - 130	≤ 30	Passed
1,3-Dichloropropane	51.9	49.9	49.0	50.6	50	50.4	101	1.22	2	70 - 130	≤ 30	Passed
2,2-Dichloropropane	49.9	51.9	48.1	50.0	50	50.0	100	1.55	3	60 - 140	≤ 30	Passed
cis-1,3-Dichloropropene	52.4	52.9	53.4	51.8	50	52.6	105	0.685	1	70 - 130	≤ 30	Passed
trans-1,3-Dichloropropene	53.1	52.1	52.2	52.3	50	52.4	105	0.457	1	70 - 130	≤ 30	Passed
tert-Butyl ethyl ether (ETB	50.6	49.4	49.2	50.5	50	49.9	100	0.727	1	70 - 130	≤ 30	Passed

Appendix 1 (Cont.): DEMONSTRATION OF CAPABILITY FOR 8260

DEMONSTRATION OF CAPABILITY

METHOD 5035/8260

PARAMETER	RAN020	RAN021	RAN022	RAN023	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	Accuracy Acceptance Limits (% Rec)	RSD (%) Criteria	Comments
	VSF4A03L	VSF4A03C	VSF4A04L	VSF4A04C								
Ethylbenzene	51.1	50.8	47.8	50.5	50	50.1	100	1.52	3	70 - 130	≤ 30	Passed
2-Hexanone (MBK)	250	282	263	265	250	265	106	13.1	5	70 - 130	≤ 30	Passed
Hexachlorobutadiene	51.0	52.6	48.9	50.6	50	50.8	102	1.52	3	70 - 140	≤ 30	Passed
Iodomethane	58.0	56.5	55.1	57.7	50	56.8	114	1.32	2	70 - 140	≤ 30	Passed
Isopropyl ether (DIPE)	50.8	48.8	48.9	50.6	50	49.8	100	1.07	2	70 - 130	≤ 30	Passed
Isopropylbenzene	52.1	50.6	48.6	51.5	50	50.7	101	1.53	3	70 - 130	≤ 30	Passed
p-Isopropyltoluene	53.1	53.6	49.7	52.1	50	52.1	104	1.73	3	70 - 130	≤ 30	Passed
Methyl acetate	45.4	49.4	43.1	49.6	50	46.9	94	3.17	7	60 - 140	≤ 30	Passed
Methylene Chloride	49.2	47.7	47.3	48.9	50	48.3	97	0.918	2	70 - 130	≤ 30	Passed
4-Methyl-2-pentanone (MIBK)	245	282	265	264	250	264	106	15.1	6	70 - 130	≤ 30	Passed
tert-Butyl methyl ether	51.8	49.7	50.2	52.1	50	51.0	102	1.18	2	70 - 130	≤ 30	Passed
Naphthalene	48.6	48.8	45.9	48.6	50	48.0	96	1.39	3	70 - 130	≤ 30	Passed
n-Propylbenzene	53.7	54.1	50.2	52.4	50	52.6	105	1.76	3	70 - 130	≤ 30	Passed
Styrene	52.1	49.4	49.5	51.1	50	50.5	101	1.31	3	70 - 130	≤ 30	Passed
tert-Amyl methyl ether (TAME)	53.2	51.3	52.0	53.1	50	52.4	105	0.913	2	70 - 130	≤ 30	Passed
1,1,1,2-Tetrachloroethane	51.1	50.1	48.5	50.6	50	50.1	100	1.13	2	70 - 130	≤ 30	Passed
1,1,2,2-Tetrachloroethane	52.0	52.4	47.8	51.3	50	50.9	102	2.10	4	70 - 130	≤ 30	Passed
Tetrachloroethene	51.1	49.3	48.4	49.6	50	49.6	99	1.12	2	70 - 130	≤ 30	Passed
Toluene	51.9	53.2	51.7	50.8	50	51.9	104	0.990	2	70 - 130	≤ 30	Passed
1,1,1-Trichloroethane	49.4	51.0	48.4	49.4	50	49.6	99	1.08	2	70 - 130	≤ 30	Passed
1,1,2-Trichloroethane	51.0	49.8	50.6	51.0	50	50.6	101	0.566	1	70 - 130	≤ 30	Passed
1,2,3-Trichlorobenzene	53.2	52.6	50.3	52.6	50	52.2	104	1.28	2	70 - 130	≤ 30	Passed
1,2,4-Trichlorobenzene	54.1	53.1	50.4	53.6	50	52.8	106	1.65	3	70 - 130	≤ 30	Passed
Trichloroethene	50.3	50.4	50.9	50.1	50	50.4	101	0.340	1	70 - 130	≤ 30	Passed
Trichlorofluoromethane	44.6	43.8	38.6	45.8	50	43.2	86	3.17	7	70 - 140	≤ 30	Passed
1,2,3-Trichloropropane	52.1	53.4	49.4	52.5	50	51.9	104	1.72	3	70 - 130	≤ 30	Passed
1,1,2-Trichloro1,2,2-trifluoroethane	50.1	50.0	48.2	50.3	50	49.7	99	0.975	2	70 - 130	≤ 30	Passed
1,2,4-Trimethylbenzene	52.8	53.1	49.4	51.9	50	51.8	104	1.68	3	70 - 130	≤ 30	Passed
1,3,5-Trimethylbenzene	54.0	54.7	50.4	52.4	50	52.9	106	1.91	4	70 - 130	≤ 30	Passed
Vinyl Acetate	47.1	43.9	38.7	47.3	50	44.3	89	4.01	9	60 - 140	≤ 30	Passed
Vinyl Chloride	46.2	45.5	40.3	47.2	50	44.8	90	3.08	7	70 - 130	≤ 30	Passed
m-Xylene & p-xylene	103	100	97.0	101	100	100.2	100	2.52	3	70 - 130	≤ 30	Passed
o-Xylene	52.0	49.8	50.0	50.9	50	50.7	101	1.00	2	70 - 130	≤ 30	Passed
1,4-Dioxane	1100	1210	1110	1080	1000	1125	113	58.0	5	60 - 150	≤ 30	Passed
2-Butanol	494	567	466	539	500	517	103	45.1	9	70 - 140	≤ 30	Passed
Cyclohexane	48.5	54.1	48.1	52.3	50	50.8	102	2.93	6	60 - 140	≤ 30	Passed
Methylcyclohexane	47.9	52.5	49.8	51.1	50	50.3	101	1.96	4	60 - 150	≤ 30	Passed
Tetrahydrofuran	52.2	56.3	50.2	52.5	50	52.8	106	2.55	5	30 - 160	≤ 30	Passed
1,2-Dichloroethane-d4	42.8	48.0	46.0	50.8	50	46.9	94	3.37	7	70 - 130	≤ 30	Passed
Toluene-d8	45.4	53.3	48.8	52.9	50	50.1	100	3.74	7	70 - 130	≤ 30	Passed
4-Bromofluorobenzene	44.8	53.0	45.7	52.4	50	49.0	98	4.32	9	70 - 130	≤ 30	Passed
Dibromofluoromethane	44.8	50.8	46.5	52.7	50	48.7	97	3.67	8	70 - 130	≤ 30	Passed
Allyl Chloride	51.7	51.3	50.4	52.0	50	51.4	103	0.695	1	70 - 130	≤ 30	Passed
Isobutyl Alcohol	1080	1190	1040	1100	1000	1103	110	63.4	6	60 - 140	≤ 30	Passed
Propionitrile	518	564	493	522	500	524	105	29.4	6	70 - 130	≤ 30	Passed

REFERENCE:

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Appendix 2: DEMONSTRATION OF CAPABILITY FOR 8015G

DEMONSTRATION OF CAPABILITY

METHOD 5035/8015

Conc Unit: µg/Kg
Sample Amount(g): 5

PARAMETER	EM04015A	EM04016A	EM04017A	EM04018A	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Acceptance Limits (% Rec)	RSD (%) Criteria	COMMENTS
	GMM002SL	GMM002SC	GMM002SX	GMM002SY								
Gasoline(TOTAL)	23701	22866	24241	23585	25000	23600	94	566	2	70 - 130	≤ 50	Passed
GRO(C6-C10)	25328	24349	25740	25129	25000	25100	100	584	2	70 - 130	≤ 50	Passed
GRO(2MP-124TMB)	23372	22474	23751	23190	25000	23200	93	535	2	70 - 130	≤ 50	Passed
GRO(C5-C12)	24306	23410	24860	24154	25000	24200	97	598	2	70 - 130	≤ 50	Passed
Bromofluorobenzene	2232	2146	2251	2215	2000	2210	111	45.7	2	70 - 130	≤ 50	Passed
1,1,1-Trifluorotoluene	1873	1829	1907	1867	2000	1870	94	31.9	2	70 - 130	≤ 50	Passed

REFERENCE:

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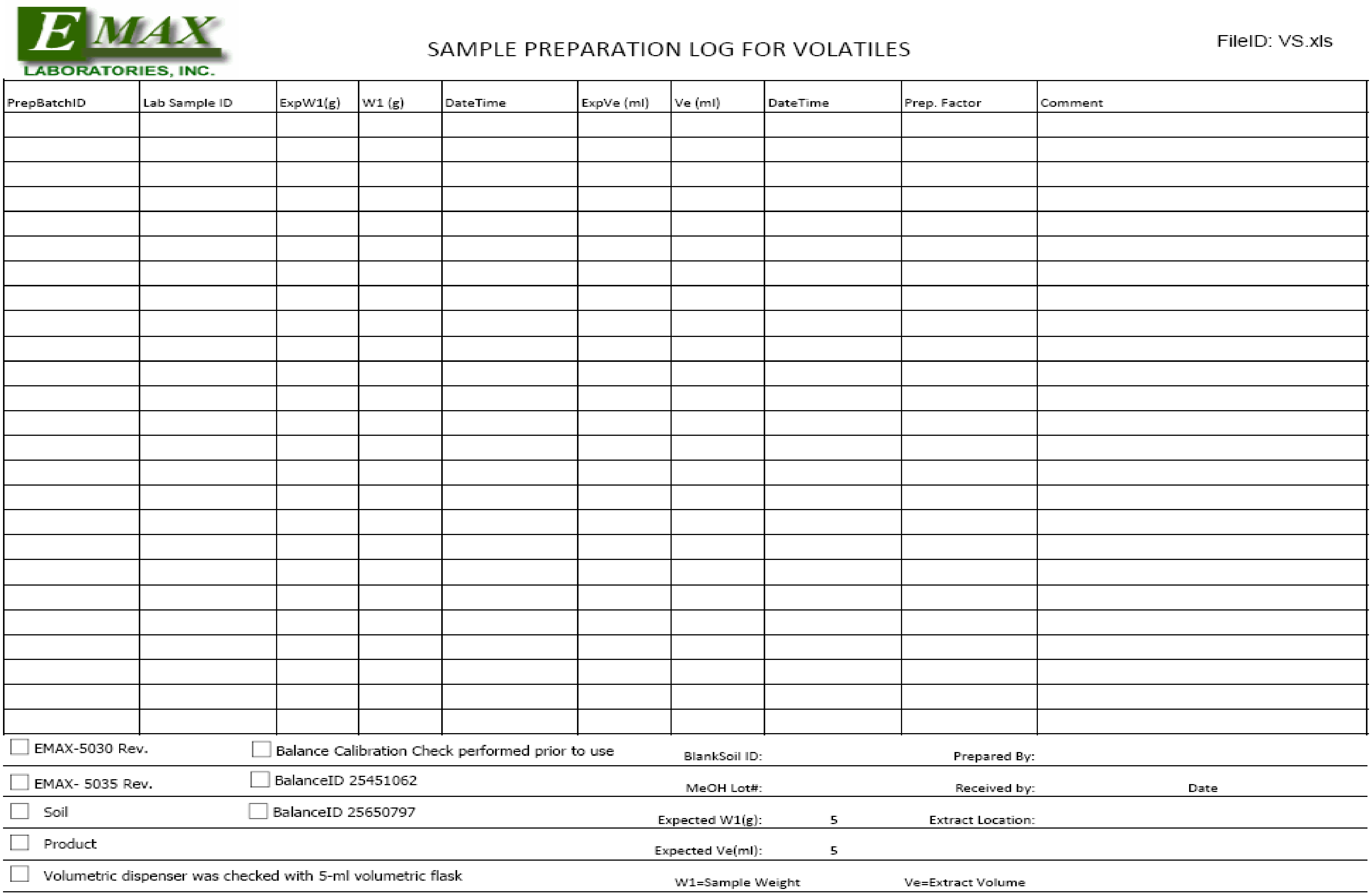
5035FSA1: SAMPLE PREPARATION LOG FOR 8260



EMAX LABORATORIES, INC.

SAMPLE PREPARATION LOG FOR VOLATILES

FileID: VS.xls

PrepBatchID	Lab Sample ID	ExpW1(g)	W1 (g)	DateTime	ExpVe (ml)	Ve (ml)	DateTime	Prep. Factor	Comment

☐ EMAX-5030 Rev. ☐ Balance Calibration Check performed prior to use BlankSoil ID: Prepared By:

☐ EMAX- 5035 Rev. ☐ BalanceID 25451062 MeOH Lot#: Received by: Date

☐ Soil ☐ BalanceID 25650797 Expected W1(g): 5 Extract Location:

☐ Product Expected Ve(ml): 5

☐ Volumetric dispenser was checked with 5-ml volumetric flask W1=Sample Weight Ve=Extract Volume

5035FSA2: EXTRACTION LOG FOR 8260

EMAX LABORATORIES, INC.

EXTRACTION LOG FOR VOLATILES

FileID: VM.xls

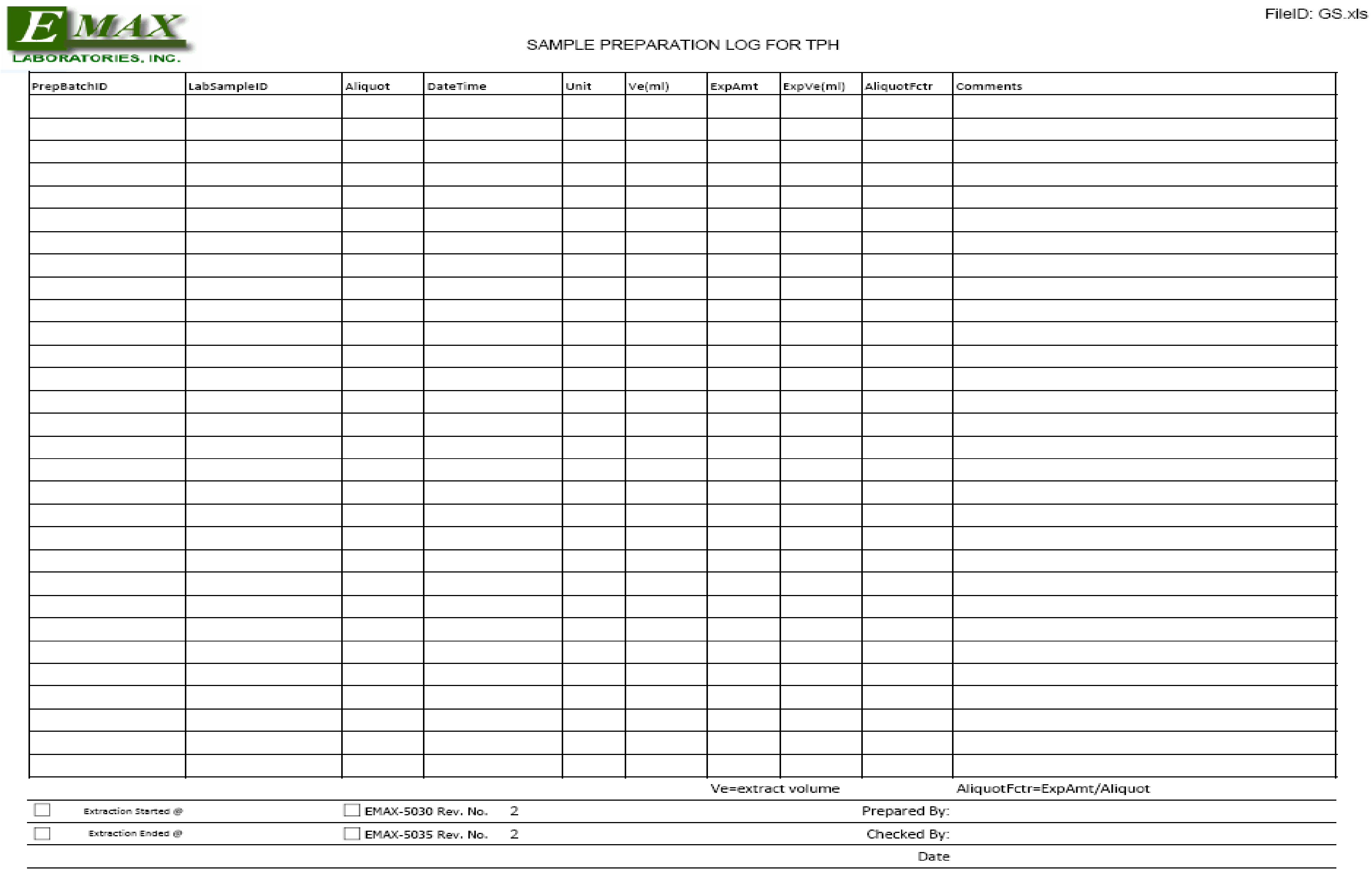
PrepBathID	Lab Sample ID	W1 (g)	DateTime	Wf (g)	DateTime	ExpWs(g)	Ws(g)	%Moisture	CorrExt Vol(ml)	Prep□Factor	PFx50 df(T)	df(I)	df(J)	Comments

☐ EMAX-5035 Rev.	☐ Balance Calibration Check performed prior to use	BlankSoil Lot#:	Prepared By:
☐ Encore	☐ Balance ID 25650797	MeOH/Surr. ID:	Standard Added By:
☐ Frozen Sample	☐ Balance ID 25451062	Weight MeOH(g):	Witnessed By:
☐ Pre-weighed vial		Vol MeOH(ml):	Extract Rcvd By:
☐ Volumetric dispenser was checked with 5-ml volumetric flask		Expected Ws(g)	Extract Location:

W1=Weight of Vial+Solvent Wf=W1 + Sample

TOC

5035FSB1: SAMPLE PREPARATION LOG FOR 8015



EMAX LABORATORIES, INC.

FileID: GS.xls

SAMPLE PREPARATION LOG FOR TPH

PrepBatchID	LabSampleID	Aliquot	DateTime	Unit	Ve(ml)	ExpAmt	ExpVe(ml)	AliquotFctr	Comments

Ve=extract volume

AliquotFctr=ExpAmt/Aliquot

☐ Extraction Started @

☐ EMAX-5030 Rev. No. 2

Prepared By:

☐ Extraction Ended @

☐ EMAX-5035 Rev. No. 2

Checked By:

Date

TOC

5035FSB2: SAMPLE PRESERVATION LOG FOR 8015

EMAX
LABORATORIES, INC.

FileID: GM.xls

PRESERVATION LOG FOR TPH

PrepBatch ID	LabSampleID	Wi(g)	DateTime	Wf(g)	DateTime	Aliquot	Unit	Ve(ml)	%Moist	Vec(ml)	ExpAmt	ExpVe(ml)	AliquotFctr	Comments

Ve=extract volume
AliquotFctr=ExpAmt/Aliquot

☐ Extraction Started @ Weight MeOH(g): ☐ EMAX-5035 Rev. No. 2 Prepared By:
☐ Extraction Ended @ Vol MeOH(ml): ☐ Volumetric dispenser was checked with 5 mL Volumetric Flask Checked By:
Comments: Date

PRINT DRF

SOP REVIEW FORM

CLOSED SYSTEM PURGE & TRAP

SOP#: EMAX-5035 **Rev** 5 **Effective Date:** 19-Jul-22

COMMENTS	**Reviewed By**	**Review Date**
Reviewed. No technical update necessary.		7/21/23

TOC QCP
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ADD
ADD 2

STANDARD OPERATING PROCEDURES

VOLATILE ORGANICS BY GC/MS

SOP No.: EMAX-8260 Revision No. 10 Effective Date: 06-Jun-14

Prepared By: Souzan Greas Souzan Greas Date: 06-04-14

Approved By: Kenette Pimentel Date: 06.04.14
QA Manager

Approved By: Caspar Pang Date: 06-04-14
Laboratory Director

Control Number: 8260-10-

1.0 SCOPE AND APPLICATION

1.1. This analytical method is used to determine the concentration of volatile organic compounds whose boiling points are below 200°C and are water insoluble or slightly water-soluble found in solid or liquid samples. The list of compounds is summarized in Tables 6 and 7. Additional analytes may be added after verification.

1.2. This SOP is an adaptation of SW846 Method 8260B.

2.0 SUMMARY OF METHOD

2.1. A measured sample is extracted using a purge and trap concentrator system. The extract is introduced to a temperature-programmed GC. The analytes are eluted through the GC column separating each analyte relative to its volatility. These analytes are captured and ionized by the mass spectrometer. The ionized fragments are measured by mass to charge ratio. Analyte qualitative identification is based on the characteristic electron impact mass spectra. Analyte quantitative identification is based on the response of the major ion relative to an internal standard using a multi-point calibration curve.

2.2. Interferences

2.2.1. Contamination may occur by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through sample container septum during shipment and storage. Trip blanks and storage blanks can serve as means of monitoring.

2.2.2. Glassware and other sample processing materials in which the samples come into contact with are possible sources of contamination. All glassware and other materials used must be purchased pre-cleaned or decontaminated prior to use.

2.2.3. Solvents and reagents are possible sources of contamination. All solvents and reagents must be GC grade and must pass the QC checks prior to use.

2.2.4. Contamination by carry-over can occur whenever high concentration samples are analyzed in sequence with a low concentration sample. To reduce potential carry-over, the concentrator must be thoroughly baked-out between samples and the sample syringe and purging device must be thoroughly rinsed with an appropriate solvent between samples.

2.2.5. Another possible source of contamination is the analytical instrument itself. This can be monitored by analyzing an instrument blank prior to any analysis.

3.0 DETECTION LIMITS

3.1. Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

3.1.1. Refer to EMAX-QA04 for generation, validation and verification for DL, LOD and LOQ.

3.1.2. Refer to Table 6 and Table 7 for established DL, LOD and LOQ levels.

4.0 DYNAMIC RANGE

4.1. The highest quantifiable concentration requiring no dilution is equal to the highest calibration point (see Sec. 9.4). All samples analyzed above this concentration are considered "over-range" and requires dilution to properly quantitate.

4.2. The concentration in the diluted sample should be at or above the project reporting limit. All diluted samples analyzed below this concentration are considered "under-range". A lower dilution factor is required to properly quantitate.

4.3. **Typical Dynamic Range**

4.3.1. Water: 5 µg/L to 200 µg/L (5 ml purge)

1 µg/L to 40 µg/L (25 ml purge)

4.3.2. Soil: 5 µg/kg to 200 µg/kg

5.0 SAMPLE HOLDING TIME & PRESERVATION

5.1. **Aqueous Samples**

5.1.1. Samples received in the laboratory are expected to be contained in 40 ml vials with teflon lined septa with zero headspace.

Note: The size of any bubble caused by degassing upon cooling the sample must not exceed 6 mm.[1]

5.1.2. Samples must be stored at ≤ 6°C without freezing.

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5.1.3. Samples preserved in HCL must be analyzed within 14 days from the date of sampling. Samples with no chemical preservative must be analyzed within 7 days from the date of sampling.

5.1.4. If Acrolein and Acrylonitrile are target analytes, samples must be analyzed within 14 days if preserved with $Na_2S_2O_3$ to pH 4-5. Samples received unpreserved must be analyzed with 3 days from sampling date[2].

5.2. **Soil Samples**

5.2.1. Samples received in glass jars or brass tubes must be stored at ≤ 6°C without freezing. Samples for low level and extracted in methanol for high level must be analyzed within 14 days from sampling date.

5.2.2. Samples received in encore tubes may be frozen, preserved with sodium bisulfate or extracted with methanol prior to analysis.

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[1] Referenced from SW846 Method 5030B, Section 6.1.

[2] Reference: 40CFR Table 11 Footnote 10

- Encore samples to be frozen must be analyzed within 14 days from sampling date.
- Encore samples to be preserved with sodium bisulfate for low level and extracted with methanol for high level must be done within 48 hours and analyzed within 14 days from sampling date.
- Preserved samples and extracts must be stored at ≤ 6°C without freezing.

6.0 ASSOCIATED SOPs

6.1.	EMAX-5030	Purge and Trap
6.2.	EMAX-5035	Closed-System Purge and Trap
6.3.	EMAX-DM01	Data Flow and Review
6.4.	EMAX-QA04	Detection Limit (DL)
6.5.	EMAX-QA05	Training
6.6.	EMAX-QA08	Corrective Action
6.7.	EMAX-QC01	Quality Control for Chemicals
6.8.	EMAX-QC02	Analytical Standard Preparation
6.9.	EMAX-QC07	Glassware Cleaning
6.10.	EMAX-SM01	Sample Management
6.11.	EMAX-SM03	Waste Disposal
6.12.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS of chemicals listed in this SOP.

7.2. Treat all reagents, standards, and samples as potential hazards. Observe standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, and gloves at all times when performing this procedure. Perform all sample and standard handling in the fume hood.

7.3. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of the body, rinse the affected body part thoroughly with copious amounts of water. If irritations or any other discomfort related to the incident persist, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS & REAGENTS

8.1. Instruments and Supplies

Gas Chromatography	HP 5890 Series II or equivalent
Detector	HP 5971 MSD or equivalent

Column	RTX 502.2 (0.32 mm x 60 m), 1.8 µm thickness or equivalent after verification that the four gases (chloromethane, bromomethene, chloroethane, and vinyl chloride) can be resolved > 90% from each other in the total ion chromatogram
Data Acquisition Software	ChemStation or equivalent
Purge & Trap Device	OI 4560/Encon Evolution/EST or equivalent
Multiple purging module	Archon/Centurion or equivalent
Gases	Ultra-high purity helium/Air
Syringes	5 ml, 25 ml Luerlok gas-tight
Microsyringes	1, 10, 20, 25, 50, 100 and 1000 µl (Hamilton 702N or equivalent)
Volumetric Flasks	2, 5, 10, 50 and 100 ml with ground glass stopper
Heated Sparge	Archon or Automatic sample heating jacket or equivalent

8.2. **Chemicals and Reagents**

Extraction Solvent	Purge & Trap Grade Methanol or equivalent
Reagent Water	Organic-free water
Reagent Soil	Organic-free Ottawa Sand or equivalent
Preservative	Sodium Bisulfate

9.0 STANDARDS

9.1. Standard preparation for VOA is summarized in Tables 1 to 4. Refer to EMAX-QC02 for proper analytical standard preparation and EMAX-SM04 for proper labeling. Other concentration levels may be prepared as long as it complies with the method and/or project requirements.

9.2. Stock Standard

9.2.1. Purchase Stock Standards as certified solutions.

9.2.2. Purchase one set of calibration standard (refer to Table 1) for calibration and a secondary source Stock Standard for calibration verification (refer to Table 2).

9.2.3. Purchase Surrogate Mix at 2500 mg/L and Internal Standard at 2500 mg/L (refer to Table 3).

9.2.4. Purchase BromoFluorobenzene (BFB) as Tuning Standard at 5000 mg/L (refer to Table 4).

9.2.5. After opening, transfer in inert vials with minimal headspace and store at -10°C to -20°C.

9.3. Intermediate Standards

9.3.1. Using the stock standard solutions, prepare intermediate standards in methanol according to Tables 1 to 4 and store with minimal headspace in an inert vial.

9.4. Initial Calibration Standards (ICAL)

9.4.1. ICAL for 5 ml Purge

9.4.1.1. Using intermediate standards (refer to Tables 1 and 3), prepare multi calibration standards (minimum of five different concentrations) in reagent water as suggested below.

Calibration Pt.	VOA (µg/L)*	Surrogate (µg/L)	Internal Std (µg/L)
1	5	5	50
2	10	10	50
3	20	20	50
4	50	50	50
5	100	100	50
6	200	200	50

** Ketones, Acrolein, Acrylonitrile and tert-Butanol are 5X the indicated concentration and m/p-Xylene is 2x the indicated concentration.*

9.4.2. ICAL for 25 ml Purge

9.4.2.1. Using intermediate standards (refer to Tables 1 and 3), prepare multi calibration standards (minimum of five different concentrations) in reagent water as suggested below:

Calibration Pt.	VOA (µg/L)*	Surrogate (µg/L)	Internal Std (µg/L)
1	0.5	0.5	10
2	1	1	10
3	2	2	10
4	10	10	10
5	20	20	10
6	40	40	10

** Ketones, Acrolein, Acrylonitrile and tert-Butanol are 5X the indicated concentration and m/p-Xylene is 2x the indicated concentration.*

9.5. Initial Calibration Verification Standard (ICV)

9.5.1. Using the Intermediate Standard prepared from the secondary source (refer to Tables 2 and 3), spike into 5 ml or 25 ml purge in reagent water as suggested below.

9.5.1.1. ICV for 5 ml purge

ICV	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
5 ml	50	50	50

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

9.5.1.2. ICV for 25 ml purge

ICV	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
25 ml	10	10	10

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

9.6. Daily Calibration Check Standard (DCC)

9.6.1. Using the Intermediate Standard prepared from the same source as the ICAL Standard (refer to Tables 1 and 3), spike into 5 ml or 25 ml purge in reagent water as suggested below.

9.6.1.1. DCC for 5 ml purge

DCC	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
5 ml	50	50	50

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

9.6.1.2. DCC for 25 ml purge

DCC	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
25	10	10	10

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

9.7. LCS and Matrix Spike Standard

9.7.1. For spike standards, use the Intermediate Standard prepared from the secondary source (refer to Tables 2 and 3), spike into the 5 ml or 25 ml purge sample as suggested below (unless otherwise specified by the project). Spike 5 ml or 25 ml reagent water for LCS water or 5 g reagent soil in 5 ml reagent water for LCS soil.

9.7.1.1. LCS and Matrix Spike for 5 ml purge

LCS or MS/MSD	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
5 ml	50	50	50

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

9.7.1.2. LCS and Matrix Spike for 25 ml purge

LCS or MS/MSD	VOA* (µg/L)	Surrogate (µg/L)	Internal Standard (µg/L)
25 ml	10	10	10

** Ketones, Acrolein, Acrylonitrile and Tert-Butanol are 5x the indicated concentration and M/P-xylene is 2X the indicated concentration.*

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. For aqueous samples, refer to EMAX-5030.

10.1.1.1. Check the pH and presence of residual chlorine from remaining sample. Record samples with pH ≥ 2 and residual chlorine ≥ 5 mg/L in the analysis log.

10.1.2. For soil samples, refer to EMAX-5035.

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10.2. Instrument Parameters

10.2.1. From the main gas supply (gas Tanks) regulate gas pressure at 80 psi.

10.1.1. Fine-tune the instrument guided by the parameter conditions suggested below. Adjust the parameter conditions accordingly to obtain optimum condition. Print the instrument parameter and post it on the instrument for daily routine maintenance check.

10.2.2. Typical GC Parameters

Carrier gas flow (column) helium	1 – 5 ml/min
Initial Temp	35°C; hold for 1 min.
Rate 1	8°C/min. to 160°C/min
Rate 2	30°C/min to 230°C/min; hold for 3 min.
Inject Port	200°C
Interface	250°C

10.2.3. Mass Spectrometer Parameter

Scan Start	0.5 min.
Mass Range	35 to 300
Multiplier	1200 to 2700

10.2.4. Typical Purge and Trap Condition

10.2.4.1. Purge samples at 40°C for 11 minutes, desorbed at 250°C for 2 minutes and then bake the trap at 260°C for 11 minutes.

10.3. Calibration

10.3.1. Set GC/MS operating condition as described in Section 10.2.

10.3.2. Perform Tune Check

10.3.2.1. Introduce a BFB to yield 5 – 50 ng by either direct injection or purge and trap in 5 ml or 25 ml organic-free water (using tuning standard). Refer to table 4.

10.3.2.2. Evaluate the tune check by the highest scan on the peak or the average of at least 3 scans (before, at and after the apex) with a background subtraction using a single scan no more than 20 scans prior to the elution of BFB.

10.3.2.3. Check Table 5 for acceptance criteria or follow the manufacturer's recommendation for tuning. A valid tune check expires after 12 hours.

10.3.2.4. If non-compliant refer to Section 12 for corrective action.

10.3.3. Initial Calibration (ICAL)

10.3.3.1. Perform ICAL when one of the conditions occurs.

- Instrument is new
- Instrument undergoes a major repair
- DCC failed to meet the acceptance criteria

10.3.3.2. Optimize the instrument condition prior to ICAL

- Ensure that instrument parameters are set up properly
- Ensure that there is no evidence of leak
- Ensure that instrument maintenance is performed on schedule
- Ensure that instrument tune check and column performance is not indicative that it is at the threshold of failing the acceptance criteria

10.3.3.3. Analyze a multi-point initial calibration curve as suggested in Figure 3 after a valid tune check.

10.3.3.4. Base quantitation of identified compounds on the integrated abundance from the EICP of the assigned primary characteristic ion (refer to Tables 6 and 7). For optimum output, assign internal standard to each compound based on the nearest retention time or as suggested on Tables (6 and 7).

10.3.3.5. Evaluate the ICAL Acceptance

10.3.3.5.1. Check for completeness of target compound list. If there is/are missing compound(s), perform the following:

- Check the established retention time window
- Check the relative intensity of major ions
- Adjust accordingly if necessary

10.3.3.5.2. Evaluate retention time of each analyte with respect to the nearest internal standard. The relative retention time (RRT) of each analyte should agree within ± 0.06 RRT units.

10.3.3.5.3. At a minimum, evaluate System Performance Check Compounds (SPCC) and Calibration Check Compounds (CCC) as specified in Appendix 1.

10.3.3.5.4. Check RSD and correlation coefficient. If more than 10% of the compounds included with the initial calibration exceed the 15% RSD limit and do not meet the minimum correlation coefficient (0.99) for alternate curve fits, then the chromatographic system is considered too reactive for analysis to begin. Perform necessary instrument maintenance and repeat calibration. Refer to 10.3.3.2, Section 12 for corrective action.

10.3.3.6. Application of ICAL Curve for Quantitation

10.3.3.6.1. Generate a summary of Relative Response Factors for each analyte at each concentration. Calculate the Average Relative Response Factor (RRFm), the Standard Deviation (SD), and the Relative Standard Deviation (RSD) according to Eq.-10.5.1.1, Eq.-10.5.1.2, Eq.-10.5.1.6 and Eq.-10.5.1.7 respectively.

10.3.3.6.2. If RSD is ≤ 15% average response factor may be applied.

10.3.3.6.3. Apply Inverse Weighting Factor ($1/y$ or $1/y^2$; y being the instrument response) if it is determined to be the best fit for specific analytes. This approach may be applied to any analyte including analyte that has RSD of ≤ 15% and correlation coefficient of ≥ 0.995.

10.3.3.6.4. Apply linear least squares regression if past experience or priori knowledge of instrument response is known to be the best fit for specific analytes. This approach may be applied to any analyte including analyte that has RSD of ≤ 15% and correlation coefficient of ≥ 0.995.

10.3.3.6.5. It may be appropriate to force the regression through zero for specific analytes[3]. When exercising this option [as included in the data acquisition software], make sure that the origin (0,0) is not included as a calibration point but rather the intercept is set to zero. This option shall only be applied if the curve favors better accuracy of quantitation.

10.3.3.7. Submit summary of ICAL, raw data and manual integration (if any) for secondary review.

10.3.4. Initial Calibration Verification (ICV)

10.3.4.1. Analyze ICV to verify the concentration of the ICAL standards (refer to Section 9.5).

10.3.4.2. Check for completeness of analytes as described in Section 10.4.3.

10.3.4.3. Compare the retention times of the internal standards to the ICAL mid-point. Excursion of ± 30 seconds indicates instrument malfunction. When non-compliant check the column head pressure, gas supply or leaks. Corrective action is required prior to further analysis.

10.3.4.4. Compare the area of the Internal Standards (IS) acquired against the midpoint of the initial calibration point. The extracted ion current profile (EICP) must be within a factor of two (-50% to +100%).

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[3] SW846 Method 8000B, Section 7.5.3

10.3.4.5. Refer to Appendix 1 for ICV acceptance criteria and/or corrective action.

10.3.4.6. When non-compliant refer to Section 12 for corrective action.

10.3.5. Daily Continuing Calibration (DCC)

10.3.5.1. Analyze DCC to check the validity of the ICAL (refer to 9.6).

10.3.5.2. Check for completeness of analytes as described in Section 10.4.3.

10.3.5.3. Evaluate System Performance Check Compounds (SPCC) and Calibration Check Compounds (CCC) as specified in Appendix 1.

10.3.5.4. Compare the retention times of the internal standards to the ICAL mid-point. Excursion of ± 30 seconds indicates instrument malfunction. When non-compliant check the column head pressure, gas supply or leaks. Corrective action is required prior to further analysis.

10.3.5.5. Compare the area of the Internal Standards (IS) acquired against the midpoint of the initial calibration point. The extracted ion current profile (EICP) must be within a factor of two (-50% to +100%).

10.3.5.6. Establish RRF of each analyte, calculate %D (Eq.-10.5.2.1) against the ICAL.

10.3.5.7. Refer to Appendix 1 for DCC acceptance criteria and/or corrective action.

10.3.5.8. When non-compliant refer to Section 12 for corrective action.

10.4. **Analysis**

10.4.1. Analytical Sequence

10.4.1.1. Analyze BFB and evaluate tuning

10.4.1.2. Analyze DCC and check ICAL validity

10.4.1.3. Analyze Lab Control Sample

10.4.1.4. Analyze Lab Control Sample Duplicate (if required)

10.4.1.5. Analyze Method Blank

10.4.1.6. Analyze samples to a maximum number of 12-hours from the time of BFB injection.

10.4.1.7. Analyze a pair of matrix spikes (MS/MSD) for every 20 samples of the same matrix.

10.4.1.8. Record analytical sequence in the analysis log.

10.4.2. Sample Result Evaluation

10.4.2.1. Check the QC criteria as soon as the data is available.

- ✓ Check method blank. If result is non-compliant and analyte in question is not detected in any sample or contamination is < 10X of the sample concentration, results maybe reportable. Verify with the PM if results can be reported.
- ✓ Compare the retention times of each Internal Standards (IS) to the ICAL mid point (must be ± 30 seconds).

- ✓ Compare the area of each IS acquired against the mid point of the ICAL. The Extracted Ion Current Profile (EICP) must be within a factor of two (-50 to +100%).
- ✓ Check concentration of target analytes if calibration range is exceeded.
- ✓ Check surrogate recoveries against project specific requirement (PSR). In the absence of PSR, default to Appendix 1 QC limits.
- ✓ If any of the above checkpoints indicate a problem, re-analysis is required. Note observations on the analysis log. When results arise to questionable result, e.g. inconsistency from the first analysis, consult the Supervisor for further action.

10.4.2.2. Properly fill up the analysis log.

10.4.3. Qualitative Identification

- The intensities of the characteristic ions maximize in the same scan or within one scan of each other.
- The relative retention time (RRT) of the sample component is within 0.06 RRT units of the RRT of the standard component.
- The relative intensity of the characteristic ions agrees within 30% of the relative intensity of these ions in the reference spectrum.
- Check the chromatogram for possible misidentified analytes. Investigate visible peaks in the chromatogram that were not identified in the data output. Manually integrate the peak if necessary. For manual integration refer to EMAX-DM01.
- Structural isomers that produce very similar mass spectra should 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 the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.[4]

10.4.3.1. For samples containing components not associated with the calibration standards, perform a library search for purposes of tentative identification[5] (TIC). Execute LSC (Chem Station program) to initiate the library search using NIST/EPA/MSDC mass spectral library. Visually inspect each extracted mass ion chromatograph to determine the identification of the unknown before final reporting following the guidelines below.

- Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within + 20%. Example: for an ion with an abundance of 50% of the standard spectra, the corresponding sample ion abundance must be between 30 and 70%.

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[4] SW846 Method 8260B, Section 7.6.1.4

[5] Library search is performed only when indicated in the PSR.

- Molecular ions present in reference spectrum should be present in sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting analytes.
- Ions present in the reference spectrum but not present in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting analytes. Data system library reduction programs can sometimes create these discrepancies.

10.4.3.2. **Reporting TICs**

- If the library search produces a match at or above 85%, report the analyte.
- If the library search produces more than one analyte at or above 85%, report the first analyte (highest).
- If the library search produces no matches at or above 85%, the compound should be reported as unknown.

10.4.4. Quantitation

10.4.4.1. Apply the appropriate quantitation method (Section 10.3.3.6). Calculate the concentration of any positively identified target analyte using Eq.-10.5.3. Apply the dilution factor for diluted samples to calculate for the final concentration of the sample.

10.4.5. Manual Integration

10.4.5.1. Refer to EMAX-DM01, Manual Integration Section.

10.4.6. Dealing with Carryover

10.4.6.1. Check the sample analyzed after a sample having target analyte concentrations exceeding the calibration range.

10.4.6.2. If there is no target analyte detected as found in the sample that exceeded the calibration range, proceed with data reduction.

10.4.6.3. If there is any target analyte detected as found in the sample that exceeded the calibration range, re-analyze the sample to rule out carry over. If carry over is confirmed, proceed with data reduction and report the data from re-analysis.

10.4.6.4. To clean-up the autosampler purge line consider purging a 25 ml or 5 ml sample spiked with 100 µl of methanol and let it run like a blank sample. If improved result is noted repeat this process until no evidence of contamination is observed. Otherwise inform the Supervisor for further instruction.

10.5. **Calculations**

10.5.1. Initial Calibration

10.5.1.1. **Calculate for the Relative Response Factor (RRF)**

$$RRF = \frac{A_X C_{IS}}{A_{IS} C_X}$$ Eq.-10.5.1.1

where:

A_X – Area of characteristic ion for the compound being measured
A_{IS} – Area of characteristic ion for the specific internal standard
C_X – Concentration of the compound being measured
C_{IS} – Concentration of the specific internal standard

10.5.1.2. **Calculate for the Average Relative Response Factor (RRF$_m$)**

$$RRF_m = \frac{\sum RRF}{n}$$ Eq.-10.5.1.2

where:

$\sum RRF$ – Summation of response factors
n – Number of measurements

10.5.1.3. **Calculate for Least Square Linear Regression**

$$y = ax + b$$ Eq.-10.5.1.3

where:

y – Response ratio (A_X/A_{IS})
x – Amount ratio (C_X/C_{IS})
a – x1 = slope of the line

$$a = \frac{\sum (x-\overline{x})(y-\overline{y})}{\sum (x-\overline{x})^2}$$

where:

$\overline{x}$ = average of amount ratios

$\overline{y}$ = average of response ratios

b – x0 = intercept of the line

$$b = \overline{y} - a * \overline{x}$$

10.5.1.4. **Calculate for Inverse Weighting Factor**

$$y = ax + b$$ Eq.-10.5.1.4

where:

y – Response ratio (A_X/A_{IS})

x – Amount ratio (C_X/C_{IS})

a – x1 = slope of the line

$$a = \frac{\sum (x-x_a)(y-y_a)}{\sum (x-x_a)^2}$$

where:

$$x_a = \sum \left[x(1/x) / \sum (1/x) \right]$$
$$y_a = \sum \left[y(1/x) / \sum (1/x) \right]$$

or $x_a = \sum\left[x(1/x^2)/\sum(1/x^2)\right]$

$y_a = \sum\left[y(1/x^2)/\sum(1/x^2)\right]$

b – x0 = intercept of the line

$b = y_a - a * x_a$

10.5.1.5. **Calculate Inverse Quadratic**

$$y = ax^2 + bx + c$$

where:

y – Resp_Ratio =**x0** + **x1** * Amt_Ratio + **x2** * (Amt_Ratio)^2

x – Amt_Ratio

c – **x0**=Det 0/Det b

b – **x1**=Det 1/Det b

a – **x2**=Det 2/Det b

$$W_i = \frac{\frac{1}{x_i}}{\sum_{i=1}^{n} \frac{1}{x_i}}$$

where:

X_i = amount ratio= Conc of Std/Conc of IS

Y_i = response ratio=Resp of Std/Resp of IS

Wi= 1/X)/SUM(1/X)

<X>= SUM(W_i*X_i)

<Y>= SUM(W_i*Y_i)

<XX>= SUM(W_i*$(X_i)^2$)

<XXX>= SUM(W_i*$(X_i)^3$)

<XXXX>= SUM(W_i*$(X_i)^4$)

<YY>= SUM(W_i*$(Y_i)^2$)

<XY>= SUM(W_i*X_i*Y_i)

<XXY>= SUM(W_i*$(X_i)^2$*Y_i)

<Yd2>= SUM((Y_i-<Y>)^2*W_i)

Ye= x0+x1*X_i+x2*X_i^2-<Y>)

<Ye2>= SUM(Ye^2*W_i)

Det b

1	<X>	<XX>
<X>	<XX>	<XXX>
<XX>	<XXX>	<XXXX>

Det 0

1	<X>	<XX>
<X>	<XX>	<XXX>
<Y>	<XY>	<XXY>

Det 1

1	<X>	<XX>
<Y>	<XY>	<XXY>
<XX>	<XXX>	<XXXX>

Det 2

<Y>	<XY>	<XXY>
<X>	<XX>	<XXX>
<XX>	<XXX>	<XXXX>

r2= <Ye2>/<Yd2>

ccf2= $(r2)^{1/2}$

10.5.1.6. **Calculate the Standard Deviation (SD)**

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} \qquad \text{Eq.-10.5.1.6}$$

where:

x_i – Result at i^{th} measurement

$\bar{x}$ – Mean of the n measurements

n – Number of measurements

10.5.1.7. **Calculate the % relative standard deviation (%RSD)**

$$\%RSD = \frac{SD}{RRF_m} * 100\% \qquad \text{Eq.-10.5.1.7}$$

where:

SD – Standard deviation

RRF_m – Average response factor

10.5.1.8. **Calculate the relative retention time (RRT)**

$$\text{RRT} = \frac{\text{Retention Time of the Analyte}}{\text{Retention Time of the Internal Standard}} \qquad \text{Eq.-10.5.1.8}$$

10.5.2. Calibration Check/Continuing Calibration

10.5.2.1. **Calculate Percent Difference (%D)**

$$\%D = \frac{[RRF_c - RRF_m]}{RRF_m} * 100\% \qquad \text{Eq.-10.5.2.1}$$

where:

RRF_c – Response factor from continuing calibration standard
RRF_m – Average response factor

10.5.2.2. **% Drift**

$$\%Drift = \frac{[found\ Conc. - true\ Conc]}{true\ Conc.} * 100\% \qquad \text{Eq.-10.5.2.2}$$

10.5.3. Calculation of Sample Concentration (Water and Soil/Sediment Samples)

10.5.3.1. When a compound is identified, the quantitation of that compound shall be based on the integrated abundance from the EICP of the primary characteristic ion.

10.5.3.2. **Water Samples**

$$Concentration\ (ug/L) = \frac{(Ax)(Is)}{(Ais)(RRF_m)} x\ DF \qquad \text{Eq.-10.5.3.2}$$

where:

A_x – Area of characteristic ion for the compound to be measured
I_s – Concentration of internal standard added in µg/L
A_{is} – Area of characteristic ion for the internal standard
RRF_m – Average response factor
DF – Dilution factor = $\frac{purge\ volume\ in\ ml\ \ (5\ ml\ or\ 25\ ml)}{sample\ amount\ in\ ml}$

10.5.3.3. **Soil/Sediment Samples (Dry weight basis)**

$$Concentration\ (ug/kg) = \frac{(Ax)(Is)}{(Ais)(RRF_m)(DW)} x\ DF \qquad \text{Eq.-10.5.3.3}$$

where:

A_x – Area of characteristic ion for the compound to be measured
I_s – Concentration of internal standard added in µg/L
A_{is} – Area of characteristic ion for the internal standard
RRF_m – Average response factor
DF – Dilution factor = $\frac{5\ g}{(sample\ amount\ in\ g)}$
DW – % solid = $\frac{100 - \%moisture}{100}$

10.5.3.4. **Extracted Soil/Sediment Samples (Dry weight basis)**

$$Concentration\ (ug/kg) = \frac{(Ax)(Is)}{(Ais)(RRF_m)(DW)} x\ DF \qquad \text{Eq.-10.5.3.4}$$

where:

A_x – Area of characteristic ion for the compound to be measured

I_s – Concentration of internal standard added in µg/L

A_{is} – Area of characteristic ion for the internal standard

RRF_m – Average response factor

DF – Dilution factor

$$\frac{(purged\ \ volume\ \ in\ \ \mu L)(5\ g)}{(extract\ \ aliquot\ \ in\ \ \mu L)(sample\ \ amount\ \ in\ \ g)}$$

DW – % solid = $\frac{100-\%moisture}{100}$

10.5.4. Alternatively, the regression line (area ratio of Ax/Ais versus concentration using first degree) fitted to the initial calibration may be used for determination of the sample concentration when RSD of the analyte is greater than 15% (Section 10.3.3.6) .

10.5.5. Concentration of TIC is estimated by the same method as target compounds with the following assumptions:

10.5.5.1. The area Ax and Ais are derived from total ion chromatogram. Ais refers to the closest internal standard (IS) free of interference.

10.5.5.2. RRF of the TIC is 1.

10.5.6. Method Proficiency

10.5.6.1. **Percent Recovery**

$$\%\mathrm{Recovery} = \frac{(C_f - C)}{C_s} \times 100 \qquad \text{Eq.-10.5.6.1}$$

where:

C_f – Concentration found

C – Concentration of sample (use 0 for LCS)

C_s – Concentration of spike

10.5.6.2. **Relative Percent Difference (RPD)**

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100 \qquad \text{Eq.-10.5.6.2}$$

where:

C_1 – Measured concentration of the first sample aliquot

C_2 – Measured concentration of the second sample aliquot

10.6. **Data Reduction**

10.6.1. Make a copy of the analysis log.

10.6.2. Print a copy of the sample weight log (if any).

10.6.3. Highlight the data to be reported.

10.6.4. Print a copy of the raw data and the QC report.

10.6.5. Collate the reportable raw data separating the QC results from the sample results.

10.6.6. Keep all other data generated with the analytical folder marked with “For record only”.

10.7. Report Generation

10.7.1. Generate the method.txt file using WDB1C.exe.

10.7.2. Generate the sample results using F1NV3C.exe or F1NV3C4.exe.

10.7.3. Generate the QC summary using QCV3CN.exe or QCV3CN4.exe.

10.7.4. Generate the Instrument Performance Check (ICAL and DCC) using F5VOA.exe.

10.7.5. Generate the IS and RT summary using F8VC.exe.

10.7.6. Generate Lab Chronicle using LABCHRN1.exe

10.7.7. Generate Case Narrative using CN1.exe

10.7.8. Arrange the analysis package in sequence as detailed below using section separators. Attach all raw data to every form generated, to include manual integration and re-analyses.

10.7.8.1. Case Narrative

10.7.8.2. Lab Chronicle

10.7.8.3. Sample Results

10.7.8.4. Method Blank Results

10.7.8.5. LCS/LCSD Summary

10.7.8.6. MS/MSD Summary

10.7.8.7. Instrument Performance Check (ICAL)

10.7.8.8. ICAL Summary

10.7.8.9. ICV Summary

10.7.8.10. Instrument Performance Check (DCC)

10.7.8.11. IS and RT Summary

10.7.8.12. DCC Summary

10.7.8.13. Analysis Log

10.7.8.14. Sample Weight Log (if any)

10.7.8.15. Non-Conformance Report (If any)

10.8. Data Review

10.8.1. Perform a 100% data review in accordance to EMAX-DM01and the PSR.

10.8.1.1. If any of the checkpoints below indicates a problem, re-analysis is required.

- ✓ Check internal standard area. They should be within -50 to +100% of ICAL midpoint to be acceptable, otherwise follow PSR.

- ✓ Check retention time of each IS to the ICAL midpoint. They should be within ± 30 seconds to be acceptable, otherwise follow PSR.
- ✓ Check surrogate recoveries against project specific criteria (PSR). In the absence of PSR, default to in-house QC limits.
- ✓ Check concentration of target analytes if calibration range is exceeded.

10.8.1.2. Review the attached logs that they are properly filled.

10.8.1.3. Check the generated reports against the raw data. Check that the analytical data generated indicating positive results are qualitatively and quantitatively correct.

10.8.1.4. Review the case narrative and check that it accurately describes what transpired in the analytical process. Edit as necessary to reflect essential issues not captured by the case narrative generator program.

10.8.2. Submit the analytical folder for secondary review.

10.9. Preventive Maintenance

10.9.1. Perform instrument routine preventive maintenance and record on instrument-specific maintenance logs. Routine maintenance ensures that all equipment is operating under optimum conditions, thus reducing the possibility of instrument malfunction that may affect data quality.

10.9.2. The table below list suggested routine maintenance schedule.

Task	**Every Day**	**Every Week**	**Every Month**	**Every 3 Months**	**Every 6 Months**	**As Needed**
Tune Check	✓					
Check gas cylinders pressure	✓					
Check the foreline pump oil level		✓				
Check the calibration vial						✓
Check and if necessary, change injection port liners, septa and O-rings.					✓	
Replace the foreline pump oil					✓	
Replace the diffusion pump fluid					✓	
Replace the traps and filters					✓	
Clean the ion source						✓
Change the carrier gas trap(s) and purifier						✓
Replace column						✓
AutoTune the MSD						✓
Replace the worn out parts						✓

11.0 QUALITY CONTROL

11.1. Analytical Batch QC

11.1.1. Perform tune check to verify that the mass spectrometer meets standard mass spectra abundance criteria prior to calibration and check for any contamination.

11.1.2. Perform initial calibration (ICAL) to establish a calibration curve for the quantification of the analytes of interest.

11.1.3. Establish retention time window position for each analyte every after ICAL for proper qualitative identification.

11.1.4. Perform initial continuing calibration verification (ICV) every after ICAL to verify accuracy of ICAL.

11.1.5. Perform continuing calibration verification (CCV) every 12 hours to verify that instrument response is reliable, and has not changed significantly from the current ICAL curve.

11.1.6. Evaluate relative retention time for each analytes in every sample to be within ± 0.06 RRT units.

11.1.7. Verify internal standard (IS) for quantitative accuracy and that its Retention time is within ± 30 seconds from retention time of the midpoint standard in the ICAL and EICP area is within -50% to +100% of ICAL midpoint standard.

11.1.8. Evaluate surrogate recovery to monitor instrument response on every sample.

11.2. Preparation Batch QC

11.2.1. Reagent water used for IB shall be of the same source for all QC samples and sample dilutions.

11.2.2. Analyze MB, LCS, MS/MSD and < 20 field samples.

11.2.3. Solvents and reagents must undergo quality control check prior to its use. Refer to EMAX-QC01 for details.

11.2.4. Properly treat lab wares used in the sample preparation as specified in EMAX-QC07.

11.3. Method QC

11.3.1. All analytes reported must have a valid DL, LOD and LOQ as described in EMAX-QA04.

11.3.2. All analysts conducting this analysis must demonstrate capability (IDOC/DOC) as described in EMAX-QA05.

11.4. Refer to Appendix 1 for all related Quality Control parameters, frequency and acceptance criteria.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1.

12.2. Analytical Batch QC

12.2.1. Tune Check – If tune check is non-compliant consider the following suggestion to correct the problem:

- Check the abundance of mass 95 and 174. If it is significantly less than previous tune checks, it is indicative of insufficient amount of BFB injected. Probable causes are:

improper spiking, leaks, standard degradation or low vacuum system. Repeat tune check ensuring that BFB was properly spiked or rule out leaks, prepare a fresh BFB standard and repeat the tune check.

- If problem persist, re-tune the instrument and repeat tune check.
- If problem is unresolved, inform the supervisor for further action.

12.2.2. Initial Calibration

12.2.2.1. If the %RSD is out of acceptance criteria, consider the following suggestions to correct the problem.

- If one of the standards returns a bias low or bias high on all of the analytes then that point is considered an out-liner. Prepare a standard at that ICAL point and re-analyze.
- If the highest ICAL point appears to be saturated, drop the highest point.
- If the lowest point returns a bias low or bias high response or the peaks are not distinct and sharp, drop the lowest point.

Note : The lowest calibration point identifies the limit of quantitation (LOQ). Therefore, check that the LOQ is in conformance to the current projects where the ICAL will be used.

12.2.2.2. If instrument problem is suspected, consider the following suggestion to correct the problem:

- Check the connection and make sure they are air tight and perform maintenance as needed.
- Check the gas flow.
- Re-tune the MS.
- Prepare a fresh standard and repeat calibration.
- Clean the MS source and repeat calibration.
- If problem is unresolved, inform the supervisor for further action.

12.2.3. Initial Calibration Verification (ICV) – If the ICV is non-compliant, consider the following suggestions to correct the problem:

- Re-analyze ICV to rule out poor purge.
- If ICV is still out of acceptance criteria, prepare a fresh standard and re-analyze to rule out any preparation error.
- If ICV is still out of acceptance criteria, prepare a fresh ICAL standard and repeat calibration.
- If problem is unresolved, inform the supervisor for further action.

12.2.4. Daily Calibration Check (DCC) – If DCC is non-compliant consider the following suggestions to correct the problem:

- If majority of the analyte response are low and no evidence of leak in the system is apparent, it is indicative of a bad purge or leak in the vial. Re-analyze DCC.
- If problem persist, rule out standard degradation. Prepare a fresh standard and repeat DCC.
- Otherwise execute instrument maintenance and perform ICAL.

12.2.5. Instrument Blank – If instrument blank is non-compliant, consider the following suggestions to correct the problem:

- If trace level of THMs is observed, it is indicative that water filters need replacement. Otherwise, bake the trap at the manufacturer's recommended temperature for about 30 minutes.
- If contamination is high, flush the sample line with methanol and replace the trap.
- If problem is unresolved, inform the supervisor for further action.

12.3. **Preparation Batch QC**

12.3.1. For insufficient amount of sample(s), inform the supervisor immediately for further action.

12.3.2. If MB is non-compliant, consider the suggestions as described in Instrument Blank.

12.3.3. If LCS is non-compliant, consider the following suggestions to correct the problem:

- If result is bias low or high, prepare a fresh standard and re-analyze LCS and the associated samples.
- If problem is unresolved, inform the supervisor for further advice.

12.3.4. If MS is non-compliant consider the following suggestion to correct the problem:

- Check the standard log and analytical log and verify that the spike amount value used for calculation is correct.
- If LCS is within acceptance criteria then and the right amount of spike amount used for calculation is correct, then it is indicative of matrix interference. Discuss the probable matrix interference in the case narrative.

12.4. Discuss water samples that are labeled preserved having a pH ≥ 2 and/or residual chlorine ≥ 5 mg/L in the case narrative.

12.5. A Non-Conformance Report (NCR) is required when the following circumstances occur.

- Anomalies other than specified in Appendix 1, is observed.
- Sample is out of technical holding time.

12.5.1. Refer to EMAX-QA08 for NCR details.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to wastewater drains.

13.2. Prepare all standards in fume hoods.

14.0 WASTE MANAGEMENT

14.1. No samples shall be dumped on the laboratory sink.

14.2. Separate and properly identify all unused and expired analytical standards for proper disposal.

14.3. Place all waste generated during analytical process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired analytical standards and other waste generated during the analytical process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. Definition of Terms

15.1.1. Analyte – The specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family, and which are analyzed together.

15.1.2. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

15.1.2.1. **Preparation Batch** - is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.

15.1.2.2. **Analytical batch** - is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices, preparation batches, and can exceed 20 samples.

15.1.3. Detection Limit (DL) – is defined as the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the DL, the false positive rate (Type I error) is 1%.

15.1.4. Limit of Detection (LOD) – is defined as the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative result rate (Type II error) is 1 %.

15.1.5. Limit of Quantitation (LOQ) – is at the lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard.

15.1.6. Safety Data Sheet (SDS) – is written information concerning a chemical physical properties, toxicity, health hazards, fire hazard and reactivity data including storage, spill and handling precautions.

15.1.7. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.1.8. Calibration Blank – is a target-analyte-free solvent subjected to the entire analytical process to establish zero baseline or background value.

15.1.9. Carry-over – are contaminants retained in the instrument/apparatus from a highly contaminated sample that is passed into the succeeding sample(s).

15.1.10. Calibration Check Compounds (CCC) – evaluate the integrity of the system. Variability of these compounds may indicate system leak or reactive sites in the column.

15.1.11. Instrument Method – is a file generated to contain the instrument calibration and instrument parameter settings for a particular analysis.

15.1.12. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.1.13. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system.

15.1.14. Lab Control Sample Duplicate (LCSD) – is a replicate of LCS analyzed to monitor precision in the absence of MS/MSD sample.

15.1.15. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.1.16. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.1.17. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.1.18. Matrix – is a component or form of a sample.

15.1.19. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method’s recovery efficiency.

15.1.20. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.1.21. Response Factor – is the ratio of the peak area of the target compound in the sample or sample extract.

15.1.22. Surrogate – are compounds added to every blank, sample, matrix spike, matrix spike duplicate and standard; used to evaluate analytical efficiency by measuring recovery. Compounds not expected to be detected in environmental media.

15.1.23. SPCC – System performance check compounds are compounds that are used to check compound stability and to check for degradation cause by contaminated lines or active sites in the system.

15.1.24. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.1.25. Reagent Soil – organic-free Ottawa sand or equivalent.

15.2. **Application of EMAX QC Procedures**

15.2.1. The procedures and QC criteria summarized in this SOP applies to all projects when performing Volatile analysis by GC/MS. The standard analyte list and RL are presented in Tables 6 & 7. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.3. Department of Defense (DoD) and Department of Energy (DoE) Projects

15.3.1. Samples from DoD and DoE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD Quality Systems Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. U.S. EPA Method 8260B; SW846, as updated

16.2. EMAX Quality Systems Manual, as updated

17.0 APPENDICES

17.1. Tables

17.1.1. Table 1 Initial Calibration Intermediate Standards Preparation

17.1.2. Table 2 Initial Calibration Verification/LCS/MS/MSD Intermediate Standards Preparation

17.1.3. Table 3 Surrogate/Internal Standards Preparation

17.1.4. Table 4 Tuning Solution Standards Preparation

17.1.5. Table 5 BFB Key Ion Abundance Criteria

17.1.6. Table 6 Typical Analyte List, Quantitation Ions, IS, Surrogates, Calibration Standards, Detection Limits for 5 ml Purge

17.1.7. Table 7 Typical Analyte List, Quantitation Ions, IS, Surrogates, Calibration Standards, Detection Limits for 25 ml Purge

17.2. Figures

17.2.1. Figure 1 Peak Evaluation Techniques

17.2.2. Figure 2 Typical Chromatogram

17.2.3. Figure 3 Typical ICAL Summary

17.2.4. Figure 4 Typical Instrument Performance Check (Tuning)

17.2.5. Figure 5 Typical Instrument Performance Check (Tuning) Summary

17.2.6. Figure 6 Typical Internal Standard Area and Retention Time Summary

17.2.7. Figure 7 Typical Sample Result Summary

17.2.8. Figure 8 Typical LCS/LCSD Summary

17.2.9. Figure 9 Typical MS/MSD Summary

17.2.10. Figure 10 Typical Case Narrative

17.3. **Appendices**

17.3.1.	Appendix 1	Summary of Quality Control Procedures
17.3.2.	Appendix 2	Demonstration of Capability for 25 ml
17.3.3.	Appendix 3	Demonstration of Capability for 5 ml
17.3.4.	Appendix 4	Demonstration of Capability for 5 g

17.4. **Forms**

17.4.1.	8260FS	Sample Preparation Log
17.4.2.	8260FA	Analytical Run Log
17.4.3.	8260FM	Instrument Maintenance Log

Table 1: INITIAL CALIBRATION INTERMEDIATE STANDARDS PREPARATION

ICAL/DCC Intermediate Standard	Stock Standard			Preparation (Solvent: Methanol)		Final Conc. (mg/L)
	Standard Name	Source	Conc. (mg/L)	Aliquot (µl)	Final Vol. (ml)	
I	1-Chlorohexane	AccuStandard	2000	50	2	50
	2-Chloroethylvinylether	CPI	2000	50	2	50
	Oxygenate Gasoline Additive	AccuStandard	2000-10000	50	2	50 - 250
	Custom VOA Mix	CPI	2000, 20000, 40000	50	2	50, 500, 1000
II	VOC Gas Mix	Ultra Scientific	2000	250	2	250
	Vinyl Acetate	CPI	2500	200	2	250
III	Carbon Disulfide	CPI	5000	100	2	250
IV	VOA Calibration Mix 1	Restek	5000	100	2	250
	Acrolein / Acrylonitrile	AccuStandard	5000	100	2	250

Table 2: INITIAL CALIBRATION VERIFICATION/LCS/MS/MSD INTERMEDIATE STANDARDS PREPARATION

ICV / LCS / MS Intermediate Standard	Stock Standard			Preparation (Solvent: Methanol)		Final Conc. (mg/L)
	Standard Name	Source	Conc. (mg/L)	Aliquot (µl)	Final Vol. (ml)	
I	1-Chlorohexane	Ultra Scientific	1000	100	2	50
	2-Chloroethylvinylether	AccuStandard	2000	50	2	50
	California Oxygenate Mix	Restek	2000 - 10000	50	2	50 – 250
	Custom 8260 Mega Mix	Restek	2000, 20000, 40000	50	2	50, 500, 1000
II	Volatile Organic Cpds Mix 6	Supelco	2000	250	2	250
	Vinyl Acetate	Restek	2000	250	2	250
III	Carbon Disulfide Solution	Ultra scientific	5000	20	2	50
IV	TCL Volatile Mix 1	Supelco	2000	250	2	250
	Acrolein / Acrylonitrile	Ultra Scientific	2000	250	2	250

Table 3: SURROGATE / INTERNAL STANDARDS PREPARATION

Intermediate Standard	Stock Standard			Preparation (Solvent: Methanol)		Final Conc. (mg/L)
	Standard Name	Source	Conc. (mg/L)	Aliquot (µl)	Final Vol. (ml)	
Surrogate	8260 Surrogate Mix	Restek	2500	200	2	250
Internal Standard	Custom 8260 Internal Standard Mix, 3-30	CPI	2500	200	2	250

Table 4: TUNING SOLUTION STANDARDS PREPARATION

BFB Intermediate Standard	Stock Standard			Preparation (Solvent: Methanol)		Final Conc. (mg/L)
	Standard Name	Source	Conc. (mg/L)	Aliquot (µl)	Final Vol. (ml)	
Tuning Compound	BFB	Restek	5000	20	2	50

Table 5: BFB KEY ION ABUNDANCE CRITERIA

M/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

Table 6: TYPICAL TARGET ANALYTE LIST FOR 5-ml PURGE

ANALYTES	CHARACTERISTIC ION(S)		IS	SURR	ICAL ANALYTE CONCENTRATIONS (µg/L)								ICV/DCC EV(µg/L)	LCS/MS EV(µg/L)	WATER (µg/L)			SOIL (µg/Kg)		
	PRIMARY	SECONDARY			1	2	3	4	5	6	7	8			DL	LOD	LOQ	DL	LOD	LOQ
1,1,1,2-Tetrachloroethane	131	133, 119, 117	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1,1-Trichloroethane	97	99, 61	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1,2,2-Tetrachloroethane	83	85	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1,2-Trichloro-1,2,2-trifluoroethane	151	153	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
1,1,2-Trichloroethane	97	83, 85, 99	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1-Dichloroethane	63	65, 83	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1-Dichloroethene	61	63, 96	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,1-Dichloropropene	110	112	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,2,3-Trichlorobenzene	180	182, 145	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
1,2,3-Trichloropropane	110	61, 77	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
1,2,4-Trichlorobenzene	180	182, 145	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
1,2,4-Trimethylbenzene	105	120	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.55	1	5
1,2-Dibromo-3-chloropropane	157	155, 75	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
1,2-Dibromoethane	107	109	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,2-Dichlorobenzene	146	111, 148	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,2-Dichloroethane	62	64	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,2-Dichloropropane	63	41, 76	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,3,5-Trimethylbenzene	105	120, 119	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.59	1	5
1,3-Dichlorobenzene	146	111, 148	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.52	1	5
1,3-Dichloropropane	76	78	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1,4-Dichlorobenzene	146	111, 148	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
1-Chlorohexane	91	93, 55, 56	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.58	1	5
2,2-Dichloropropane	77	97, 79	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
2-Butanone (MEK)	43	72	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	2.5	5	10
2-Chloroethyl vinyl ether	63	65, 106	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
2-Chlorotoluene	91	126	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.82	1	5
2-Hexanone (MBK)	43	58, 100	IS2	Sur3	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	2.86	5	10
4-Chlorotoluene	91	126	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.61	1	5	0.67	1	5
4-Methyl-2-pentanone (MIBK)	43	58, 85, 100	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	2.75	5	10
Acetone	43	58, 42	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	3.06	5	10
Acrolein	56	55	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	2.5	5	10
Acrylonitrile	53	52, 51	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	2.5	5	10	2.5	5	10
Benzene	78	77, 52	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Bromobenzene	156	77, 158	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Bromochloromethane	49	128, 130	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Bromodichloromethane	83	85	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Bromoform	173	171, 175	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
Bromomethane	94	96	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1.1	2	5	1.81	2	5

Table 6: TYPICAL TARGET ANALYTE LIST FOR 5-ml PURGE

ANALYTES	CHARACTERISTIC ION(S)		IS	SURR	ICAL ANALYTE CONCENTRATIONS (µg/L)								ICV/DCC	LCS/MS	WATER (µg/L)			SOIL (µg/Kg)		
	PRIMARY	SECONDARY			1	2	3	4	5	6	7	8	EV(µg/L)	EV(µg/L)	DL	LOD	LOQ	DL	LOD	LOQ
Carbon disulfide	76	78	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Carbon tetrachloride	119	117	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.54	1	5
Chlorobenzene	112	51, 77, 114	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Chloroethane	64	49, 66	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
Chloroform	83	85, 47	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Chloromethane	50	52	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1.02	2	5
cis-1,2-Dichloroethene	96	61, 98	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
cis-1,3-Dichloropropene	75	77, 39, 110	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Dibromochloromethane	129	127	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Dibromomethane	93	95, 174	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Dichlorodifluoromethane	85	87	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1.3	2	5	1.16	2	5
Dichlorofluoromethane	67	69	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Diisopropyl ether (DIPE)	45	87	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Ethyl Methacrylate	69	99, 41	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
Ethylbenzene	91	106	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Ethyl-tert-butyl ether (ETBE)	59	87	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Hexachlorobutadiene	225	223, 227	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
Iodomethane	142	127	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
Isopropylbenzene	105	120, 79, 103	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.64	1	5
m/p-Xylenes	91	106	IS2	Sur3	4	10	20	40	100	160	200	400	100	100	1	2	10	1	2	10
Methylene chloride	49	84, 86	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	1	2	5
Methyl-t-butyl ether (MTBE)	73	57	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
Naphthalene	128	127	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
n-Butylbenzene	91	92, 134	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.73	1	5	0.7	1	5
n-Propylbenzene	91	65, 120	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.51	1	5	0.65	1	5
o-Xylene	91	106	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
p-Isopropyltoluene	119	91, 134	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.56	1	5	0.62	1	5
sec-Butylbenzene	105	134	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.67	1	5
Styrene	104	78, 103	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
tert-Amylmethyl ether (TAME)	87	55,73	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
tert-Butyl alcohol (TBA)	59	41	IS1	Sur0/1	10	25	50	100	250	400	500	1000	250	250	7.1	10	25	9.18	10	20
tert-Butylbenzene	134	91, 119	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.62	1	5
Tetrachloroethene	164	129, 131, 166	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.52	1	5	0.5	1	5
Toluene	91	92	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
trans-1,2-Dichloroethene	61	96, 98	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
trans-1,3-Dichloropropene	75	77, 39	IS2	Sur3	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5
trans-1,4-Dichloro-2-butene	53	88	IS3	Sur2	2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
Trichloroethene	130	97, 132, 95	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.5	1	5	0.5	1	5

Table 6: TYPICAL TARGET ANALYTE LIST FOR 5-ml PURGE

ANALYTES	CHARACTERISTIC ION(S)		IS	SURR	ICAL ANALYTE CONCENTRATIONS (µg/L)								ICV/DCC EV(µg/L)	LCS/MS EV(µg/L)	WATER (µg/L)			SOIL (µg/Kg)		
	PRIMARY	SECONDARY			1	2	3	4	5	6	7	8			DL	LOD	LOQ	DL	LOD	LOQ
Trichlorofluoromethane	101	103	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.86	1	5	1.06	2	5
Vinyl acetate	43	86	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	1	2	5	1.26	2	5
Vinyl chloride	62	64	IS1	Sur0/1	2	5	10	20	50	80	100	200	50	50	0.61	1	5	1	2	5
Dibromofluoromethane (Sur0)	111	113, 192	IS1		2	5	10	20	50	80	100	200	50	50	1	2	5	0.5	1	5
1,2-Dichloroethane-d4 (Sur1)	65	102	IS1		2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
4-Bromofluorobenzene (Sur2)	95	174, 176	IS3		2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
Toluene-D8 (Sur3)	98	100	IS2		2	5	10	20	50	80	100	200	50	50	1	2	5	1	2	5
1,4-Difluorobenzene (IS1)	114	88																		
Chlorobenzene-d5 (IS2)	117	82, 119																		
1,2-Dichlorobenzene-d4 (IS3)	152	150																		

Note: Since, retention time of Dibromofluoromethane (Sur0) and 1,2-Dichloroethane-d4 (Sur1) is too close (~43 sec) hence, Dibromofluoromethane (Sur0) is only used when required by the project.

Table 7: TYPICAL TARGET ANALYTE LIST FOR 25-ml PURGE

Analytes	CHARACTERISTIC ION(S)				ICAL ANALYTE CONCENTRATIONS (µg/L)									ICV/DCC	LCS/MS	WATER (µg/L)		
	PRIMARY	SECONDARY	IS	SURR	1	2	3	4	5	6	7	8	9	EV(µg/L)	EV(µg/L)	DL	LOD	LOQ
1,1,1,2-Tetrachloroethane	131	133, 119, 117	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,1,1-Trichloroethane	97	99, 61	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,1,2,2-Tetrachloroethane	83	85	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
1,1,2-Trichloro-1,2,2-trifluoroethane	151	153	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.17	0.3	0.5
1,1,2-Trichloroethane	97	83, 85, 99	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,1-Dichloroethane	63	65, 83	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,1-Dichloroethene	61	63, 96	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,1-Dichloropropene	110	112	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,2,3-Trichlorobenzene	180	182, 145	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
1,2,3-Trichloropropane	110	61, 77	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
1,2,4-Trichlorobenzene	180	182, 145	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
1,2,4-Trimethylbenzene	105	120	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
1,2-Dibromo-3-chloropropane	157	155, 75	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
1,2-Dibromoethane	107	109	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,2-Dichlorobenzene	146	111, 148	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,2-Dichloroethane	62	64	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,2-Dichloropropane	63	41, 76	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,3,5-Trimethylbenzene	105	120, 119	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.13	0.2	0.5
1,3-Dichlorobenzene	146	111, 148	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
1,3-Dichloropropane	76	78	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1,4-Dichlorobenzene	146	111, 148	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
1-Chlorohexane	91	93, 55, 56	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.14	0.2	0.5
2,2-Dichloropropane	77	97, 79	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.16	0.2	0.5
2-Butanone (MEK)	43	72	IS1	Sur0/1	1.5	2.5	5	10	25	50	100	150	200	50	50	2	4	10
2-Chloroethyl vinyl ether	63	65, 106	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
2-Chlorotoluene	91	126	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.12	0.2	0.5
2-Hexanone (MBK)	43	58, 100	IS2	Sur3	1.5	2.5	5	10	25	50	100	150	200	50	50	2.3	4	5
4-Chlorotoluene	91	126	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
4-Methyl-2-pentanone (MIBK)	43	58, 85, 100	IS1	Sur0/1	1.5	2.5	5	10	25	50	100	150	200	50	50	2.2	4	5
Acetone	43	58, 42	IS1	Sur0/1	1.5	2.5	5	10	25	50	100	150	200	50	50	2.6	5	10
Acrolein	56	55	IS1	Sur0/1	1.5	2.5	5	10	25	50	100	150	200	50	50	2.5	5	10
Acrylonitrile	53	52, 51	IS1	Sur0/1	1.5	2.5	5	10	25	50	100	150	200	50	50	2.5	5	10
Benzene	78	77, 52	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5

Table 7: TYPICAL TARGET ANALYTE LIST FOR 25-ml PURGE

	CHARACTERISTIC ION(S)				ICAL ANALYTE CONCENTRATIONS (µg/L)									ICV/DCC	LCS/MS	WATER (µg/L)		
Analytes	PRIMARY	SECONDARY	IS	SURR	1	2	3	4	5	6	7	8	9	EV(µg/L)	EV(µg/L)	DL	LOD	LOQ
Bromobenzene	156	77, 158	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Bromochloromethane	49	128, 130	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
Bromodichloromethane	83	85	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Bromoform	173	171, 175	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
Bromomethane	94	96	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.16	0.3	0.5
Carbon disulfide	76	78	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Carbon tetrachloride	119	117	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Chlorobenzene	112	51, 77, 114	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Chloroethane	64	49, 66	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.27	0.3	0.5
Chloroform	83	85, 47	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Chloromethane	50	52	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
cis-1,2-Dichloroethene	96	61, 98	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
cis-1,3-Dichloropropene	75	77, 39, 110	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Dibromochloromethane	129	127	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Dibromomethane	93	95, 174	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Dichlorodifluoromethane	85	87	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
Dichlorofluoromethane	67	69	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Diisopropyl ether (DIPE)	45	87	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
Ethyl Methacrylate	69	99, 41	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
Ethylbenzene	91	106	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Ethyl-tert-butyl ether (ETBE)	59	87	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
Hexachlorobutadiene	225	223, 227	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.22	0.3	0.5
Iodomethane	142	127	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
Isopropylbenzene	105	120, 79, 103	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
m/p-Xylenes	91	106	IS2	Sur3	0.6	1	2	4	10	20	40	60	80	20	20	0.21	0.4	1
Methylene chloride	49	84, 86	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
Methyl-t-butyl ether (MTBE)	73	57	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.13	0.2	0.5
Naphthalene	128	127	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
n-Butylbenzene	91	92, 134	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.17	0.2	0.5
n-Propylbenzene	91	65, 120	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.13	0.2	0.5
o-Xylene	91	106	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
p-Isopropyltoluene	119	91, 134	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.14	0.2	0.5
sec-Butylbenzene	105	134	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.13	0.2	0.5

Table 7: TYPICAL TARGET ANALYTE LIST FOR 25-ml PURGE

	CHARACTERISTIC ION(S)				ICAL ANALYTE CONCENTRATIONS (µg/L)									ICV/DCC	LCS/MS	WATER (µg/L)		
Analytes	PRIMARY	SECONDARY	IS	SURR	1	2	3	4	5	6	7	8	9	EV(µg/L)	EV(µg/L)	DL	LOD	LOQ
Styrene	104	78, 103	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
tert-Amylmethyl ether (TAME)	87	55,73	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
tert-Butyl alcohol (TBA)	59	41	IS1	Sur0/1	1.5	2	5	10	25	50	100	150	200	50	50	2.5	5	10
tert-Butylbenzene	134	91, 119	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.13	0.2	0.5
Tetrachloroethene	164	129, 131, 166	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.2	0.5
Toluene	91	92	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
trans-1,2-Dichloroethene	61	96, 98	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
trans-1,3-Dichloropropene	75	77, 39	IS2	Sur3	0.3	0.5	1	2	5	10	20	30	40	10	10	0.11	0.2	0.5
trans-1,4-Dichloro-2-butene	53	88	IS3	Sur2	0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
Trichloroethene	130	97, 132, 95	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.1	0.2	0.5
Trichlorofluoromethane	101	103	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.15	0.3	0.5
Vinyl acetate	43	86	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.25	0.5	1
Vinyl chloride	62	64	IS1	Sur0/1	0.3	0.5	1	2	5	10	20	30	40	10	10	0.12	0.2	0.5
Dibromofluoromethane (Sur0)	111	113, 192	IS1		0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
1,2-Dichloroethane-d4 (Sur1)	65	102	IS1		0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
4-Bromofluorobenzene (Sur2)	95	174, 176	IS3		0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
Toluene-D8 (Sur3)	98	100	IS2		0.3	0.5	1	2	5	10	20	30	40	10	10	0.5	1	2
1,4-Difluorobenzene (IS1)	114	88																
Chlorobenzene-d5 (IS2)	117	82, 119																
1,2-Dichlorobenzene-d4 (IS3)	152	150																

Note: Since retention time of Dibromofluoromethane (Sur0) and 1,2-Dichloroethane-d4 (Sur1) is too close (~43 sec) hence, Dibromofluoromethane (Sur0) is only used when required by the project.

Figure 1: PEAK EVALUATION TECHNIQUES

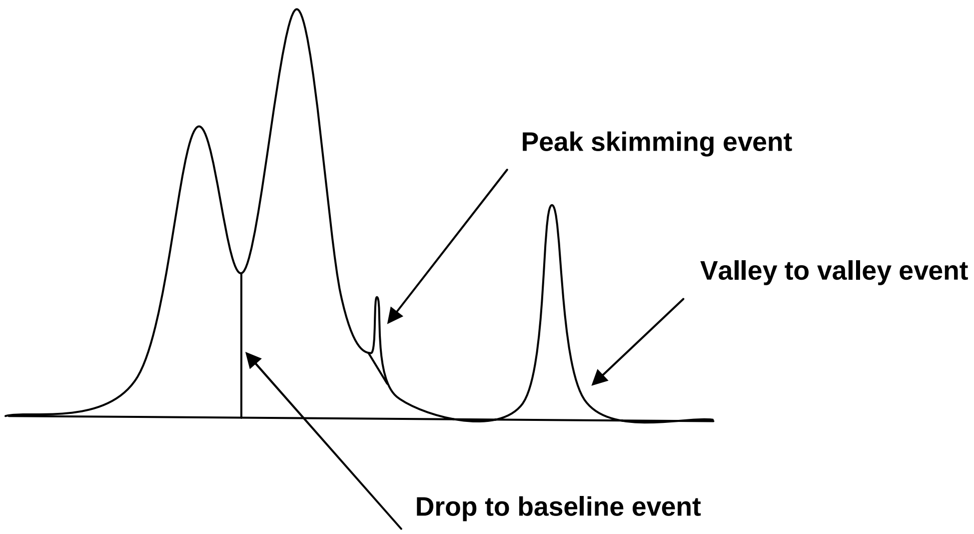
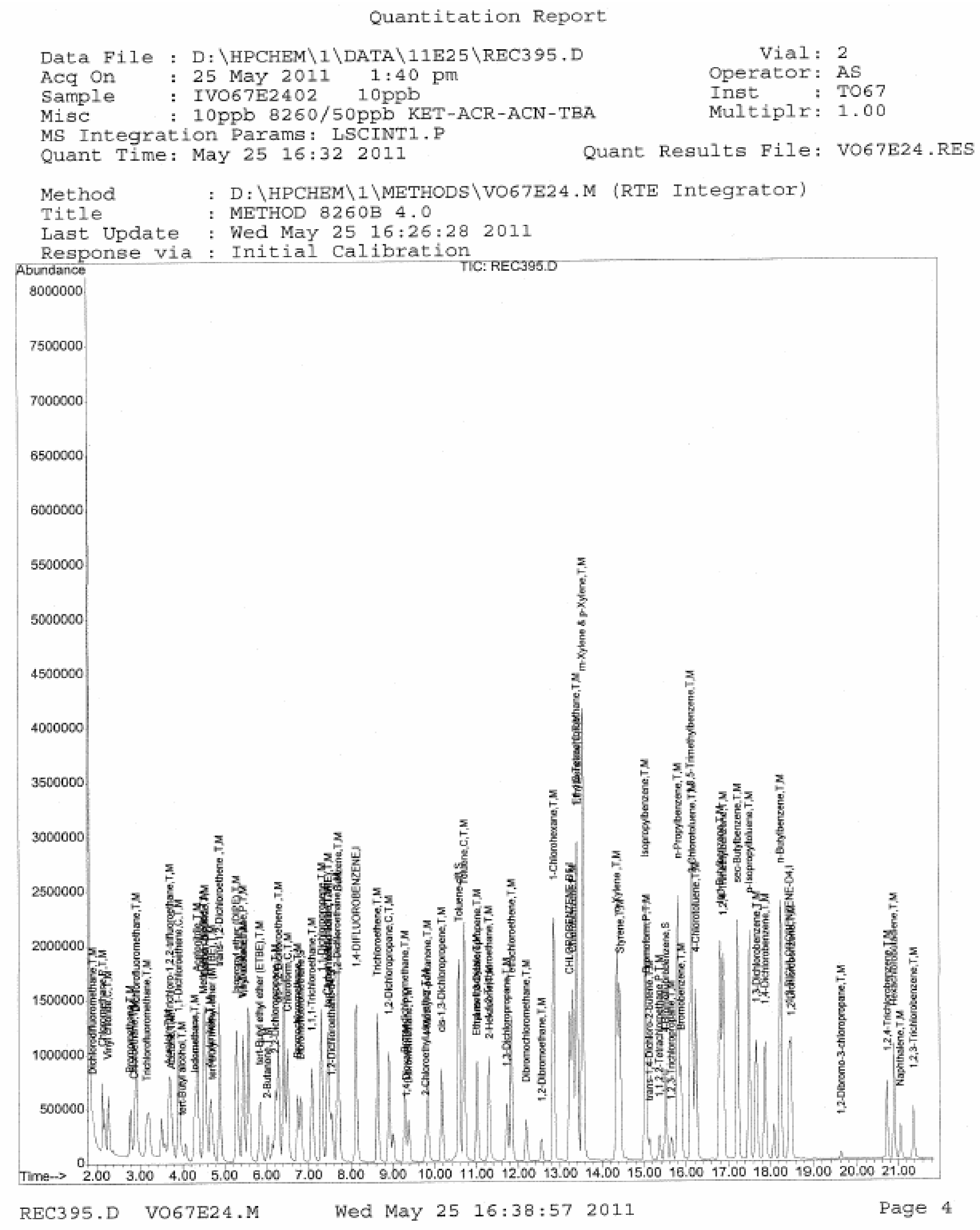


Figure 2: TYPICAL CHROMATOGRAM



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                         Quantitation Report

Data File : D:\HPCHEM\1\DATA\11E25\REC395.D              Vial: 2
Acq On    : 25 May 2011    1:40 pm                   Operator: AS
Sample    : IVO67E2402    10ppb                      Inst    : TO67
Misc      : 10ppb 8260/50ppb KET-ACR-ACN-TBA         Multiplr: 1.00
MS Integration Params: LSCINT1.P
Quant Time: May 25 16:32 2011               Quant Results File: VO67E24.RES

Method        : D:\HPCHEM\1\METHODS\VO67E24.M (RTE Integrator)
Title         : METHOD 8260B 4.0
Last Update   : Wed May 25 16:26:28 2011
Response via  : Initial Calibration
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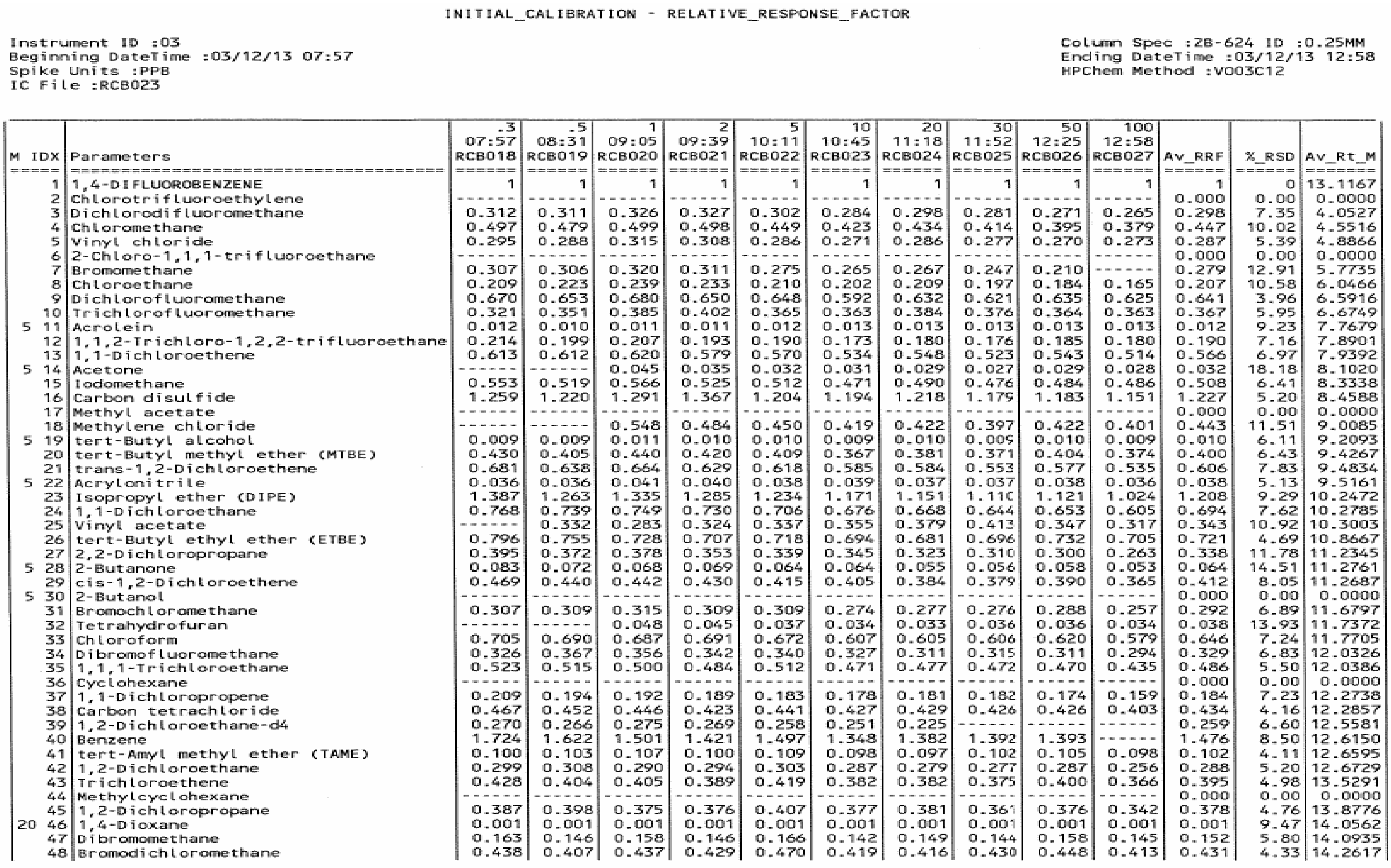
REC395.D   VO67E24.M        Wed May 25 16:38:57 2011                  Page 4
```

Figure 3: TYPICAL ICAL SUMMARY



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                              INITIAL_CALIBRATION - RELATIVE_RESPONSE_FACTOR

Instrument ID :03                                                         Column Spec :ZB-624 ID :0.25MM
Beginning DateTime :03/12/13 07:57                                        Ending DateTime :03/12/13 12:58
Spike Units :PPB                                                          HPChem Method :V003C12
IC File :RCB023

-----------------------------------------------------------------------------------------------------------------------------
     |                                      |    .3|    .5|     1|     2|     5|    10|    20|    30|    50|   100|      |      |
     |                                      | 07:57| 08:31| 09:05| 09:39| 10:11| 10:45| 11:18| 11:52| 12:25| 12:58|      |      |
M IDX|Parameters                            |RCB018|RCB019|RCB020|RCB021|RCB022|RCB023|RCB024|RCB025|RCB026|RCB027|Av_RRF| %_RSD|Av_Rt_M
=====|======================================|======|======|======|======|======|======|======|======|======|======|======|======|=======
    1|1,4-DIFLUOROBENZENE                   |     1|     1|     1|     1|     1|     1|     1|     1|     1|     1|     1|     0|13.1167
    2|Chlorotrifluoroethylene               |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
    3|Dichlorodifluoromethane               | 0.312| 0.311| 0.326| 0.327| 0.302| 0.284| 0.298| 0.281| 0.271| 0.265| 0.298|  7.35| 4.0527
    4|Chloromethane                         | 0.497| 0.479| 0.499| 0.498| 0.449| 0.423| 0.434| 0.414| 0.395| 0.379| 0.447| 10.02| 4.5516
    5|Vinyl chloride                        | 0.295| 0.288| 0.315| 0.308| 0.286| 0.271| 0.286| 0.277| 0.270| 0.273| 0.287|  5.39| 4.8866
    6|2-Chloro-1,1,1-trifluoroethane        |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
    7|Bromomethane                          | 0.307| 0.306| 0.320| 0.311| 0.275| 0.265| 0.267| 0.247| 0.210|------| 0.279| 12.91| 5.7735
    8|Chloroethane                          | 0.209| 0.223| 0.239| 0.233| 0.210| 0.202| 0.209| 0.197| 0.184| 0.165| 0.207| 10.58| 6.0466
    9|Dichlorofluoromethane                 | 0.670| 0.653| 0.680| 0.650| 0.648| 0.592| 0.632| 0.621| 0.635| 0.625| 0.641|  3.96| 6.5916
   10|Trichlorofluoromethane                | 0.321| 0.351| 0.385| 0.402| 0.365| 0.363| 0.384| 0.376| 0.364| 0.363| 0.367|  5.95| 6.6749
 5 11|Acrolein                              | 0.012| 0.010| 0.011| 0.011| 0.012| 0.013| 0.013| 0.013| 0.013| 0.013| 0.012|  9.23| 7.7679
   12|1,1,2-Trichloro-1,2,2-trifluoroethane | 0.214| 0.199| 0.207| 0.193| 0.190| 0.173| 0.180| 0.176| 0.185| 0.180| 0.190|  7.16| 7.8901
   13|1,1-Dichloroethene                    | 0.613| 0.612| 0.620| 0.579| 0.570| 0.534| 0.548| 0.523| 0.543| 0.514| 0.566|  6.97| 7.9392
 5 14|Acetone                               |------|------| 0.045| 0.035| 0.032| 0.031| 0.029| 0.027| 0.029| 0.028| 0.032| 18.18| 8.1020
   15|Iodomethane                           | 0.553| 0.519| 0.566| 0.525| 0.512| 0.471| 0.490| 0.476| 0.484| 0.486| 0.508|  6.41| 8.3338
   16|Carbon disulfide                      | 1.259| 1.220| 1.291| 1.367| 1.204| 1.194| 1.218| 1.179| 1.183| 1.151| 1.227|  5.20| 8.4588
   17|Methyl acetate                        |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
   18|Methylene chloride                    |------|------| 0.548| 0.484| 0.450| 0.419| 0.422| 0.397| 0.422| 0.401| 0.443| 11.51| 9.0085
 5 19|tert-Butyl alcohol                    | 0.009| 0.009| 0.011| 0.010| 0.010| 0.009| 0.010| 0.009| 0.010| 0.009| 0.010|  6.11| 9.2093
   20|tert-Butyl methyl ether (MTBE)        | 0.430| 0.405| 0.440| 0.420| 0.409| 0.367| 0.381| 0.371| 0.404| 0.374| 0.400|  6.43| 9.4267
   21|trans-1,2-Dichloroethene              | 0.681| 0.638| 0.664| 0.629| 0.618| 0.585| 0.584| 0.553| 0.577| 0.535| 0.606|  7.83| 9.4834
 5 22|Acrylonitrile                         | 0.036| 0.036| 0.041| 0.040| 0.038| 0.039| 0.037| 0.037| 0.038| 0.036| 0.038|  5.13| 9.5161
   23|Isopropyl ether (DIPE)                | 1.387| 1.263| 1.335| 1.285| 1.234| 1.171| 1.151| 1.110| 1.121| 1.024| 1.208|  9.29|10.2472
   24|1,1-Dichloroethane                    | 0.768| 0.739| 0.749| 0.730| 0.706| 0.676| 0.668| 0.644| 0.653| 0.605| 0.694|  7.62|10.2785
   25|Vinyl acetate                         |------| 0.332| 0.283| 0.324| 0.337| 0.355| 0.379| 0.413| 0.347| 0.317| 0.343| 10.92|10.3003
   26|tert-Butyl ethyl ether (ETBE)         | 0.796| 0.755| 0.728| 0.707| 0.718| 0.694| 0.681| 0.696| 0.732| 0.705| 0.721|  4.69|10.8667
   27|2,2-Dichloropropane                   | 0.395| 0.372| 0.378| 0.353| 0.339| 0.345| 0.323| 0.310| 0.300| 0.263| 0.338| 11.78|11.2345
 5 28|2-Butanone                            | 0.083| 0.072| 0.068| 0.069| 0.064| 0.064| 0.055| 0.056| 0.058| 0.053| 0.064| 14.51|11.2761
   29|cis-1,2-Dichloroethene                | 0.469| 0.440| 0.442| 0.430| 0.415| 0.405| 0.384| 0.379| 0.390| 0.365| 0.412|  8.05|11.2687
 5 30|2-Butanol                             |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
   31|Bromochloromethane                    | 0.307| 0.309| 0.315| 0.309| 0.309| 0.274| 0.277| 0.276| 0.288| 0.257| 0.292|  6.89|11.6797
   32|Tetrahydrofuran                       |------|------| 0.048| 0.045| 0.037| 0.034| 0.033| 0.036| 0.036| 0.034| 0.038| 13.93|11.7372
   33|Chloroform                            | 0.705| 0.690| 0.687| 0.691| 0.672| 0.607| 0.605| 0.606| 0.620| 0.579| 0.646|  7.24|11.7705
   34|Dibromofluoromethane                  | 0.326| 0.367| 0.356| 0.342| 0.340| 0.327| 0.311| 0.315| 0.311| 0.294| 0.329|  6.83|12.0326
   35|1,1,1-Trichloroethane                 | 0.523| 0.515| 0.500| 0.484| 0.512| 0.471| 0.477| 0.472| 0.470| 0.435| 0.486|  5.50|12.0386
   36|Cyclohexane                           |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
   37|1,1-Dichloropropene                   | 0.209| 0.194| 0.192| 0.189| 0.183| 0.178| 0.181| 0.182| 0.174| 0.159| 0.184|  7.23|12.2738
   38|Carbon tetrachloride                  | 0.467| 0.452| 0.446| 0.423| 0.441| 0.427| 0.429| 0.426| 0.426| 0.403| 0.434|  4.16|12.2857
   39|1,2-Dichloroethane-d4                 | 0.270| 0.266| 0.275| 0.269| 0.258| 0.251| 0.225|------|------|------| 0.259|  6.60|12.5581
   40|Benzene                               | 1.724| 1.622| 1.501| 1.421| 1.497| 1.348| 1.382| 1.392| 1.393|------| 1.476|  8.50|12.6150
   41|tert-Amyl methyl ether (TAME)         | 0.100| 0.103| 0.107| 0.100| 0.109| 0.098| 0.097| 0.102| 0.105| 0.098| 0.102|  4.11|12.6595
   42|1,2-Dichloroethane                    | 0.299| 0.308| 0.290| 0.294| 0.303| 0.287| 0.279| 0.277| 0.287| 0.256| 0.288|  5.20|12.6729
   43|Trichloroethene                       | 0.428| 0.404| 0.405| 0.389| 0.419| 0.382| 0.382| 0.375| 0.400| 0.366| 0.395|  4.98|13.5291
   44|Methylcyclohexane                     |------|------|------|------|------|------|------|------|------|------| 0.000|  0.00| 0.0000
   45|1,2-Dichloropropane                   | 0.387| 0.398| 0.375| 0.376| 0.407| 0.377| 0.381| 0.361| 0.376| 0.342| 0.378|  4.76|13.8776
20 46|1,4-Dioxane                           | 0.001| 0.001| 0.001| 0.001| 0.001| 0.001| 0.001| 0.001| 0.001| 0.001| 0.001|  9.47|14.0562
   47|Dibromomethane                        | 0.163| 0.146| 0.158| 0.146| 0.166| 0.142| 0.149| 0.144| 0.158| 0.145| 0.152|  5.80|14.0935
   48|Bromodichloromethane                  | 0.438| 0.407| 0.437| 0.429| 0.470| 0.419| 0.416| 0.430| 0.448| 0.413| 0.431|  4.33|14.2617
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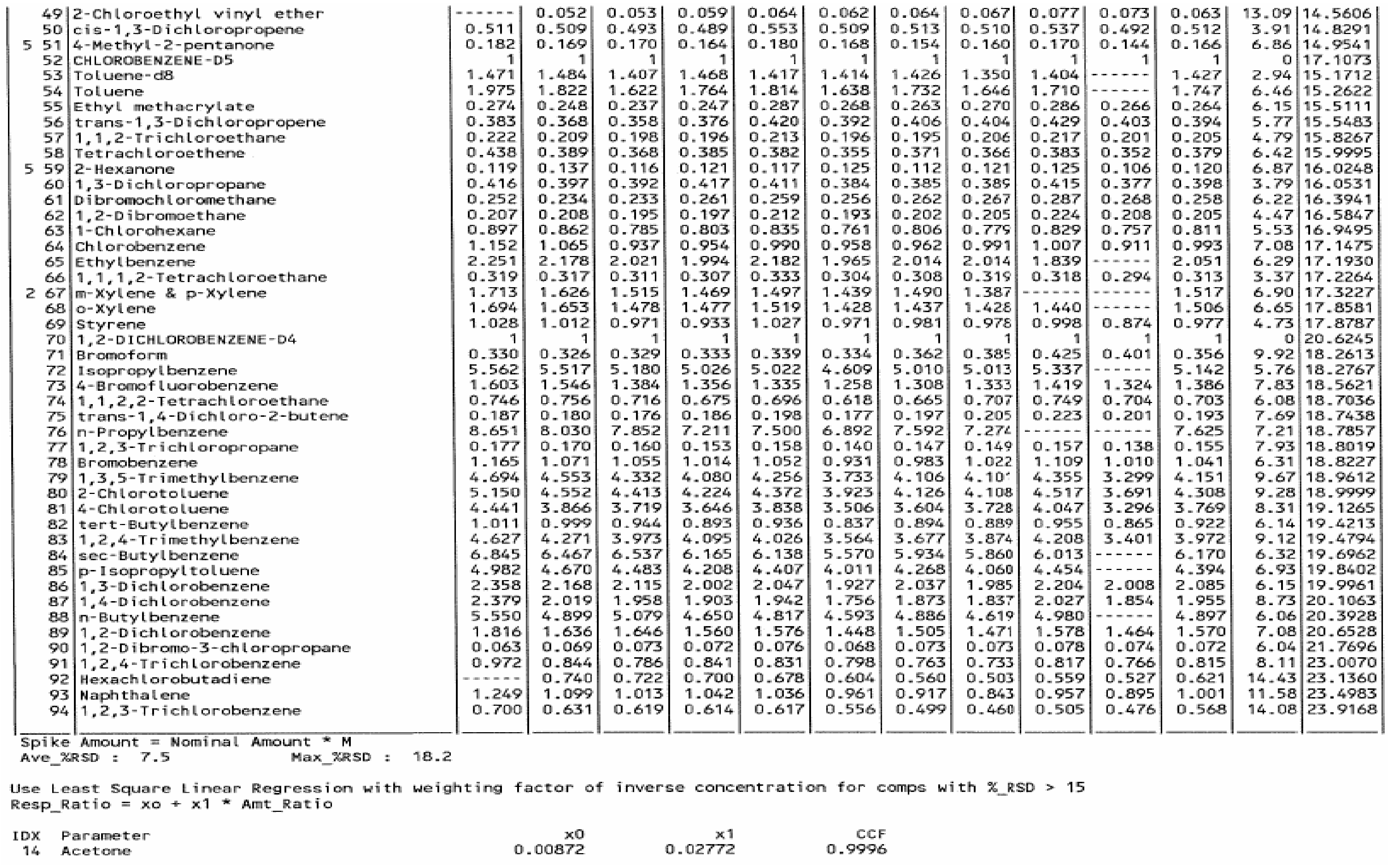
Figure 3 (cont.): TYPICAL ICAL SUMMARY



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    49|2-Chloroethyl vinyl ether          |------|0.052|0.053|0.059|0.064|0.062|0.064|0.067|0.077|0.073|0.063|13.09|14.5606|
    50|cis-1,3-Dichloropropene            | 0.511|0.509|0.493|0.489|0.553|0.509|0.513|0.510|0.537|0.492|0.512| 3.91|14.8291|
  5 51|4-Methyl-2-pentanone               | 0.182|0.169|0.170|0.164|0.180|0.168|0.154|0.160|0.170|0.144|0.166| 6.86|14.9541|
    52|CHLOROBENZENE-D5                   |     1|    1|    1|    1|    1|    1|    1|    1|    1|    1|    1|    0|17.1073|
    53|Toluene-d8                         | 1.471|1.484|1.407|1.468|1.417|1.414|1.426|1.350|1.404|------|1.427| 2.94|15.1712|
    54|Toluene                            | 1.975|1.822|1.622|1.764|1.814|1.638|1.732|1.646|1.710|------|1.747| 6.46|15.2622|
    55|Ethyl methacrylate                 | 0.274|0.248|0.237|0.247|0.287|0.268|0.263|0.270|0.286|0.266|0.264| 6.15|15.5111|
    56|trans-1,3-Dichloropropene          | 0.383|0.368|0.358|0.376|0.420|0.392|0.406|0.404|0.429|0.403|0.394| 5.77|15.5483|
    57|1,1,2-Trichloroethane              | 0.222|0.209|0.198|0.196|0.213|0.196|0.195|0.206|0.217|0.201|0.205| 4.79|15.8267|
    58|Tetrachloroethene                  | 0.438|0.389|0.368|0.385|0.382|0.355|0.371|0.366|0.383|0.352|0.379| 6.42|15.9995|
  5 59|2-Hexanone                         | 0.119|0.137|0.116|0.121|0.117|0.125|0.112|0.121|0.125|0.106|0.120| 6.87|16.0248|
    60|1,3-Dichloropropane                | 0.416|0.397|0.392|0.417|0.411|0.384|0.385|0.389|0.415|0.377|0.398| 3.79|16.0531|
    61|Dibromochloromethane               | 0.252|0.234|0.233|0.261|0.259|0.256|0.262|0.267|0.287|0.268|0.258| 6.22|16.3941|
    62|1,2-Dibromoethane                  | 0.207|0.208|0.195|0.197|0.212|0.193|0.202|0.205|0.224|0.208|0.205| 4.47|16.5847|
    63|1-Chlorohexane                     | 0.897|0.862|0.785|0.803|0.835|0.761|0.806|0.779|0.829|0.757|0.811| 5.53|16.9495|
    64|Chlorobenzene                      | 1.152|1.065|0.937|0.954|0.990|0.958|0.962|0.991|1.007|0.911|0.993| 7.08|17.1475|
    65|Ethylbenzene                       | 2.251|2.178|2.021|1.994|2.182|1.965|2.014|2.014|1.839|------|2.051| 6.29|17.1930|
    66|1,1,1,2-Tetrachloroethane          | 0.319|0.317|0.311|0.307|0.333|0.304|0.308|0.319|0.318|0.294|0.313| 3.37|17.2264|
  2 67|m-Xylene & p-Xylene                | 1.713|1.626|1.515|1.469|1.497|1.439|1.490|1.387|------|------|1.517| 6.90|17.3227|
    68|o-Xylene                           | 1.694|1.653|1.478|1.477|1.519|1.428|1.437|1.428|1.440|------|1.506| 6.65|17.8581|
    69|Styrene                            | 1.028|1.012|0.971|0.933|1.027|0.971|0.981|0.978|0.998|0.874|0.977| 4.73|17.8787|
    70|1,2-DICHLOROBENZENE-D4             |     1|    1|    1|    1|    1|    1|    1|    1|    1|    1|    1|    0|20.6245|
    71|Bromoform                          | 0.330|0.326|0.329|0.333|0.339|0.334|0.362|0.385|0.425|0.401|0.356| 9.92|18.2613|
    72|Isopropylbenzene                   | 5.562|5.517|5.180|5.026|5.022|4.609|5.010|5.013|5.337|------|5.142| 5.76|18.2767|
    73|4-Bromofluorobenzene               | 1.603|1.546|1.384|1.356|1.335|1.258|1.308|1.333|1.419|1.324|1.386| 7.83|18.5621|
    74|1,1,2,2-Tetrachloroethane          | 0.746|0.756|0.716|0.675|0.696|0.618|0.665|0.707|0.749|0.704|0.703| 6.08|18.7036|
    75|trans-1,4-Dichloro-2-butene        | 0.187|0.180|0.176|0.186|0.198|0.177|0.197|0.205|0.223|0.201|0.193| 7.69|18.7438|
    76|n-Propylbenzene                    | 8.651|8.030|7.852|7.211|7.500|6.892|7.592|7.274|------|------|7.625| 7.21|18.7857|
    77|1,2,3-Trichloropropane             | 0.177|0.170|0.160|0.153|0.158|0.140|0.147|0.149|0.157|0.138|0.155| 7.93|18.8019|
    78|Bromobenzene                       | 1.165|1.071|1.055|1.014|1.052|0.931|0.983|1.022|1.109|1.010|1.041| 6.31|18.8227|
    79|1,3,5-Trimethylbenzene             | 4.694|4.553|4.332|4.080|4.256|3.733|4.106|4.10'|4.355|3.299|4.151| 9.67|18.9612|
    80|2-Chlorotoluene                    | 5.150|4.552|4.413|4.224|4.372|3.923|4.126|4.108|4.517|3.691|4.308| 9.28|18.9999|
    81|4-Chlorotoluene                    | 4.441|3.866|3.719|3.646|3.838|3.506|3.604|3.728|4.047|3.296|3.769| 8.31|19.1265|
    82|tert-Butylbenzene                  | 1.011|0.999|0.944|0.893|0.936|0.837|0.894|0.889|0.955|0.865|0.922| 6.14|19.4213|
    83|1,2,4-Trimethylbenzene             | 4.627|4.271|3.973|4.095|4.026|3.564|3.677|3.874|4.208|3.401|3.972| 9.12|19.4794|
    84|sec-Butylbenzene                   | 6.845|6.467|6.537|6.165|6.138|5.570|5.934|5.860|6.013|------|6.170| 6.32|19.6962|
    85|p-Isopropyltoluene                 | 4.982|4.670|4.483|4.208|4.407|4.011|4.268|4.060|4.454|------|4.394| 6.93|19.8402|
    86|1,3-Dichlorobenzene                | 2.358|2.168|2.115|2.002|2.047|1.927|2.037|1.985|2.204|2.008|2.085| 6.15|19.9961|
    87|1,4-Dichlorobenzene                | 2.379|2.019|1.958|1.903|1.942|1.756|1.873|1.837|2.027|1.854|1.955| 8.73|20.1063|
    88|n-Butylbenzene                     | 5.550|4.899|5.079|4.650|4.817|4.593|4.886|4.619|4.980|------|4.897| 6.06|20.3928|
    89|1,2-Dichlorobenzene                | 1.816|1.636|1.646|1.560|1.576|1.448|1.505|1.471|1.578|1.464|1.570| 7.08|20.6528|
    90|1,2-Dibromo-3-chloropropane        | 0.063|0.069|0.073|0.072|0.076|0.068|0.073|0.073|0.078|0.074|0.072| 6.04|21.7696|
    91|1,2,4-Trichlorobenzene             | 0.972|0.844|0.786|0.841|0.831|0.798|0.763|0.733|0.817|0.766|0.815| 8.11|23.0070|
    92|Hexachlorobutadiene                |------|0.740|0.722|0.700|0.678|0.604|0.560|0.503|0.559|0.527|0.621|14.43|23.1360|
    93|Naphthalene                        | 1.249|1.099|1.013|1.042|1.036|0.961|0.917|0.843|0.957|0.895|1.001|11.58|23.4983|
    94|1,2,3-Trichlorobenzene             | 0.700|0.631|0.619|0.614|0.617|0.556|0.499|0.460|0.505|0.476|0.568|14.08|23.9168|

 Spike Amount = Nominal Amount * M
 Ave_%RSD :  7.5               Max_%RSD :   18.2

Use Least Square Linear Regression with weighting factor of inverse concentration for comps with %_RSD > 15
Resp_Ratio = xo + x1 * Amt_Ratio

IDX  Parameter                          x0           x1          CCF
 14  Acetone                         0.00872      0.02772      0.9996
```
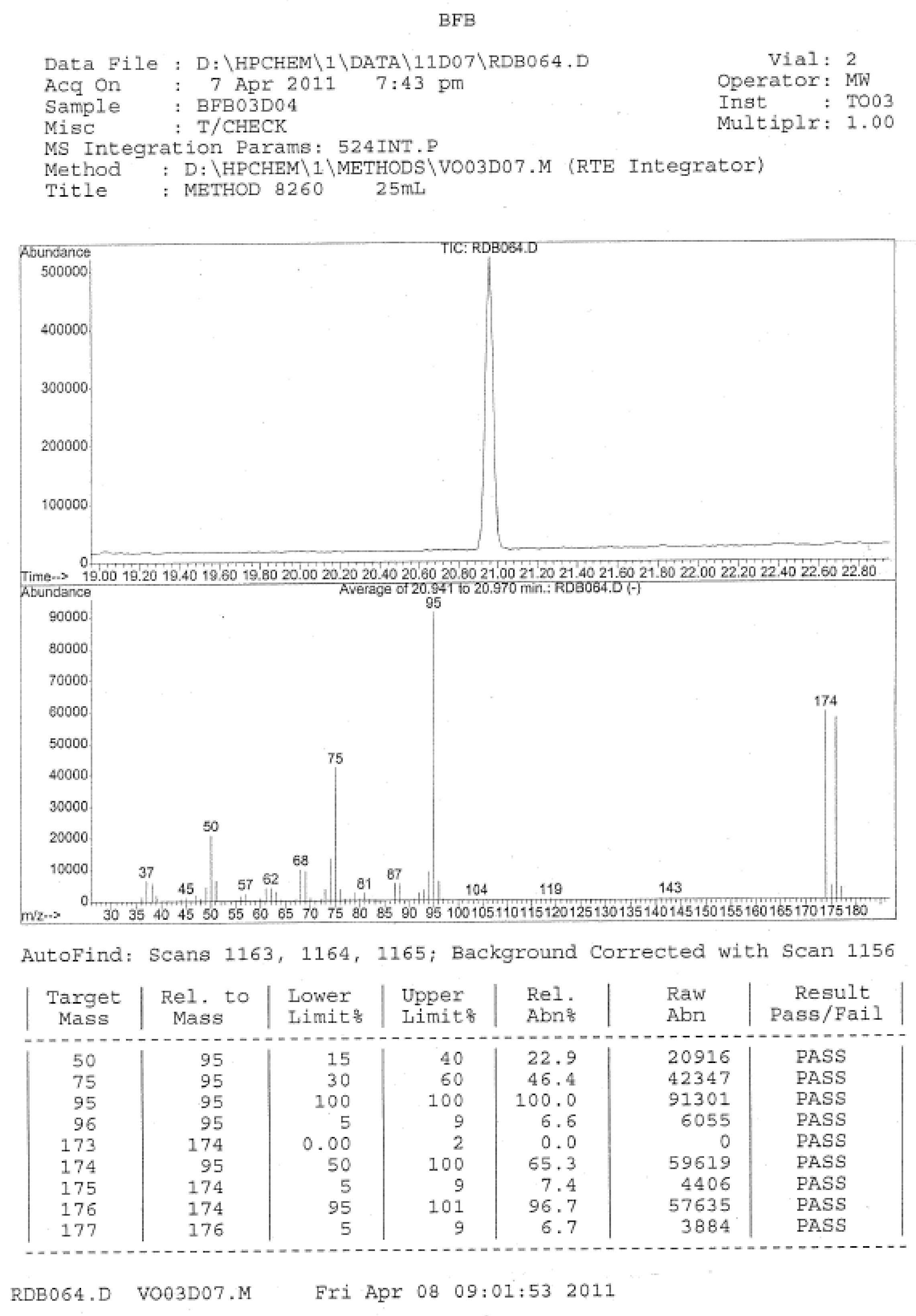

Figure 4: TYPICAL INSTRUMENT PERFORMANCE CHECK (TUNING)



BFB

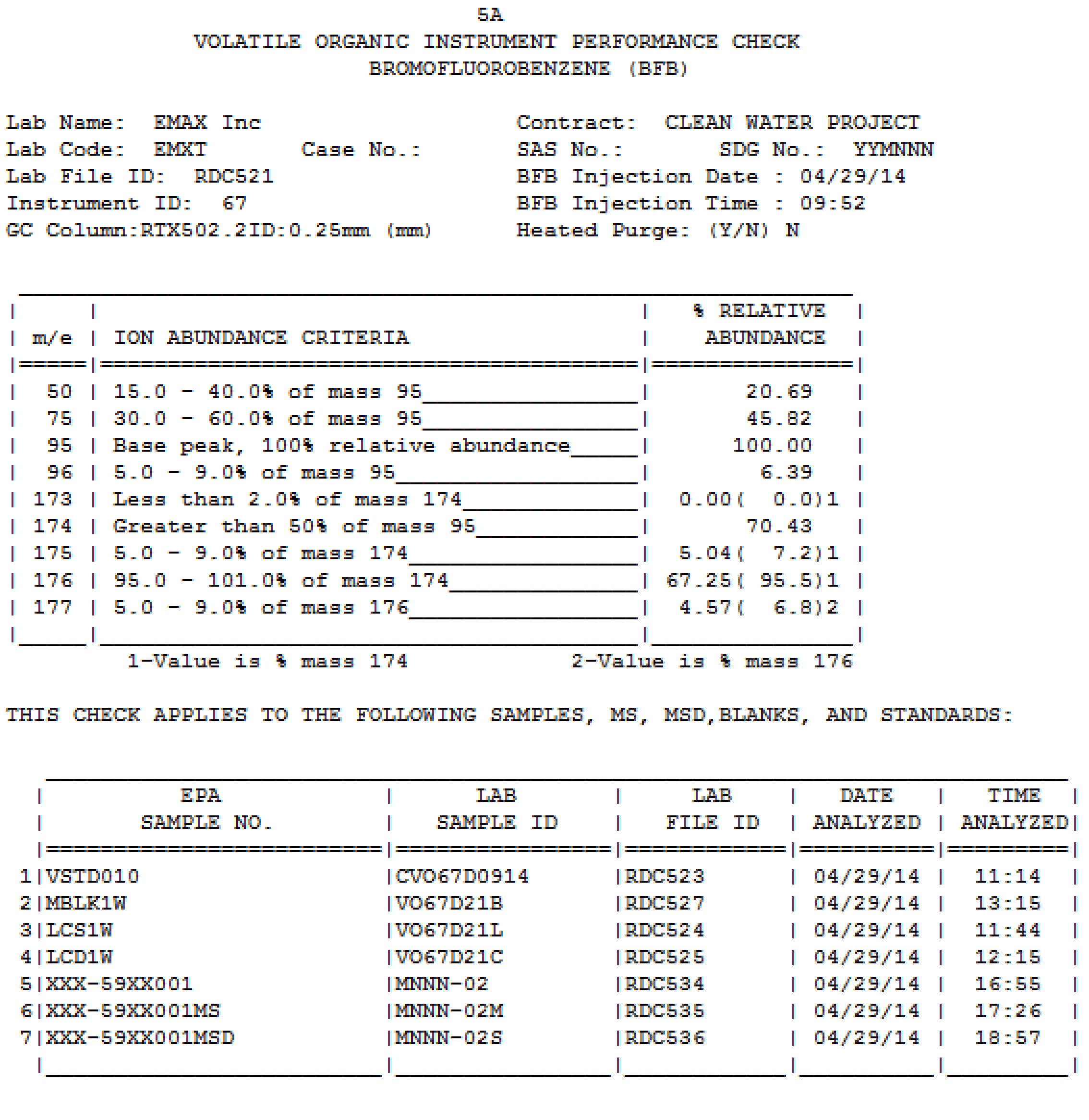
```
Data File : D:\HPCHEM\1\DATA\11D07\RDB064.D                Vial: 2
Acq On    :  7 Apr 2011   7:43 pm                      Operator: MW
Sample    : BFB03D04                                   Inst    : TO03
Misc      : T/CHECK                                    Multiplr: 1.00
MS Integration Params: 524INT.P
Method    : D:\HPCHEM\1\METHODS\VO03D07.M (RTE Integrator)
Title     : METHOD 8260     25mL
```

AutoFind: Scans 1163, 1164, 1165; Background Corrected with Scan 1156

Target Mass	Rel. to Mass	Lower Limit%	Upper Limit%	Rel. Abn%	Raw Abn	Result Pass/Fail
50	95	15	40	22.9	20916	PASS
75	95	30	60	46.4	42347	PASS
95	95	100	100	100.0	91301	PASS
96	95	5	9	6.6	6055	PASS
173	174	0.00	2	0.0	0	PASS
174	95	50	100	65.3	59619	PASS
175	174	5	9	7.4	4406	PASS
176	174	95	101	96.7	57635	PASS
177	176	5	9	6.7	3884	PASS

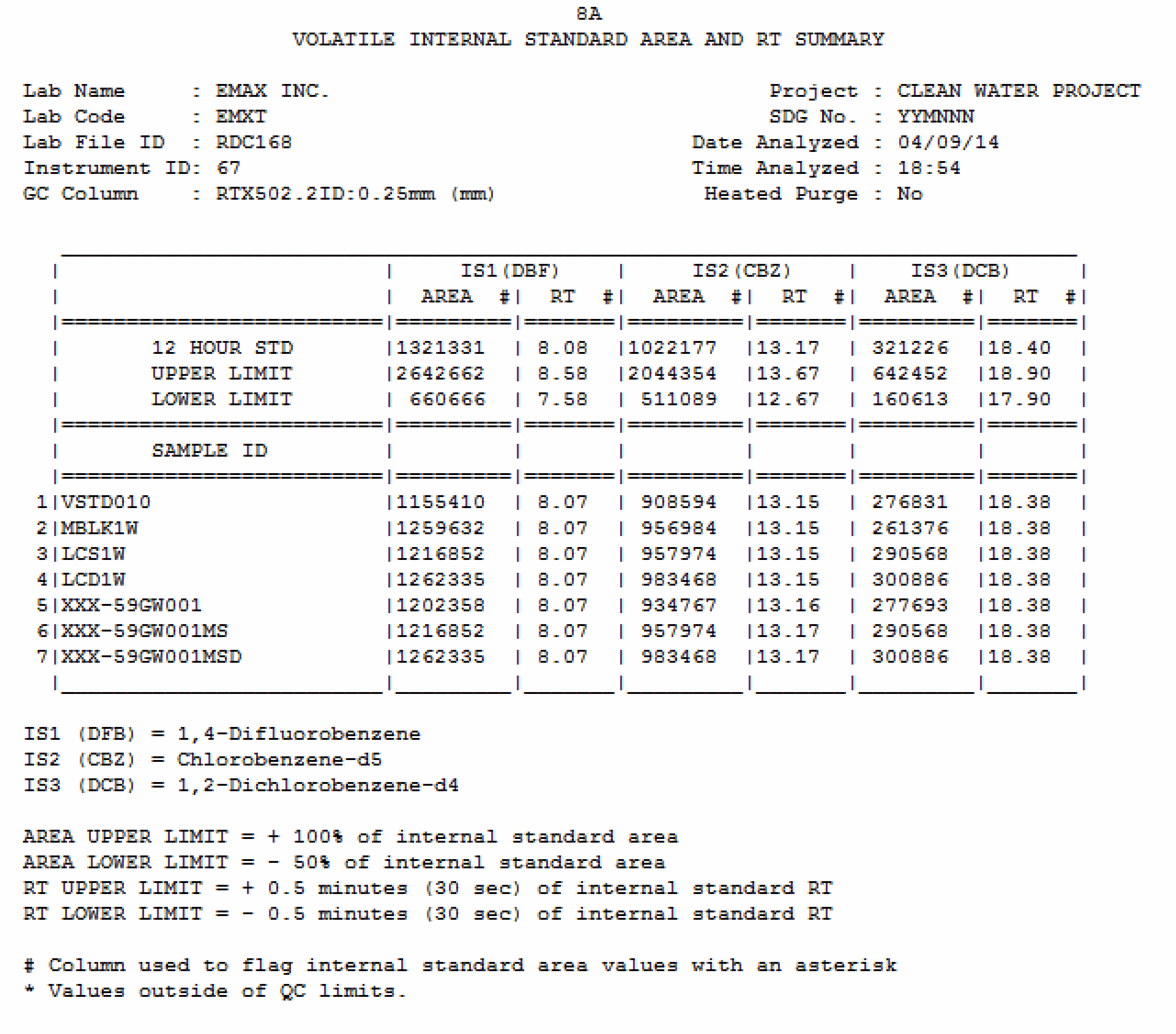
RDB064.D VO03D07.M   Fri Apr 08 09:01:53 2011

Figure 5: TYPICAL INSTRUMENT PERFORMANCE CHECK (TUNING) SUMMARY



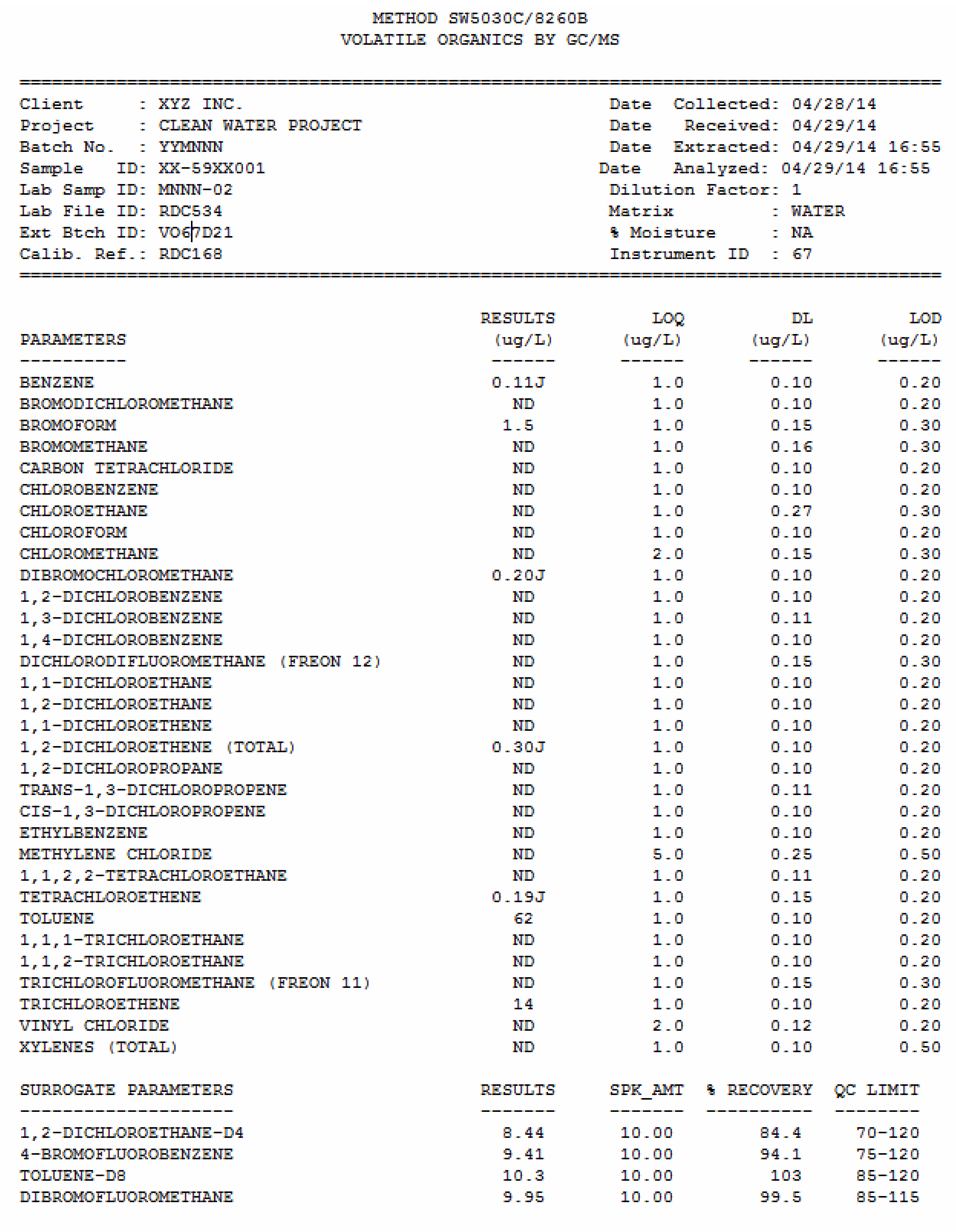
```
                                   5A
               VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK
                          BROMOFLUOROBENZENE (BFB)

Lab Name:  EMAX Inc                    Contract:  CLEAN WATER PROJECT
Lab Code:  EMXT       Case No.:        SAS No.:        SDG No.:  YYMNNN
Lab File ID:  RDC521                   BFB Injection Date : 04/29/14
Instrument ID:  67                     BFB Injection Time : 09:52
GC Column:RTX502.2ID:0.25mm (mm)       Heated Purge: (Y/N) N

 _____________________________________________________________
|     |                                        |  % RELATIVE   |
| m/e | ION ABUNDANCE CRITERIA                 |   ABUNDANCE   |
|=====|========================================|===============|
|  50 | 15.0 - 40.0% of mass 95________________|      20.69    |
|  75 | 30.0 - 60.0% of mass 95________________|      45.82    |
|  95 | Base peak, 100% relative abundance_____|     100.00    |
|  96 | 5.0 - 9.0% of mass 95__________________|       6.39    |
| 173 | Less than 2.0% of mass 174_____________|  0.00(  0.0)1 |
| 174 | Greater than 50% of mass 95____________|      70.43    |
| 175 | 5.0 - 9.0% of mass 174_________________|  5.04(  7.2)1 |
| 176 | 95.0 - 101.0% of mass 174______________| 67.25( 95.5)1 |
| 177 | 5.0 - 9.0% of mass 176_________________|  4.57(  6.8)2 |
|_____|________________________________________|_______________|
         1-Value is % mass 174              2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD,BLANKS, AND STANDARDS:

    __________________________________________________________________________
  |            EPA           |      LAB        |     LAB     |   DATE   |   TIME  |
  |         SAMPLE NO.       |   SAMPLE ID     |   FILE ID   | ANALYZED | ANALYZED|
  |==========================|=================|=============|==========|=========|
 1|VSTD010                   |CVO67D0914       |RDC523       | 04/29/14 |  11:14  |
 2|MBLK1W                    |VO67D21B         |RDC527       | 04/29/14 |  13:15  |
 3|LCS1W                     |VO67D21L         |RDC524       | 04/29/14 |  11:44  |
 4|LCD1W                     |VO67D21C         |RDC525       | 04/29/14 |  12:15  |
 5|XXX-59XX001               |MNNN-02          |RDC534       | 04/29/14 |  16:55  |
 6|XXX-59XX001MS             |MNNN-02M         |RDC535       | 04/29/14 |  17:26  |
 7|XXX-59XX001MSD            |MNNN-02S         |RDC536       | 04/29/14 |  18:57  |
  |__________________________|_________________|_____________|__________|_________|
```

Figure 6: TYPICAL INTERNAL STANDARD AREA AND RETENTION TIME SUMMARY



```
                                    8A
                VOLATILE INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name      : EMAX INC.                              Project : CLEAN WATER PROJECT
Lab Code      : EMXT                                   SDG No. : YYMNNN
Lab File ID   : RDC168                           Date Analyzed : 04/09/14
Instrument ID: 67                                Time Analyzed : 18:54
GC Column     : RTX502.2ID:0.25mm (mm)            Heated Purge : No

    _______________________________________________________________________________
   |                          |     IS1(DBF)      |     IS2(CBZ)      |     IS3(DCB)      |
   |                          |  AREA   #|  RT   #|  AREA   #|  RT   #|  AREA   #|  RT   #|
   |==========================|=========|=======|=========|=======|=========|=======|
   |        12 HOUR STD       |1321331  | 8.08  |1022177  |13.17  | 321226  |18.40  |
   |        UPPER LIMIT       |2642662  | 8.58  |2044354  |13.67  | 642452  |18.90  |
   |        LOWER LIMIT       | 660666  | 7.58  | 511089  |12.67  | 160613  |17.90  |
   |==========================|=========|=======|=========|=======|=========|=======|
   |        SAMPLE ID         |         |       |         |       |         |       |
   |==========================|=========|=======|=========|=======|=========|=======|
  1|VSTD010                   |1155410  | 8.07  | 908594  |13.15  | 276831  |18.38  |
  2|MBLK1W                    |1259632  | 8.07  | 956984  |13.15  | 261376  |18.38  |
  3|LCS1W                     |1216852  | 8.07  | 957974  |13.15  | 290568  |18.38  |
  4|LCD1W                     |1262335  | 8.07  | 983468  |13.15  | 300886  |18.38  |
  5|XXX-59GW001               |1202358  | 8.07  | 934767  |13.16  | 277693  |18.38  |
  6|XXX-59GW001MS             |1216852  | 8.07  | 957974  |13.17  | 290568  |18.38  |
  7|XXX-59GW001MSD            |1262335  | 8.07  | 983468  |13.17  | 300886  |18.38  |
   |__________________________|_________|_______|_________|_______|_________|_______|

IS1 (DFB) = 1,4-Difluorobenzene
IS2 (CBZ) = Chlorobenzene-d5
IS3 (DCB) = 1,2-Dichlorobenzene-d4

AREA UPPER LIMIT = + 100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.5 minutes (30 sec) of internal standard RT
RT LOWER LIMIT = - 0.5 minutes (30 sec) of internal standard RT

# Column used to flag internal standard area values with an asterisk
* Values outside of QC limits.
```

Figure 7: TYPICAL SAMPLE RESULT SUMMARY



```
                             METHOD SW5030C/8260B
                          VOLATILE ORGANICS BY GC/MS

=====================================================================================
Client      : XYZ INC.                                 Date   Collected: 04/28/14
Project     : CLEAN WATER PROJECT                      Date    Received: 04/29/14
Batch No.   : YYMNNN                                   Date   Extracted: 04/29/14 16:55
Sample    ID: XX-59XX001                              Date   Analyzed: 04/29/14 16:55
Lab Samp ID: MNNN-02                                   Dilution Factor: 1
Lab File ID: RDC534                                    Matrix          : WATER
Ext Btch ID: VO67D21                                   % Moisture      : NA
Calib. Ref.: RDC168                                    Instrument ID   : 67
=====================================================================================

                                          RESULTS         LOQ         DL        LOD
PARAMETERS                                 (ug/L)      (ug/L)     (ug/L)     (ug/L)
----------                                 ------      ------     ------     ------
BENZENE                                    0.11J         1.0       0.10       0.20
BROMODICHLOROMETHANE                         ND          1.0       0.10       0.20
BROMOFORM                                   1.5          1.0       0.15       0.30
BROMOMETHANE                                 ND          1.0       0.16       0.30
CARBON TETRACHLORIDE                         ND          1.0       0.10       0.20
CHLOROBENZENE                                ND          1.0       0.10       0.20
CHLOROETHANE                                 ND          1.0       0.27       0.30
CHLOROFORM                                   ND          1.0       0.10       0.20
CHLOROMETHANE                                ND          2.0       0.15       0.30
DIBROMOCHLOROMETHANE                       0.20J         1.0       0.10       0.20
1,2-DICHLOROBENZENE                          ND          1.0       0.10       0.20
1,3-DICHLOROBENZENE                          ND          1.0       0.11       0.20
1,4-DICHLOROBENZENE                          ND          1.0       0.10       0.20
DICHLORODIFLUOROMETHANE (FREON 12)           ND          1.0       0.15       0.30
1,1-DICHLOROETHANE                           ND          1.0       0.10       0.20
1,2-DICHLOROETHANE                           ND          1.0       0.10       0.20
1,1-DICHLOROETHENE                           ND          1.0       0.10       0.20
1,2-DICHLOROETHENE (TOTAL)                 0.30J         1.0       0.10       0.20
1,2-DICHLOROPROPANE                          ND          1.0       0.10       0.20
TRANS-1,3-DICHLOROPROPENE                    ND          1.0       0.11       0.20
CIS-1,3-DICHLOROPROPENE                      ND          1.0       0.10       0.20
ETHYLBENZENE                                 ND          1.0       0.10       0.20
METHYLENE CHLORIDE                           ND          5.0       0.25       0.50
1,1,2,2-TETRACHLOROETHANE                    ND          1.0       0.11       0.20
TETRACHLOROETHENE                          0.19J         1.0       0.15       0.20
TOLUENE                                      62          1.0       0.10       0.20
1,1,1-TRICHLOROETHANE                        ND          1.0       0.10       0.20
1,1,2-TRICHLOROETHANE                        ND          1.0       0.10       0.20
TRICHLOROFLUOROMETHANE (FREON 11)            ND          1.0       0.15       0.30
TRICHLOROETHENE                              14          1.0       0.10       0.20
VINYL CHLORIDE                               ND          2.0       0.12       0.20
XYLENES (TOTAL)                              ND          1.0       0.10       0.50

SURROGATE PARAMETERS                      RESULTS     SPK_AMT   % RECOVERY  QC LIMIT
--------------------                      -------     -------   ----------  --------
1,2-DICHLOROETHANE-D4                       8.44       10.00         84.4    70-120
4-BROMOFLUOROBENZENE                        9.41       10.00         94.1    75-120
TOLUENE-D8                                  10.3       10.00          103    85-120
DIBROMOFLUOROMETHANE                        9.95       10.00         99.5    85-115
```

Figure 8: TYPICAL LCS/LCSD SUMMARY

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT: XYZ INC.
PROJECT: CLEAN WATER PROJECT
BATCH NO.: YYMNNN
METHOD: SW5030C/8260B

MATRIX:	WATER			% MOISTURE:	NA
DILUTION FACTOR:	1	1	1		
SAMPLE ID:	MBLK1W				
LAB SAMP ID:	VO67D21B	VO67D21L	VO67D21C		
LAB FILE ID:	RDC527	RDC524	RDC525		
DATE EXTRACTED:	04/29/1413:15	04/29/1411:44	04/29/1412:15	DATE COLLECTED:	NA
DATE ANALYZED:	04/29/1413:15	04/29/1411:44	04/29/1412:15	DATE RECEIVED:	04/29/14
PREP. BATCH:	VO67D21	VO67D21	VO67D21		
CALIB. REF:	RDC168	RDC168	RDC168		

ACCESSION:

PARAMETER	BLNK RSLT (ug/L)	SPIKE AMT (ug/L)	BS RSLT (ug/L)	BS % REC	SPIKE AMT (ug/L)	BSD RSLT (ug/L)	BSD % REC	RPD (%)	QC LIMIT (%)	MAX RPD (%)
Benzene	ND	10.0	9.32	93	10.0	9.17	92	2	80-120	30
Bromodichloromethane	ND	10.0	9.65	97	10.0	9.37	94	3	75-120	30
Bromoform	ND	10.0	10.1	101	10.0	9.80	98	3	70-130	30
Bromomethane	ND	10.0	10.6	106	10.0	9.80	98	7	30-145	30
Carbon Tetrachloride	ND	10.0	8.35	83	10.0	8.20	82	2	65-140	30
Chlorobenzene	ND	10.0	9.78	98	10.0	9.68	97	1	80-120	30
Chloroethane	ND	10.0	11.0	110	10.0	10.1	101	8	60-135	30
Chloroform	ND	10.0	9.84	98	10.0	9.56	96	3	65-135	30
Chloromethane	ND	10.0	10.2	102	10.0	9.58	96	7	40-125	30
Dibromochloromethane	ND	10.0	9.64	96	10.0	9.49	95	2	60-135	30
1,2-Dichlorobenzene	ND	10.0	10.3	103	10.0	10.1	101	2	70-120	30
1,3-Dichlorobenzene	ND	10.0	10.1	101	10.0	9.91	99	2	75-125	30
1,4-Dichlorobenzene	ND	10.0	10.0	100	10.0	9.87	99	1	75-125	30
Dichlorodifluoromethane (Freon 12)	ND	10.0	9.93	99	10.0	9.39	94	6	30-155	30
1,1-Dichloroethane	ND	10.0	9.27	93	10.0	8.99	90	3	70-135	30
1,2-Dichloroethane	ND	10.0	7.97	80	10.0	7.88	79	1	70-130	30
1,1-Dichloroethene	ND	10.0	7.58	76	10.0	7.41	74	2	70-130	30
1,2-Dichloroethene (Total)	ND	20.0	17.1	85	20.0	16.6	83	3	70-125	30
1,2-Dichloropropane	ND	10.0	9.90	99	10.0	9.70	97	2	75-125	30
Trans-1,3-Dichloropropene	ND	10.0	8.39	84	10.0	8.49	85	1	55-140	30
cis-1,3-Dichloropropene	ND	10.0	9.23	92	10.0	8.93	89	3	70-130	30
Ethylbenzene	ND	10.0	9.84	98	10.0	9.67	97	2	75-125	30
Methylene Chloride	ND	10.0	8.28	83	10.0	8.40	84	1	55-140	30
1,1,2,2-Tetrachloroethane	ND	10.0	10.5	105	10.0	10.3	103	2	65-130	30
Tetrachloroethene	ND	10.0	9.31	93	10.0	9.20	92	1	45-150	30
Toluene	ND	10.0	9.57	96	10.0	9.47	95	1	75-120	30
1,1,1-Trichloroethane	ND	10.0	8.74	87	10.0	8.56	86	2	65-130	30
1,1,2-Trichloroethane	ND	10.0	10.3	103	10.0	10.3	103	0	75-125	30
Trichlorofluoromethane (Freon 11)	ND	10.0	10.8	108	10.0	9.93	99	9	60-145	30
Trichloroethene	ND	10.0	9.46	95	10.0	9.19	92	3	70-125	30
Vinyl Chloride	ND	10.0	10.3	103	10.0	9.61	96	7	50-145	30
Xylenes (Total)	ND	30.0	28.5	95	30.0	28.0	93	2	80-120	30

SURROGATE PARAMETER	SPIKE AMT (ug/L)	BS RSLT (ug/L)	BS % REC	SPIKE AMT (ug/L)	BSD RSLT (ug/L)	BSD % REC	QC LIMIT (%)
1,2-Dichloroethane-d4	10.0	8.20	82	10.0	8.24	82	70-120
4-Bromofluorobenzene	10.0	9.69	97	10.0	9.70	97	75-120
Toluene-d8	10.0	10.4	104	10.0	10.4	104	85-120
Dibromofluoromethane	10.0	9.92	99	10.0	9.85	98	85-115

Figure 9: TYPICAL MS/MSD SUMMARY

```
                                                    EMAX QUALITY CONTROL DATA
                                                         MS/MSD ANALYSIS

CLIENT:          XYZ INC.
PROJECT:         CLEAN WATER PROJECT
BATCH NO.:       YYMNNN
METHOD:          SW5030C/8260B
========================================================================================================================

MATRIX:          WATER                                                  % MOISTURE:      NA
DILUTION FACTOR: 1              1              1
SAMPLE ID:       XXX-59XX001    XXX-59XX001MS  XXX-59XX001MSD
LAB SAMP ID:     MNNN-02        MNNN-02M       MNNN-02S
LAB FILE ID:     RDC534         RDC535         RDC536
DATE EXTRACTED:  04/29/1416:55  04/29/1417:26  04/29/1418:15        DATE COLLECTED:  NA
DATE ANALYZED:   04/29/1416:55  04/29/1417:26  04/29/1418:15        DATE RECEIVED:   04/29/14
PREP. BATCH:     VO67D21        VO67D21        VO67D21
CALIB. REF:      RDC168         RDC168         RDC168

ACCESSION:

                                    BLNK RSLT  SPIKE AMT  BS RSLT     BS   SPIKE AMT  BSD RSLT    BSD    RPD   QC LIMIT  MAX RPD
PARAMETER                             (ug/L)     (ug/L)     (ug/L)    % REC   (ug/L)     (ug/L)    % REC  ( % )   ( % )    ( % )
---------                           ---------- ---------  ---------- ------ ---------  ---------- ------ ------ -------  -------
Benzene                                     ND      10.0        9.32     93      10.0        9.17     92      2  80-120       30
Bromodichloromethane                        ND      10.0        9.65     97      10.0        9.37     94      3  75-120       30
Bromoform                                   ND      10.0        10.1    101      10.0        9.80     98      3  70-130       30
Bromomethane                                ND      10.0        10.6    106      10.0        9.80     98      7  30-145       30
Carbon Tetrachloride                        ND      10.0        8.35     83      10.0        8.20     82      2  65-140       30
Chlorobenzene                               ND      10.0        9.78     98      10.0        9.68     97      1  80-120       30
Chloroethane                                ND      10.0        11.0    110      10.0        10.1    101      8  60-135       30
Chloroform                                  ND      10.0        9.84     98      10.0        9.56     96      3  65-135       30
Chloromethane                               ND      10.0        10.2    102      10.0        9.58     96      7  40-125       30
Dibromochloromethane                        ND      10.0        9.64     96      10.0        9.49     95      2  60-135       30
1,2-Dichlorobenzene                         ND      10.0        10.3    103      10.0        10.1    101      2  70-120       30
1,3-Dichlorobenzene                         ND      10.0        10.1    101      10.0        9.91     99      2  75-125       30
1,4-Dichlorobenzene                         ND      10.0        10.0    100      10.0        9.87     99      1  75-125       30
Dichlorodifluoromethane (Freon 12)          ND      10.0        9.93     99      10.0        9.39     94      6  30-155       30
1,1-Dichloroethane                          ND      10.0        9.27     93      10.0        8.99     90      3  70-135       30
1,2-Dichloroethane                          ND      10.0        7.97     80      10.0        7.88     79      1  70-130       30
1,1-Dichloroethene                          ND      10.0        7.58     76      10.0        7.41     74      2  70-130       30
1,2-Dichloroethene (Total)                  ND      20.0        17.1     85      20.0        16.6     83      3  70-125       30
1,2-Dichloropropane                         ND      10.0        9.90     99      10.0        9.70     97      2  75-125       30
Trans-1,3-Dichloropropene                   ND      10.0        8.39     84      10.0        8.49     85      1  55-140       30
cis-1,3-Dichloropropene                     ND      10.0        9.23     92      10.0        8.93     89      3  70-130       30
Ethylbenzene                                ND      10.0        9.84     98      10.0        9.67     97      2  75-125       30
Methylene Chloride                          ND      10.0        8.28     83      10.0        8.40     84      1  55-140       30
1,1,2,2-Tetrachloroethane                   ND      10.0        10.5    105      10.0        10.3    103      2  65-130       30
Tetrachloroethene                           ND      10.0        9.31     93      10.0        9.20     92      1  45-150       30
Toluene                                     ND      10.0        9.57     96      10.0        9.47     95      1  75-120       30
1,1,1-Trichloroethane                       ND      10.0        8.74     87      10.0        8.56     86      2  65-130       30
1,1,2-Trichloroethane                       ND      10.0        10.3    103      10.0        10.3    103      0  75-125       30
Trichlorofluoromethane (Freon 11)           ND      10.0        10.8    108      10.0        9.93     99      9  60-145       30
Trichloroethene                             ND      10.0        9.46     95      10.0        9.19     92      3  70-125       30
Vinyl Chloride                              ND      10.0        10.3    103      10.0        9.61     96      7  50-145       30
Xylenes (Total)                             ND      30.0        28.5     95      30.0        28.0     93      2  80-120       30

========================================================================================================================

                                    SPIKE AMT  BS RSLT     BS   SPIKE AMT  BSD RSLT    BSD   QC LIMIT
SURROGATE PARAMETER                   (ug/L)     (ug/L)    % REC   (ug/L)     (ug/L)    % REC   ( % )
-------------------                 ---------  ---------- ------ ---------  ---------- ------ -------
1,2-Dichloroethane-d4                    10.0        8.20     82      10.0        8.24     82  70-120
4-Bromofluorobenzene                     10.0        9.69     97      10.0        9.70     97  75-120
Toluene-d8                               10.0        10.4    104      10.0        10.4    104  85-120
Dibromofluoromethane                     10.0        9.92     99      10.0        9.85     98  85-115
```

Figure 10: TYPICAL CASE NARRATIVE

CASE NARRATIVE

Client : XYZ INC.

Project : CLEAN WATER PROJECT

SDG : YYDNNN

METHOD SW5030C/8260B
VOLATILE ORGANICS BY GC/MS

A total of two (2) water samples were received on 04/29/14 for Volatile Organics by GC/MS analysis, Method 5030C/8260B in accordance with USEPA SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods and Project QAPP Clean Water Project.

Holding Time
Samples were analyzed within the prescribed holding time.

Instrument Performance and Calibration
Instrument tune check was performed prior to calibration. Instrument mass ratios were within specification. Multi-calibration points were generated to establish initial calibration (ICAL). ICAL was verified using secondary source (ICV). Continuing calibration (CCV) was carried on at a frequency required by the project. All project calibration requirements were satisfied. Refer to calibration summary forms of ICAL, ICV and CCV for details.

Method Blank
Method blank was analyzed at the frequency required by the project. For this SDG, one method blank was analyzed with the samples. Results were compliant to project requirement.

Lab Control Sample
A set of LCS/LCD was analyzed with the samples in this SDG.
Percent recoveries for VO67D21L/C were all within QC limits.

Matrix QC Sample
Matrix QC sample was analyzed at the frequency prescribed by the project.
Percent recoveries and RPDs for MNNN-02M/S were within project QC limits.

Surrogate
Surrogates were added on QC and field samples. Surrogate recoveries were within project QC limits. Refer to sample result forms for details.

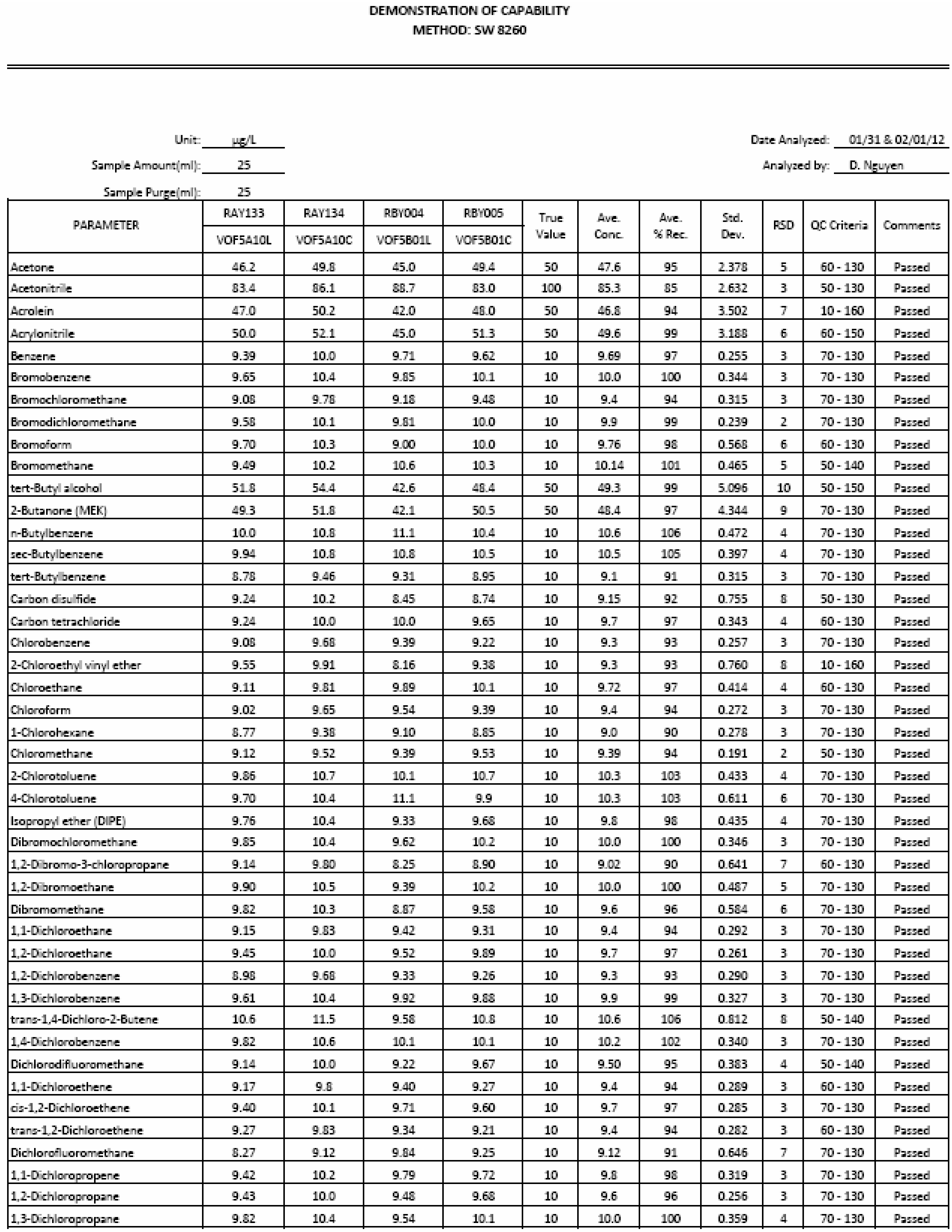
Sample Analysis
Samples were analyzed according to prescribed analytical procedures. All project requirements were met; otherwise, anomalies were discussed within the associated QC parameter.

TOC

Appendix 1: SUMMARY OF QUALITY CONTROL PROCEDURES

QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	1st Rvw	2nd Rvw
Check of mass spectral ion intensities using BFB	Prior to initial calibration and calibration verification	Refer to criteria listed in Table 5	Retune instrument and verify		
Multi point Initial Calibration(ICAL) minimum of 5 points	Initially; as needed	SPCCs : RF ≥ 0.1 for Bromoform, Chloromethane and 1,1-Dichloroethane RF ≥ 0.3 for Chlorobenzene and 1,1,2,2-Tetrachloroethane CCCs: RSD ≤ 30% for the following analytes: Chloroform, 1,1-DCE, 1,2-DCP, Ethylbenzene, Toluene and Vinyl Chloride. 1.) if RRF is applied, then RSD ≤ 15% 2.) If 1st order is applied, then r ≥ 0.995 with min 5 pt ICAL 3.) If 2nd order is applied, then r ≥ 0.99 with min 6 pt ICAL	Check for outliers. Otherwise, optimize the instrument then repeat initial calibration.		
Initial calibration verification (ICV)	After initial calibration	All analytes within ± 20% of expected value except for the following compounds due to erratic chromatographic behavior: Bromomethane, Chloroethane, Chloromethane, Dichlorodifluoromethane but must be within ± 35% of expected value.	Verify second source standard. Prepare fresh standard and rerun ICV. If that fails, Optimize instrument and repeat ICAL.		
Evaluation of relative retention times (RRT)	Each sample	Within ± 0.06 RRT units	Correct the problem then reanalyze all samples analyzed since the last retention time check		
Continuing Calibration verification (CCV)	Daily, before sample analysis and every 12 hours of analysis time	SPCCs: Min. RF same as ICAL CCC : %Diff ≤ 20% (when using RFs) or drift (when using least squares regression or non-linear calibration)	Correct the problem then repeat initial calibration		
Internal Standard (IS)	All samples	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning		
Method blank (MB)	One per preparation batch	No analytes detected > ½ LOQ	Rule out instrument contamination by re-analyzing the MB. If problem persist refer to PSR. In the absence of PSR, report NDs and results >10X of the MB concentration. Otherwise, cure contamination source, re-prep and re-analyze method blank and all associated samples.		
LCS	One LCS per preparation	Within project QC Limits	Re-prep and re-analyze the LCS and all associated samples		
MS/MSD	One MS/MSD per every 20 project samples per matrix	Within project QC Limits	Check if sample was properly spiked. If indicative of matrix interference, discuss in case narrative, otherwise re-prep and re-analyze the sample		
Surrogate	Every Sample, MB, LCS, MS/MSD, DCC	Within project QC Limits	Correct the problem then re-analyze		
Comments: This QCP is applicable in the absence of the PSR Report values between LOD and LOQ. Refer to PSR for Flagging Criteria.			Reviewed by:		
			Date:		

Appendix 2: DEMONSTRATION OF CAPABILITY for 25 ml



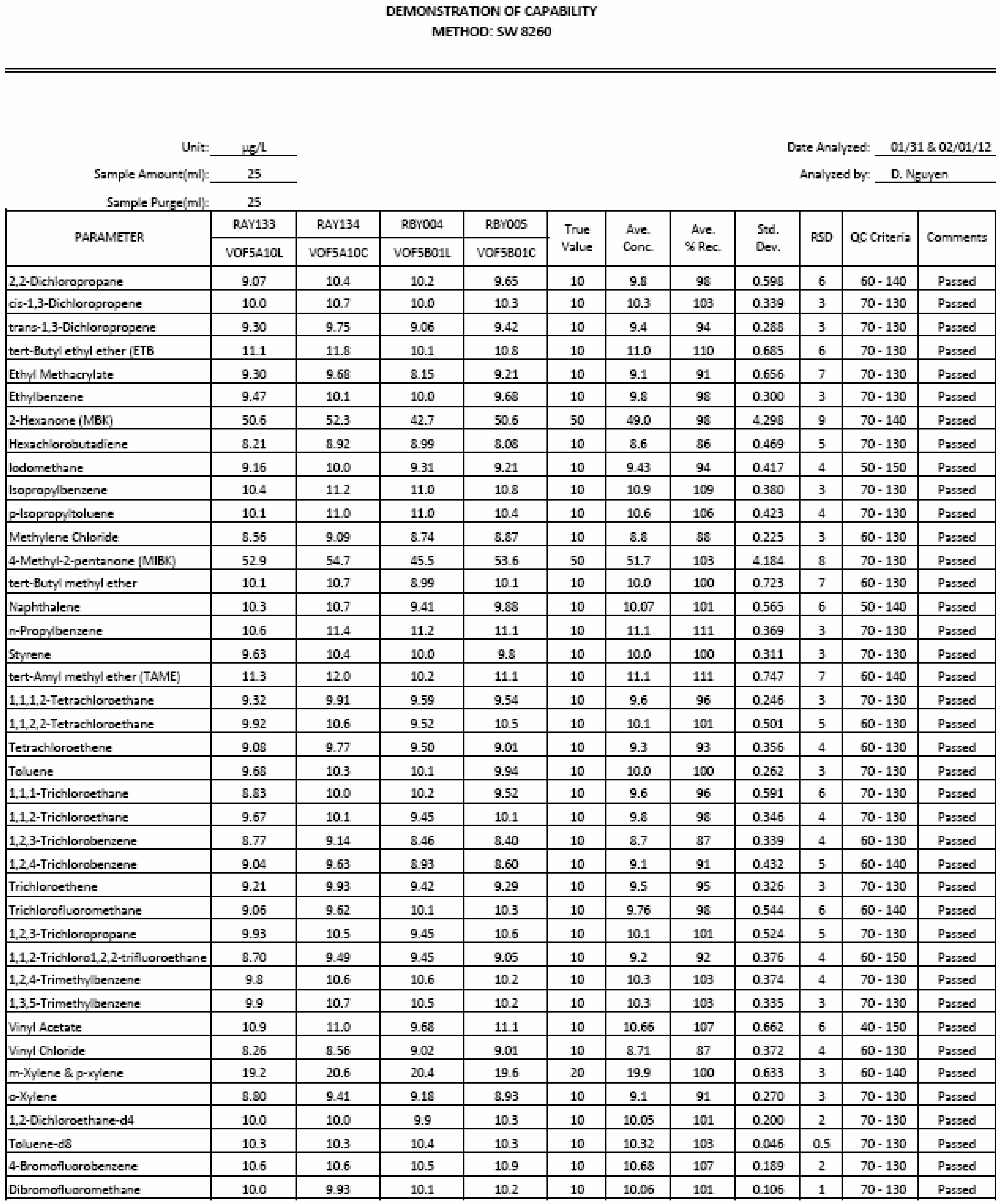
DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/L
Sample Amount(ml): 25
Sample Purge(ml): 25

Date Analyzed: 01/31 & 02/01/12
Analyzed by: D. Nguyen

PARAMETER	RAY133	RAY134	RBY004	RBY005	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
	VOF5A10L	VOF5A10C	VOF5B01L	VOF5B01C							
Acetone	46.2	49.8	45.0	49.4	50	47.6	95	2.378	5	60 - 130	Passed
Acetonitrile	83.4	86.1	88.7	83.0	100	85.3	85	2.632	3	50 - 130	Passed
Acrolein	47.0	50.2	42.0	48.0	50	46.8	94	3.502	7	10 - 160	Passed
Acrylonitrile	50.0	52.1	45.0	51.3	50	49.6	99	3.188	6	60 - 150	Passed
Benzene	9.39	10.0	9.71	9.62	10	9.69	97	0.255	3	70 - 130	Passed
Bromobenzene	9.65	10.4	9.85	10.1	10	10.0	100	0.344	3	70 - 130	Passed
Bromochloromethane	9.08	9.78	9.18	9.48	10	9.4	94	0.315	3	70 - 130	Passed
Bromodichloromethane	9.58	10.1	9.81	10.0	10	9.9	99	0.239	2	70 - 130	Passed
Bromoform	9.70	10.3	9.00	10.0	10	9.76	98	0.568	6	60 - 130	Passed
Bromomethane	9.49	10.2	10.6	10.3	10	10.14	101	0.465	5	50 - 140	Passed
tert-Butyl alcohol	51.8	54.4	42.6	48.4	50	49.3	99	5.096	10	50 - 150	Passed
2-Butanone (MEK)	49.3	51.8	42.1	50.5	50	48.4	97	4.344	9	70 - 130	Passed
n-Butylbenzene	10.0	10.8	11.1	10.4	10	10.6	106	0.472	4	70 - 130	Passed
sec-Butylbenzene	9.94	10.8	10.8	10.5	10	10.5	105	0.397	4	70 - 130	Passed
tert-Butylbenzene	8.78	9.46	9.31	8.95	10	9.1	91	0.315	3	70 - 130	Passed
Carbon disulfide	9.24	10.2	8.45	8.74	10	9.15	92	0.755	8	50 - 130	Passed
Carbon tetrachloride	9.24	10.0	10.0	9.65	10	9.7	97	0.343	4	60 - 130	Passed
Chlorobenzene	9.08	9.68	9.39	9.22	10	9.3	93	0.257	3	70 - 130	Passed
2-Chloroethyl vinyl ether	9.55	9.91	8.16	9.38	10	9.3	93	0.760	8	10 - 160	Passed
Chloroethane	9.11	9.81	9.89	10.1	10	9.72	97	0.414	4	60 - 130	Passed
Chloroform	9.02	9.65	9.54	9.39	10	9.4	94	0.272	3	70 - 130	Passed
1-Chlorohexane	8.77	9.38	9.10	8.85	10	9.0	90	0.278	3	70 - 130	Passed
Chloromethane	9.12	9.52	9.39	9.53	10	9.39	94	0.191	2	50 - 130	Passed
2-Chlorotoluene	9.86	10.7	10.1	10.7	10	10.3	103	0.433	4	70 - 130	Passed
4-Chlorotoluene	9.70	10.4	11.1	9.9	10	10.3	103	0.611	6	70 - 130	Passed
Isopropyl ether (DIPE)	9.76	10.4	9.33	9.68	10	9.8	98	0.435	4	70 - 130	Passed
Dibromochloromethane	9.85	10.4	9.62	10.2	10	10.0	100	0.346	3	70 - 130	Passed
1,2-Dibromo-3-chloropropane	9.14	9.80	8.25	8.90	10	9.02	90	0.641	7	60 - 130	Passed
1,2-Dibromoethane	9.90	10.5	9.39	10.2	10	10.0	100	0.487	5	70 - 130	Passed
Dibromomethane	9.82	10.3	8.87	9.58	10	9.6	96	0.584	6	70 - 130	Passed
1,1-Dichloroethane	9.15	9.83	9.42	9.31	10	9.4	94	0.292	3	70 - 130	Passed
1,2-Dichloroethane	9.45	10.0	9.52	9.89	10	9.7	97	0.261	3	70 - 130	Passed
1,2-Dichlorobenzene	8.98	9.68	9.33	9.26	10	9.3	93	0.290	3	70 - 130	Passed
1,3-Dichlorobenzene	9.61	10.4	9.92	9.88	10	9.9	99	0.327	3	70 - 130	Passed
trans-1,4-Dichloro-2-Butene	10.6	11.5	9.58	10.8	10	10.6	106	0.812	8	50 - 140	Passed
1,4-Dichlorobenzene	9.82	10.6	10.1	10.1	10	10.2	102	0.340	3	70 - 130	Passed
Dichlorodifluoromethane	9.14	10.0	9.22	9.67	10	9.50	95	0.383	4	50 - 140	Passed
1,1-Dichloroethene	9.17	9.8	9.40	9.27	10	9.4	94	0.289	3	60 - 130	Passed
cis-1,2-Dichloroethene	9.40	10.1	9.71	9.60	10	9.7	97	0.285	3	70 - 130	Passed
trans-1,2-Dichloroethene	9.27	9.83	9.34	9.21	10	9.4	94	0.282	3	60 - 130	Passed
Dichlorofluoromethane	8.27	9.12	9.84	9.25	10	9.12	91	0.646	7	70 - 130	Passed
1,1-Dichloropropene	9.42	10.2	9.79	9.72	10	9.8	98	0.319	3	70 - 130	Passed
1,2-Dichloropropane	9.43	10.0	9.48	9.68	10	9.6	96	0.256	3	70 - 130	Passed
1,3-Dichloropropane	9.82	10.4	9.54	10.1	10	10.0	100	0.359	4	70 - 130	Passed

Appendix 2 (cont.): DEMONSTRATION OF CAPABILITY for 25 ml



DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/L
Sample Amount(ml): 25
Sample Purge(ml): 25

Date Analyzed: 01/31 & 02/01/12
Analyzed by: D. Nguyen

PARAMETER	RAY133	RAY134	RBY004	RBY005	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
	VOF5A10L	VOF5A10C	VOF5B01L	VOF5B01C							
2,2-Dichloropropane	9.07	10.4	10.2	9.65	10	9.8	98	0.598	6	60 - 140	Passed
cis-1,3-Dichloropropene	10.0	10.7	10.0	10.3	10	10.3	103	0.339	3	70 - 130	Passed
trans-1,3-Dichloropropene	9.30	9.75	9.06	9.42	10	9.4	94	0.288	3	70 - 130	Passed
tert-Butyl ethyl ether (ETB	11.1	11.8	10.1	10.8	10	11.0	110	0.685	6	70 - 130	Passed
Ethyl Methacrylate	9.30	9.68	8.15	9.21	10	9.1	91	0.656	7	70 - 130	Passed
Ethylbenzene	9.47	10.1	10.0	9.68	10	9.8	98	0.300	3	70 - 130	Passed
2-Hexanone (MBK)	50.6	52.3	42.7	50.6	50	49.0	98	4.298	9	70 - 140	Passed
Hexachlorobutadiene	8.21	8.92	8.99	8.08	10	8.6	86	0.469	5	70 - 130	Passed
Iodomethane	9.16	10.0	9.31	9.21	10	9.43	94	0.417	4	50 - 150	Passed
Isopropylbenzene	10.4	11.2	11.0	10.8	10	10.9	109	0.380	3	70 - 130	Passed
p-Isopropyltoluene	10.1	11.0	11.0	10.4	10	10.6	106	0.423	4	70 - 130	Passed
Methylene Chloride	8.56	9.09	8.74	8.87	10	8.8	88	0.225	3	60 - 130	Passed
4-Methyl-2-pentanone (MIBK)	52.9	54.7	45.5	53.6	50	51.7	103	4.184	8	70 - 130	Passed
tert-Butyl methyl ether	10.1	10.7	8.99	10.1	10	10.0	100	0.723	7	60 - 130	Passed
Naphthalene	10.3	10.7	9.41	9.88	10	10.07	101	0.565	6	50 - 140	Passed
n-Propylbenzene	10.6	11.4	11.2	11.1	10	11.1	111	0.369	3	70 - 130	Passed
Styrene	9.63	10.4	10.0	9.8	10	10.0	100	0.311	3	70 - 130	Passed
tert-Amyl methyl ether (TAME)	11.3	12.0	10.2	11.1	10	11.1	111	0.747	7	60 - 140	Passed
1,1,1,2-Tetrachloroethane	9.32	9.91	9.59	9.54	10	9.6	96	0.246	3	70 - 130	Passed
1,1,2,2-Tetrachloroethane	9.92	10.6	9.52	10.5	10	10.1	101	0.501	5	60 - 130	Passed
Tetrachloroethene	9.08	9.77	9.50	9.01	10	9.3	93	0.356	4	60 - 130	Passed
Toluene	9.68	10.3	10.1	9.94	10	10.0	100	0.262	3	70 - 130	Passed
1,1,1-Trichloroethane	8.83	10.0	10.2	9.52	10	9.6	96	0.591	6	70 - 130	Passed
1,1,2-Trichloroethane	9.67	10.1	9.45	10.1	10	9.8	98	0.346	4	70 - 130	Passed
1,2,3-Trichlorobenzene	8.77	9.14	8.46	8.40	10	8.7	87	0.339	4	60 - 130	Passed
1,2,4-Trichlorobenzene	9.04	9.63	8.93	8.60	10	9.1	91	0.432	5	60 - 140	Passed
Trichloroethene	9.21	9.93	9.42	9.29	10	9.5	95	0.326	3	70 - 130	Passed
Trichlorofluoromethane	9.06	9.62	10.1	10.3	10	9.76	98	0.544	6	60 - 140	Passed
1,2,3-Trichloropropane	9.93	10.5	9.45	10.6	10	10.1	101	0.524	5	70 - 130	Passed
1,1,2-Trichloro1,2,2-trifluoroethane	8.70	9.49	9.45	9.05	10	9.2	92	0.376	4	60 - 150	Passed
1,2,4-Trimethylbenzene	9.8	10.6	10.6	10.2	10	10.3	103	0.374	4	70 - 130	Passed
1,3,5-Trimethylbenzene	9.9	10.7	10.5	10.2	10	10.3	103	0.335	3	70 - 130	Passed
Vinyl Acetate	10.9	11.0	9.68	11.1	10	10.66	107	0.662	6	40 - 150	Passed
Vinyl Chloride	8.26	8.56	9.02	9.01	10	8.71	87	0.372	4	60 - 130	Passed
m-Xylene & p-xylene	19.2	20.6	20.4	19.6	20	19.9	100	0.633	3	60 - 140	Passed
o-Xylene	8.80	9.41	9.18	8.93	10	9.1	91	0.270	3	70 - 130	Passed
1,2-Dichloroethane-d4	10.0	10.0	9.9	10.3	10	10.05	101	0.200	2	70 - 130	Passed
Toluene-d8	10.3	10.3	10.4	10.3	10	10.32	103	0.046	0.5	70 - 130	Passed
4-Bromofluorobenzene	10.6	10.6	10.5	10.9	10	10.68	107	0.189	2	70 - 130	Passed
Dibromofluoromethane	10.0	9.93	10.1	10.2	10	10.06	101	0.106	1	70 - 130	Passed

Appendix 3: DEMONSTRATION OF CAPABILITY for 5 ml

DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/L

Sample Amount(ml): 5

Sample Purge(ml): 5

Date Analyzed: 01/07/13 & 01/08/13

Analyzed by: C. Mendoza

PARAMETER	RAN044 VSF4A07L	RAN045 VSF4A07C	RAN058 VSF4A08L	RAN059 VSF4A08C	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
Acetone	261	261	275	272	250	267	107	7.569	3	60 130	Passed
Acetonitrile	540	546	510	533	500	532	106	15.685	3	30 160	Passed
Acrolein	334	330	337	325	250	331	133	5.396	2	30 160	Passed
Acrylonitrile	269	270	278	271	250	272	109	4.119	2	70 130	Passed
Benzene	51.0	52.3	48.2	49.6	50	50.3	101	1.744	3	70 130	Passed
Bromobenzene	46.8	48.0	45.4	46.2	50	46.6	93	1.104	2	70 130	Passed
Bromochloromethane	51.7	52.2	50.7	51.2	50	51.5	103	0.611	1	70 130	Passed
Bromodichloromethane	49.5	50.8	48.4	49.2	50	49.5	99	1.022	2	70 130	Passed
Bromoform	47.8	48.6	45.6	47.5	50	47.4	95	1.282	3	70 130	Passed
Bromomethane	54.8	51.5	50.4	50.5	50	51.8	104	2.076	4	60 130	Passed
tert-Butyl alcohol	281	286	255	271	250	273	109	13.989	5	60 140	Passed
2-Butanone (MEK)	279	278	284	282	250	281	112	3.049	1	70 130	Passed
n-Butylbenzene	53.8	54.5	49.7	50.6	50	52.2	104	2.387	5	70 130	Passed
sec-Butylbenzene	52.0	52.5	47.9	49.4	50	50.5	101	2.181	4	70 130	Passed
tert-Butylbenzene	52.4	52.3	48.2	49.6	50	50.6	101	2.047	4	70 130	Passed
Carbon disulfide	48.2	46.9	44.2	46.0	50	46.4	93	1.669	4	60 130	Passed
Carbon tetrachloride	52.9	53.1	49.7	51.2	50	51.7	103	1.588	3	70 130	Passed
Chlorobenzene	49.3	50.2	47.1	47.9	50	48.6	97	1.402	3	70 130	Passed
2-Chloroethyl vinyl ether	50.1	49.7	36.4	38.4	50	43.7	87	7.258	17	50 150	Passed
Chloroethane	58.5	52.1	53.0	53.1	50	54.2	108	2.944	5	70 130	Passed
Chloroform	52.1	52.6	50.9	51.3	50	51.7	103	0.749	1	70 130	Passed
1-Chlorohexane	56.0	56.6	50.6	51.8	50	53.7	107	2.974	6	70 130	Passed
Chloromethane	53.8	48.8	48.5	50.0	50	50.3	101	2.456	5	60 130	Passed
2-Chlorotoluene	49.0	48.9	45.9	46.6	50	47.6	95	1.619	3	70 130	Passed
4-Chlorotoluene	51.9	53.0	49.5	49.8	50	51.1	102	1.675	3	70 130	Passed
2-Chloro-1,1,1-trifluoroethane	54.6	53.8	51.2	54.3	50	53.5	107	1.562	3	30 160	Passed
Chlorotrifluoroethylene	46.4	44.7	41.6	45.6	50	44.6	89	2.093	5	30 160	Passed
Dibromochloromethane	48.4	49.7	47.4	47.9	50	48.4	97	1.017	2	70 130	Passed
1,2-Dibromo-3-chloropropane	47.1	47.9	44.3	45.6	50	46.2	92	1.577	3	60 130	Passed
1,2-Dibromoethane	49.2	50.7	47.3	48.4	50	48.9	98	1.452	3	70 130	Passed
Dibromomethane	48.1	49.6	47.1	48.3	50	48.3	97	1.022	2	70 130	Passed
1,1-Dichloroethane	55.3	55.9	52.7	53.4	50	54.3	109	1.554	3	70 130	Passed
1,2-Dichloroethane	49.5	50.1	48.7	49.8	50	49.5	99	0.593	1	70 130	Passed
1,2-Dichlorobenzene	47.0	47.6	45.5	45.6	50	46.4	93	1.084	2	70 130	Passed
1,3-Dichlorobenzene	48.6	49.3	45.9	46.2	50	47.5	95	1.704	4	70 130	Passed
trans-1,4-Dichloro-2-Butene	51.0	50.7	48.7	50.0	50	50.1	100	1.012	2	70 130	Passed
1,4-Dichlorobenzene	49.0	49.7	46.6	46.7	50	48.0	96	1.599	3	70 130	Passed
Dichlorodifluoromethane	51.3	47.0	46.7	47.4	50	48.1	96	2.151	4	60 130	Passed
1,1-Dichloroethene	58.3	58.5	54.2	55.1	50	56.5	113	2.189	4	70 130	Passed
cis-1,2-Dichloroethene	53.3	53.5	50.9	51.2	50	52.2	104	1.358	3	70 130	Passed
trans-1,2-Dichloroethene	55.7	55.7	51.9	52.8	50	54.0	108	1.960	4	70 130	Passed
Dichlorofluoromethane	56.9	57.0	54.7	55.1	50	55.9	112	1.234	2	70 130	Passed
1,1-Dichloropropene	53.1	53.5	48.5	49.7	50	51.2	102	2.483	5	70 130	Passed
1,2-Dichloropropane	51.0	52.2	48.8	50.4	50	50.6	101	1.413	3	70 130	Passed

Appendix 3 (cont.): DEMONSTRATION OF CAPABILITY for 5 ml

DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/L

Sample Amount(ml): 5

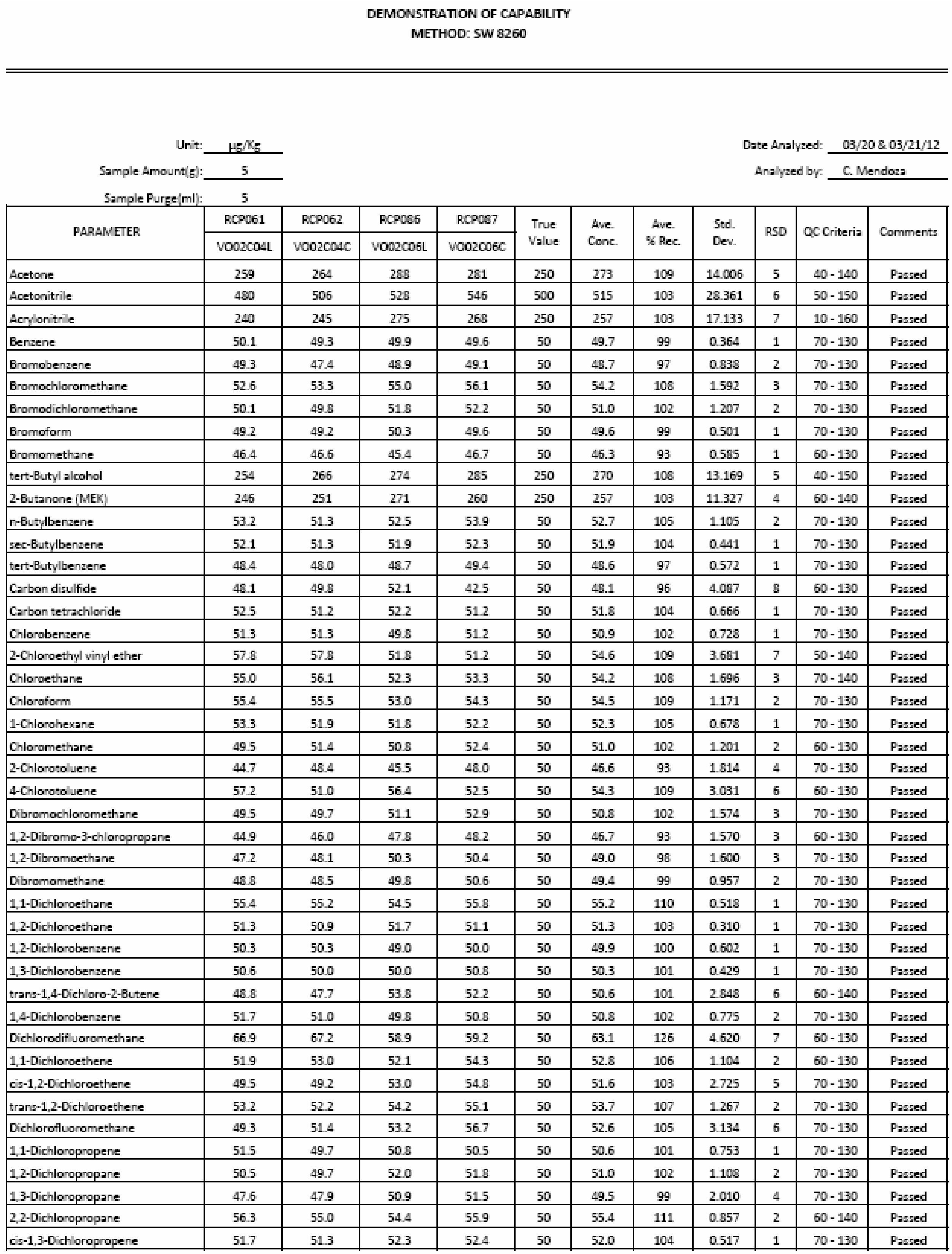
Sample Purge(ml): 5

Date Analyzed: 01/07/13 & 01/08/13

Analyzed by: C. Mendoza

PARAMETER	RAN044 VSF4A07L	RAN045 VSF4A07C	RAN058 VSF4A08L	RAN059 VSF4A08C	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
1,3-Dichloropropane	49.4	50.8	47.8	49.3	50	49.3	99	1.251	3	70 130	Passed
2,2-Dichloropropane	57.2	57.1	54.0	54.5	50	55.7	111	1.706	3	70 140	Passed
cis-1,3-Dichloropropene	51.3	52.8	49.1	50.4	50	50.9	102	1.548	3	70 130	Passed
trans-1,3-Dichloropropene	51.2	52.4	49.6	50.5	50	50.9	102	1.191	2	70 130	Passed
tert-Butyl ethyl ether (ETB	56.5	57.2	53.8	55.1	50	55.7	111	1.523	3	70 130	Passed
Ethyl Methacrylate	52.9	53.6	49.9	51.0	50	52	104	1.679	3	30 160	Passed
Ethylbenzene	51.6	52.9	48.5	49.6	50	50.7	101	1.946	4	70 130	Passed
2-Hexanone (MBK)	275	275	284	277	250	278.0	111	4.403	2	70 130	Passed
Hexachlorobutadiene	47.3	49.2	45.7	45.1	50	46.8	94	1.814	4	70 130	Passed
Iodomethane	40.7	39.4	36.9	39.0	50	39.0	78	1.595	4	60 130	Passed
Isopropyl ether (DIPE)	57.2	58.2	54.5	56.0	50	56.5	113	1.595	3	70 130	Passed
Isopropylbenzene	52.1	52.3	48.0	49.5	50	50.5	101	2.093	4	70 130	Passed
p-Isopropyltoluene	52.4	53.0	48.7	49.2	50	51	102	2.199	4	70 130	Passed
Methyl acetate	52.9	52.1	54.2	55.6	50	53.7	107	1.525	3	30 160	Passed
Methylene Chloride	50.4	51.6	49.6	50.2	50	50.5	101	0.856	2	70 130	Passed
4-Methyl-2-pentanone (MIBK)	278	279	283	276	250	278.7	111	2.713	1	70 130	Passed
tert-Butyl methyl ether	54.7	55.3	52.6	53.8	50	54.1	108	1.140	2	70 130	Passed
Naphthalene	43.7	44.3	40.8	39.8	50	42.2	84	2.180	5	60 140	Passed
n-Propylbenzene	51.9	52.3	47.9	49.3	50	50.4	101	2.098	4	70 130	Passed
Styrene	51.6	53.2	49.6	50.4	50	51.2	102	1.553	3	70 130	Passed
tert-Amyl methyl ether (TAME)	55.3	56.0	53.3	54.2	50	54.7	109	1.212	2	70 130	Passed
1,1,1,2-Tetrachloroethane	48.7	50.4	47.5	48.2	50	48.7	97	1.250	3	30 160	Passed
1,1,2,2-Tetrachloroethane	49.1	49.2	45.7	47.4	50	47.9	96	1.652	3	30 160	Passed
Tetrachloroethene	50.6	51.2	47.0	48.0	50	49.2	98	2.014	4	70 130	Passed
Toluene	51.3	52.4	48.6	49.7	50	50.5	101	1.718	3	70 130	Passed
1,1,1-Trichloroethane	55.0	55.2	52.6	52.9	50	53.9	108	1.405	3	30 160	Passed
1,1,2-Trichloroethane	48.3	50.1	46.3	48.0	50	48.2	96	1.553	3	30 160	Passed
1,2,3-Trichlorobenzene	48.0	49.6	46.0	44.8	50	47.1	94	2.140	5	70 130	Passed
1,2,4-Trichlorobenzene	50.8	51.5	46.7	45.5	50	48.6	97	2.965	6	70 130	Passed
Trichloroethene	50.7	51.5	47.7	48.3	50	49.5	99	1.834	4	70 130	Passed
Trichlorofluoromethane	61.7	55.1	54.8	55.3	50	56.7	113	3.322	6	70 140	Passed
1,2,3-Trichloropropane	47.8	47.7	45.6	47.4	50	47.1	94	1.036	2	70 130	Passed
1,1,2-Trichloro1,2,2-trifluoroethane	57.4	56.8	52.9	53.6	50	55.2	110	2.264	4	70 - 130	Passed
1,2,4-Trimethylbenzene	51.5	52.0	48.2	49.2	50	50.2	100	1.810	4	70 130	Passed
1,3,5-Trimethylbenzene	51.7	52.3	48.0	49.2	50	50.3	101	2.016	4	70 130	Passed
Vinyl Acetate	65.3	59.2	58.1	58.5	50	60.3	121	3.366	6	50 140	Passed
Vinyl Chloride	59.8	52.9	54.5	54.5	50	55.4	111	3.040	5	70 140	Passed
m-Xylene & p-xylene	103	105	97.0	98.7	100	101.0	101	3.765	4	70 130	Passed
o-Xylene	52.3	53.5	49.4	50.7	50	51.5	103	1.786	3	70 130	Passed
Allyl Chloride	57.3	58.3	54.1	55.5	50	56.3	113	1.869	3	30 160	Passed

Appendix 4: DEMONSTRATION OF CAPABILITY for 5 g



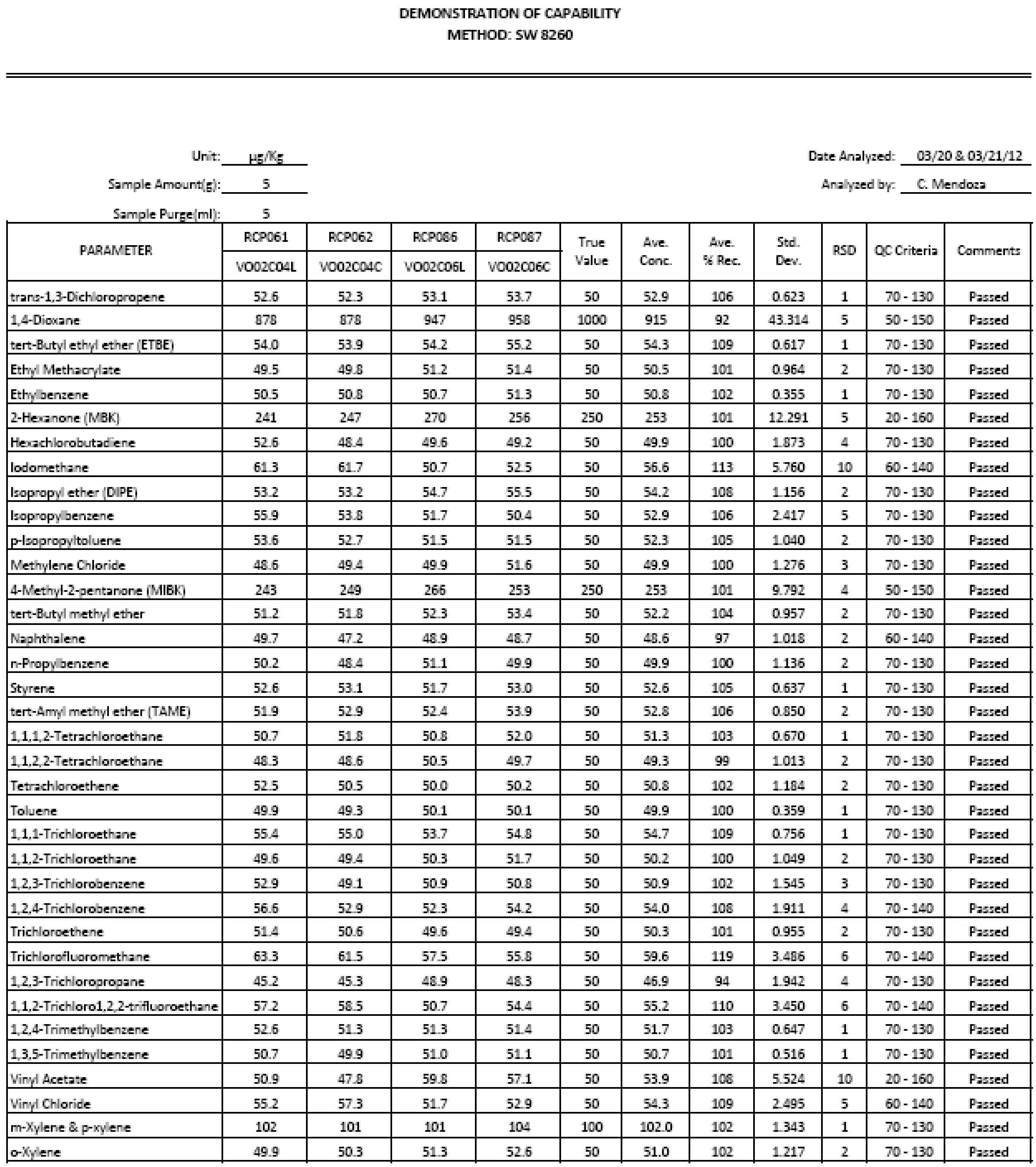
DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/Kg
Sample Amount(g): 5
Sample Purge(ml): 5

Date Analyzed: 03/20 & 03/21/12
Analyzed by: C. Mendoza

PARAMETER	RCP061	RCP062	RCP086	RCP087	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
	VO02C04L	VO02C04C	VO02C06L	VO02C06C							
Acetone	259	264	288	281	250	273	109	14.006	5	40 - 140	Passed
Acetonitrile	480	506	528	546	500	515	103	28.361	6	50 - 150	Passed
Acrylonitrile	240	245	275	268	250	257	103	17.133	7	10 - 160	Passed
Benzene	50.1	49.3	49.9	49.6	50	49.7	99	0.364	1	70 - 130	Passed
Bromobenzene	49.3	47.4	48.9	49.1	50	48.7	97	0.838	2	70 - 130	Passed
Bromochloromethane	52.6	53.3	55.0	56.1	50	54.2	108	1.592	3	70 - 130	Passed
Bromodichloromethane	50.1	49.8	51.8	52.2	50	51.0	102	1.207	2	70 - 130	Passed
Bromoform	49.2	49.2	50.3	49.6	50	49.6	99	0.501	1	70 - 130	Passed
Bromomethane	46.4	46.6	45.4	46.7	50	46.3	93	0.585	1	60 - 130	Passed
tert-Butyl alcohol	254	266	274	285	250	270	108	13.169	5	40 - 150	Passed
2-Butanone (MEK)	246	251	271	260	250	257	103	11.327	4	60 - 140	Passed
n-Butylbenzene	53.2	51.3	52.5	53.9	50	52.7	105	1.105	2	70 - 130	Passed
sec-Butylbenzene	52.1	51.3	51.9	52.3	50	51.9	104	0.441	1	70 - 130	Passed
tert-Butylbenzene	48.4	48.0	48.7	49.4	50	48.6	97	0.572	1	70 - 130	Passed
Carbon disulfide	48.1	49.8	52.1	42.5	50	48.1	96	4.087	8	60 - 130	Passed
Carbon tetrachloride	52.5	51.2	52.2	51.2	50	51.8	104	0.666	1	70 - 130	Passed
Chlorobenzene	51.3	51.3	49.8	51.2	50	50.9	102	0.728	1	70 - 130	Passed
2-Chloroethyl vinyl ether	57.8	57.8	51.8	51.2	50	54.6	109	3.681	7	50 - 140	Passed
Chloroethane	55.0	56.1	52.3	53.3	50	54.2	108	1.696	3	70 - 140	Passed
Chloroform	55.4	55.5	53.0	54.3	50	54.5	109	1.171	2	70 - 130	Passed
1-Chlorohexane	53.3	51.9	51.8	52.2	50	52.3	105	0.678	1	70 - 130	Passed
Chloromethane	49.5	51.4	50.8	52.4	50	51.0	102	1.201	2	60 - 130	Passed
2-Chlorotoluene	44.7	48.4	45.5	48.0	50	46.6	93	1.814	4	70 - 130	Passed
4-Chlorotoluene	57.2	51.0	56.4	52.5	50	54.3	109	3.031	6	60 - 130	Passed
Dibromochloromethane	49.5	49.7	51.1	52.9	50	50.8	102	1.574	3	70 - 130	Passed
1,2-Dibromo-3-chloropropane	44.9	46.0	47.8	48.2	50	46.7	93	1.570	3	60 - 130	Passed
1,2-Dibromoethane	47.2	48.1	50.3	50.4	50	49.0	98	1.600	3	70 - 130	Passed
Dibromomethane	48.8	48.5	49.8	50.6	50	49.4	99	0.957	2	70 - 130	Passed
1,1-Dichloroethane	55.4	55.2	54.5	55.8	50	55.2	110	0.518	1	70 - 130	Passed
1,2-Dichloroethane	51.3	50.9	51.7	51.1	50	51.3	103	0.310	1	70 - 130	Passed
1,2-Dichlorobenzene	50.3	50.3	49.0	50.0	50	49.9	100	0.602	1	70 - 130	Passed
1,3-Dichlorobenzene	50.6	50.0	50.0	50.8	50	50.3	101	0.429	1	70 - 130	Passed
trans-1,4-Dichloro-2-Butene	48.8	47.7	53.8	52.2	50	50.6	101	2.848	6	60 - 140	Passed
1,4-Dichlorobenzene	51.7	51.0	49.8	50.8	50	50.8	102	0.775	2	70 - 130	Passed
Dichlorodifluoromethane	66.9	67.2	58.9	59.2	50	63.1	126	4.620	7	60 - 130	Passed
1,1-Dichloroethene	51.9	53.0	52.1	54.3	50	52.8	106	1.104	2	60 - 130	Passed
cis-1,2-Dichloroethene	49.5	49.2	53.0	54.8	50	51.6	103	2.725	5	70 - 130	Passed
trans-1,2-Dichloroethene	53.2	52.2	54.2	55.1	50	53.7	107	1.267	2	70 - 130	Passed
Dichlorofluoromethane	49.3	51.4	53.2	56.7	50	52.6	105	3.134	6	70 - 130	Passed
1,1-Dichloropropene	51.5	49.7	50.8	50.5	50	50.6	101	0.753	1	70 - 130	Passed
1,2-Dichloropropane	50.5	49.7	52.0	51.8	50	51.0	102	1.108	2	70 - 130	Passed
1,3-Dichloropropane	47.6	47.9	50.9	51.5	50	49.5	99	2.010	4	70 - 130	Passed
2,2-Dichloropropane	56.3	55.0	54.4	55.9	50	55.4	111	0.857	2	60 - 140	Passed
cis-1,3-Dichloropropene	51.7	51.3	52.3	52.4	50	52.0	104	0.517	1	70 - 130	Passed

Appendix 4 (cont.): DEMONSTRATION OF CAPABILITY for 5 g



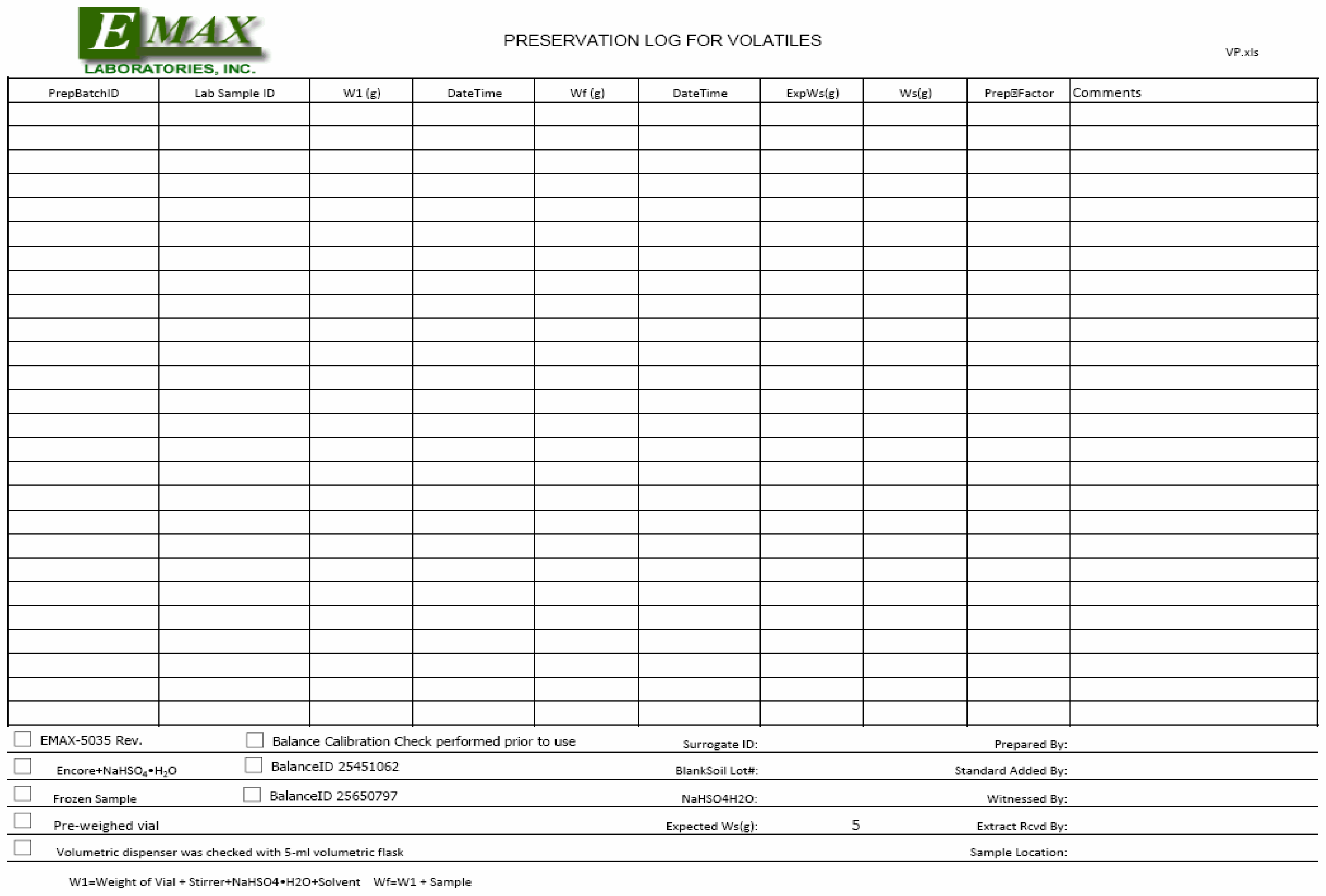
DEMONSTRATION OF CAPABILITY
METHOD: SW 8260

Unit: µg/Kg
Sample Amount(g): 5
Sample Purge(ml): 5

Date Analyzed: 03/20 & 03/21/12
Analyzed by: C. Mendoza

PARAMETER	RCP061	RCP062	RCP086	RCP087	True Value	Ave. Conc.	Ave. % Rec.	Std. Dev.	RSD	QC Criteria	Comments
	VO02C04L	VO02C04C	VO02C06L	VO02C06C							
trans-1,3-Dichloropropene	52.6	52.3	53.1	53.7	50	52.9	106	0.623	1	70 - 130	Passed
1,4-Dioxane	878	878	947	958	1000	915	92	43.314	5	50 - 150	Passed
tert-Butyl ethyl ether (ETBE)	54.0	53.9	54.2	55.2	50	54.3	109	0.617	1	70 - 130	Passed
Ethyl Methacrylate	49.5	49.8	51.2	51.4	50	50.5	101	0.964	2	70 - 130	Passed
Ethylbenzene	50.5	50.8	50.7	51.3	50	50.8	102	0.355	1	70 - 130	Passed
2-Hexanone (MBK)	241	247	270	256	250	253	101	12.291	5	20 - 160	Passed
Hexachlorobutadiene	52.6	48.4	49.6	49.2	50	49.9	100	1.873	4	70 - 130	Passed
Iodomethane	61.3	61.7	50.7	52.5	50	56.6	113	5.760	10	60 - 140	Passed
Isopropyl ether (DIPE)	53.2	53.2	54.7	55.5	50	54.2	108	1.156	2	70 - 130	Passed
Isopropylbenzene	55.9	53.8	51.7	50.4	50	52.9	106	2.417	5	70 - 130	Passed
p-Isopropyltoluene	53.6	52.7	51.5	51.5	50	52.3	105	1.040	2	70 - 130	Passed
Methylene Chloride	48.6	49.4	49.9	51.6	50	49.9	100	1.276	3	70 - 130	Passed
4-Methyl-2-pentanone (MIBK)	243	249	266	253	250	253	101	9.792	4	50 - 150	Passed
tert-Butyl methyl ether	51.2	51.8	52.3	53.4	50	52.2	104	0.957	2	70 - 130	Passed
Naphthalene	49.7	47.2	48.9	48.7	50	48.6	97	1.018	2	60 - 140	Passed
n-Propylbenzene	50.2	48.4	51.1	49.9	50	49.9	100	1.136	2	70 - 130	Passed
Styrene	52.6	53.1	51.7	53.0	50	52.6	105	0.637	1	70 - 130	Passed
tert-Amyl methyl ether (TAME)	51.9	52.9	52.4	53.9	50	52.8	106	0.850	2	70 - 130	Passed
1,1,1,2-Tetrachloroethane	50.7	51.8	50.8	52.0	50	51.3	103	0.670	1	70 - 130	Passed
1,1,2,2-Tetrachloroethane	48.3	48.6	50.5	49.7	50	49.3	99	1.013	2	70 - 130	Passed
Tetrachloroethene	52.5	50.5	50.0	50.2	50	50.8	102	1.184	2	70 - 130	Passed
Toluene	49.9	49.3	50.1	50.1	50	49.9	100	0.359	1	70 - 130	Passed
1,1,1-Trichloroethane	55.4	55.0	53.7	54.8	50	54.7	109	0.756	1	70 - 130	Passed
1,1,2-Trichloroethane	49.6	49.4	50.3	51.7	50	50.2	100	1.049	2	70 - 130	Passed
1,2,3-Trichlorobenzene	52.9	49.1	50.9	50.8	50	50.9	102	1.545	3	70 - 130	Passed
1,2,4-Trichlorobenzene	56.6	52.9	52.3	54.2	50	54.0	108	1.911	4	70 - 140	Passed
Trichloroethene	51.4	50.6	49.6	49.4	50	50.3	101	0.955	2	70 - 130	Passed
Trichlorofluoromethane	63.3	61.5	57.5	55.8	50	59.6	119	3.486	6	70 - 140	Passed
1,2,3-Trichloropropane	45.2	45.3	48.9	48.3	50	46.9	94	1.942	4	70 - 130	Passed
1,1,2-Trichloro1,2,2-trifluoroethane	57.2	58.5	50.7	54.4	50	55.2	110	3.450	6	70 - 140	Passed
1,2,4-Trimethylbenzene	52.6	51.3	51.3	51.4	50	51.7	103	0.647	1	70 - 130	Passed
1,3,5-Trimethylbenzene	50.7	49.9	51.0	51.1	50	50.7	101	0.516	1	70 - 130	Passed
Vinyl Acetate	50.9	47.8	59.8	57.1	50	53.9	108	5.524	10	20 - 160	Passed
Vinyl Chloride	55.2	57.3	51.7	52.9	50	54.3	109	2.495	5	60 - 140	Passed
m-Xylene & p-xylene	102	101	101	104	100	102.0	102	1.343	1	70 - 130	Passed
o-Xylene	49.9	50.3	51.3	52.6	50	51.0	102	1.217	2	70 - 130	Passed

8260FS: SAMPLE PREPARATION LOG



EMAX LABORATORIES, INC.

PRESERVATION LOG FOR VOLATILES

VP.xls

PrepBatchID	Lab Sample ID	W1 (g)	DateTime	Wf (g)	DateTime	ExpWs(g)	Ws(g)	Prep Factor	Comments

☐ EMAX-5035 Rev.
☐ Encore+$NaHSO_4 \bullet H_2O$
☐ Frozen Sample
☐ Pre-weighed vial
☐ Volumetric dispenser was checked with 5-ml volumetric flask

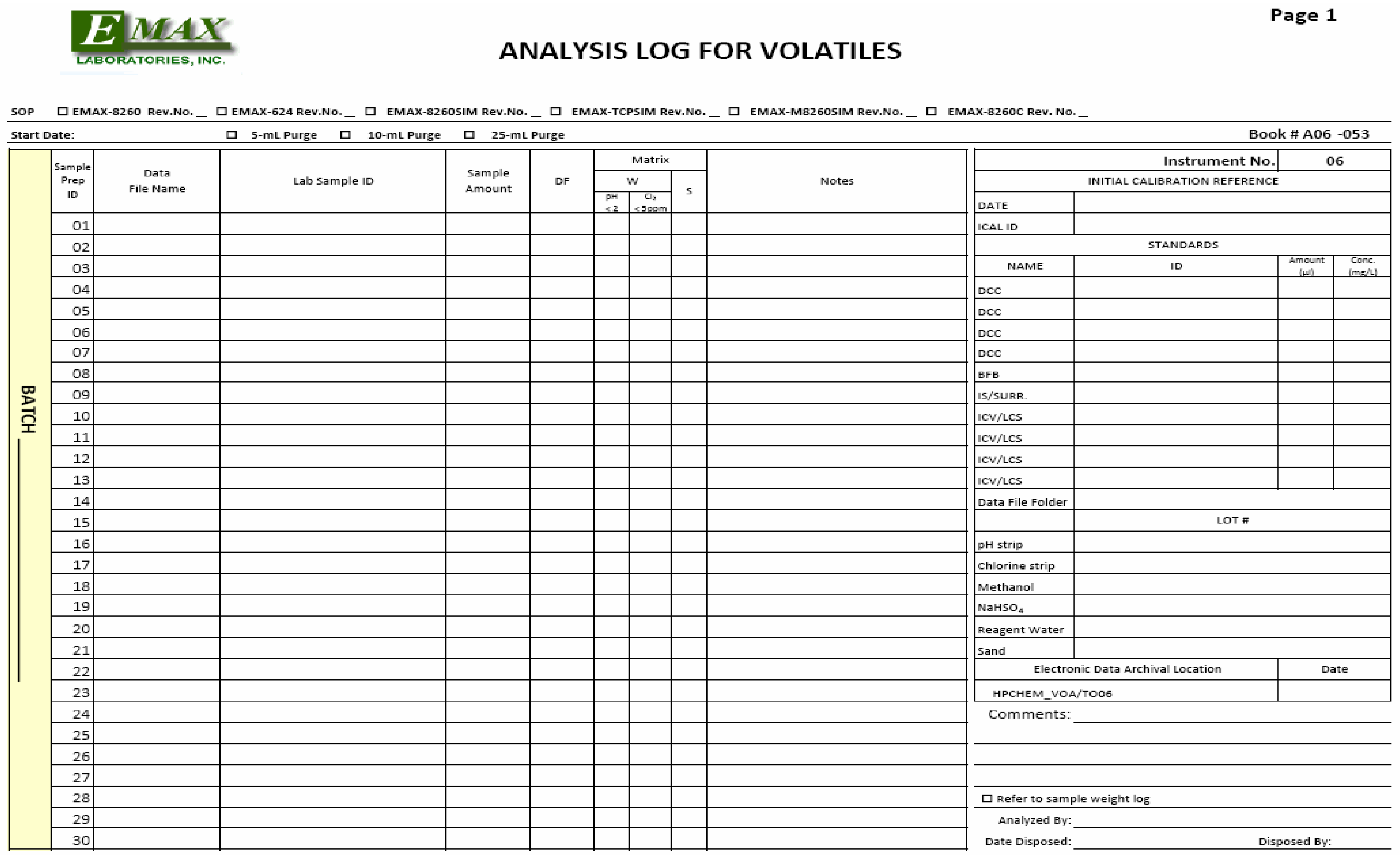
☐ Balance Calibration Check performed prior to use
☐ BalanceID 25451062
☐ BalanceID 25650797

Surrogate ID:
BlankSoil Lot#:
NaHSO4H2O:
Expected Ws(g): 5

Prepared By:
Standard Added By:
Witnessed By:
Extract Rcvd By:
Sample Location:

W1=Weight of Vial + Stirrer+NaHSO4•H2O+Solvent   Wf=W1 + Sample

8260FA: ANALYTICAL RUN LOG



EMAX LABORATORIES, INC.

Page 1

ANALYSIS LOG FOR VOLATILES

SOP ☐ EMAX-8260 Rev.No. __ ☐ EMAX-624 Rev.No. __ ☐ EMAX-8260SIM Rev.No. __ ☐ EMAX-TCPSIM Rev.No. __ ☐ EMAX-M8260SIM Rev.No. __ ☐ EMAX-8260C Rev. No. __

Start Date: ☐ 5-mL Purge ☐ 10-mL Purge ☐ 25-mL Purge **Book # A06 -053**

	Sample Prep ID	Data File Name	Lab Sample ID	Sample Amount	DF	Matrix			Notes
						W		S	
						pH < 2	Cl_2 < 5ppm		
BATCH ______	01								
	02								
	03								
	04								
	05								
	06								
	07								
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		Instrument No.	06
INITIAL CALIBRATION REFERENCE			
DATE			
ICAL ID			
STANDARDS			
NAME	ID	Amount (µl)	Conc. (mg/L)
DCC			
DCC			
DCC			
DCC			
BFB			
IS/SURR.			
ICV/LCS			
ICV/LCS			
ICV/LCS			
ICV/LCS			
Data File Folder			
	LOT #		
pH strip			
Chlorine strip			
Methanol			
$NaHSO_4$			
Reagent Water			
Sand			
Electronic Data Archival Location			Date
HPCHEM_VOA/TO06			

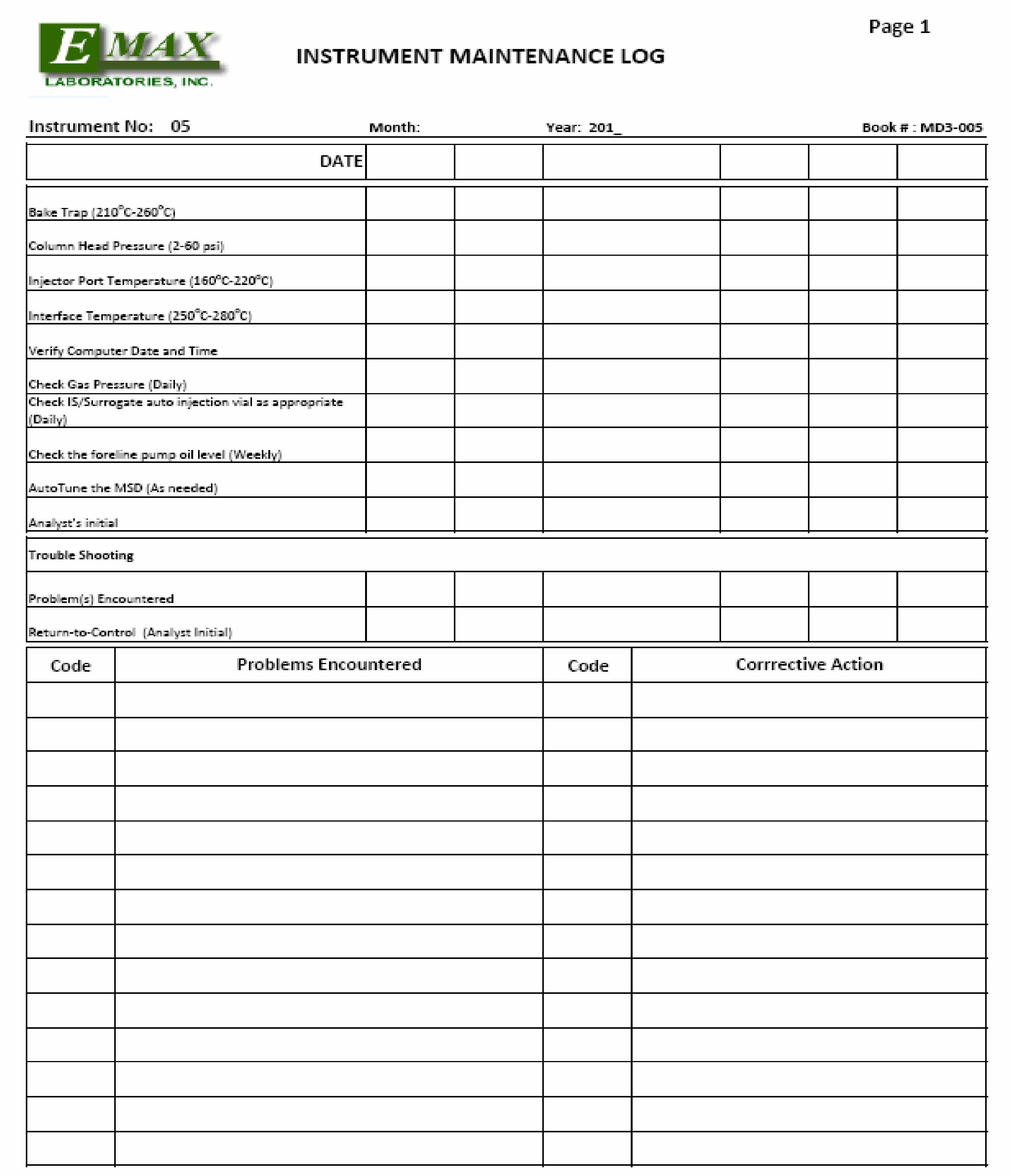
Comments: ______________________

☐ Refer to sample weight log

Analyzed By: ______________________

Date Disposed: ______________ Disposed By: ______________

8260FM: INSTRUMENT MAINTENANCE LOG



EMAX LABORATORIES, INC.

INSTRUMENT MAINTENANCE LOG

Page 1

Instrument No: 05 Month: Year: 201_ Book # : MD3-005

DATE						
Bake Trap (210°C-260°C)						
Column Head Pressure (2-60 psi)						
Injector Port Temperature (160°C-220°C)						
Interface Temperature (250°C-280°C)						
Verify Computer Date and Time						
Check Gas Pressure (Daily)						
Check IS/Surrogate auto injection vial as appropriate (Daily)						
Check the foreline pump oil level (Weekly)						
AutoTune the MSD (As needed)						
Analyst's initial						
Trouble Shooting						
Problem(s) Encountered						
Return-to-Control (Analyst Initial)						

Code	Problems Encountered	Code	Corrrective Action

PRINT DRF

ANNUAL REVIEW FORM

VOLATILE ORGANIC COMPOUNDS BY GC/MS

SOP#: EMAX-8260 **Rev** 10 **Effective Date:** 06-Jun-14

COMMENTS	Reviewed By	Review Date
DRF (6/4/15)		6/9/15
No revision needed	QA-Fm	6/21/16
None		05/2/17
None (DRF 04/03/18)		8/6/18
No update needed per DRF by DNguyen dtd 6/12/19		6/12/19
No update needed per DRF by DNguyen dated 6/2/20		6/2/20
No update needed per DRF by DNguyen dated 6/3/21		6/3/21
SOP revision is being drafted to update EMAX physical address.		
No technical update necessary		06/06/22
SOP revision is being drafted		5/5/23

TOC QCP
ADD
ADD 2

STANDARD OPERATING PROCEDURE

TOTAL ORGANIC CARBON

SOP No.: EMAX-9060 Revision No. 4 Effective Date: 11-Oct-17

Prepared By: Tyler Kosaka Date: 10/11/17

Approved By: Kenette Pimentel Date: 10.11.17
QA Manager

Approved By: Caspar Pang Date: 10-11-17
Laboratory Director

Control Number: 9060-04

1.0 SCOPE AND APPLICATION

1.1. This method is used to determine total organic carbons (TOC) in an aqueous sample by combustion-infrared technique. This procedure is only applicable to homogenous samples. This SOP is an adaptation of SW846 Method 9060A.

2.0 SUMMARY OF METHOD

2.1. An aliquot of acidified sample is injected into the Analyzer, sparge with gas (compressed air or nitrogen) to remove IC content, and heated at 680°C to convert IC to Total Organic Compound.

2.2. Interference

2.2.1. Carbonate and bicarbonate carbon represents interference and must be removed or accounted for in the final calculation.

2.2.2. Suspended particles of a liquid sample or extract is known to alter results.

3.0 DETECTION LIMITS

3.1. Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

3.1.1. Refer to EMAX-QA04 for generation, validation and verification for DL, LOD and LOQ.

3.1.2. Established Dl, LOD and LOQ are:

Matrix	DL	LOD	LOQ
Water (mg/L)	0.25	0.5	1.0

4.0 DYNAMIC RANGE

4.1. The highest quantifiable range requiring no dilution is equal to the concentration of the highest calibration point. All samples analyzed above this range shall be considered “over range” and shall require dilution to properly quantitate.

4.2. The lowest quantifiable range of diluted samples is equal to the concentration of the lowest calibration point. All diluted samples analyzed below this range shall be considered “under range” and shall require lower dilution factor to properly quantitate.

5.0 SAMPLE HOLDING TIME & PRESERVATION

5.1. Sample Collection

5.1.1. Samples received in the laboratory are expected to be contained in HDPE or glass bottles and cooled to ≤ 6°C without freezing.

5.2. Holding Time

5.2.1. Samples are expected to be stable for 28 days.

5.3. Preservation

5.3.1. Preserve samples at pH < 2 with either HCl or H_2SO_4.

5.3.2. Store samples in plastic or glass containers that prevent any possible carbon contamination.

5.3.3. Store samples at ≤ 6°C without freezing.

6.0 ASSOCIATED SOPs

6.1.	EMAX-DM01	Data Flow and Review
6.2.	EMAX-QA04	Detection Limit (DL)
6.3.	EMAX-QA05	Training
6.4.	EMAX-QA08	Corrective Action
6.5.	EMAX-QC02	Analytical Standard Preparation
6.6.	EMAX-QC06	Volumetric Labware and Micropipette Verification
6.7.	EMAX-QC07	Glassware Cleaning
6.8.	EMAX-SM03	Waste Disposal
6.9.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS for chemicals listed in this SOP.

7.2. Treat all reagents, standards, and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, gloves at all times when performing this procedure.

7.3. If for any reason, solvent and/or other reagents get in contact with your skin or any other part of your body, rinse the affected body part thoroughly with copious amount of tap water. If irritations or any other discomfort related to the incident persist, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUCTIONS, CHEMICALS & REAGENTS

8.1. Instruments and Supplies

8.1.1. Total Organic Carbon Analyzer Model TOC-V_{CPN} or equivalent

8.1.2. Autosampler – ASI-V

8.1.3. Filtering apparatus and 0.45-µm-pore diam filters, preferably HPLC syringe filters or similar.

8.1.4. Micropipettes – 1 and 5 ml, 200 µl

8.2. Chemicals and Reagents

8.2.1. All reagents are reagent grade or better.

8.2.2. Hydrochloric Acid, 2M HCl

8.2.3. Sulfuric Acid, concentrated H_2SO_4

8.2.4. Reagent Water

9.0 STANDARDS

9.1. Standard Preparation

9.1.1. Refer to EMAX-QC02 for proper preparation of analytical standards.

9.1.2. Oven-dry Potassium Hydrogen Phthalate @ 105°C - 120°C for 1- hour.

9.1.3. Oven-dry Sodium Hydrogen Carbonate @ 280°C - 290°C for 1- hour.

9.1.4. All standards are cooled and stored in dessicator.

9.1.5. Other concentration levels may be prepared other than specified below as long as it is compliant to required acceptance criteria, and should be stored at ≤ 6°C without freezing.

9.2. Stock Standards

9.2.1. Primary Stock Standards - are purchased commercially as certified standards. These standards are primarily used for calibration.

Standard Name	Source	Concentration (mg/L)
Total Organic Carbon	ERA or equivalent	1,000

9.2.2. Secondary Stock Standards - are purchased commercially from different sources. These standards are used for ICV and LCS.

Standard Name	Source	Concentration (mg/L)
Pottasium Phtalate, crystal	Mallinckrodt or equivalent	Assay

9.2.3. Other Standards - are purchased commercially and these standards are used to determine the removal of carbonate and bicarbonate by purging.

Standard Name	Source	Concentration (mg/L)

Sodium Bicarbonate	BDH or equivalent	Assay
Sodium Carbonate	Mallinckrodt or equivalent	Assay

9.3. Intermediate Standards

9.3.1. Secondary Intermediate Standards - are prepared using the secondary stock standard as follows:

Standard Name	Concentration	Amount	Final Conc.	Solvent	Final Volume
Potassium Phthalate	Assay	0.2128 g	1,000 mg/L	Reagent Water	100 ml

9.3.2. Carbonate/Bicarbonate Intermediate Standards - is prepared as follows:

Standard Name	Concentration	Amount	Final Conc.	Solvent	Final Volume
Sodium Carbonate	Assay	0.4418 g	1,000 mg/L	Reagent Water	100 ml
Sodium Bicarbonate	Assay	0.3512			

9.4. ICAL Standards

9.4.1. A minimum of 5 point calibration standards are prepared using a clean 100 ml volumetric flask, in reagent water.

ICAL Pt.	Primary Stock Standard (1,000 mg/L) Aliquot (µl)	Final Volume (ml)	Concentration (mg/L)
S0	0	100	0
S1	0.1	100	1
S2	0.5	100	5
S3	1.0	100	10
S4	4.0	100	40
S5	8.0	100	80

9.5. Check Standards

9.5.1. Initial Calibration Verification (ICV)

9.5.1..1. Prepare ICV standard by diluting 2.5 ml of secondary intermediate standard (1000 mg/L) solution to 100 ml reagent water. The expected value of this is 25 mg/L.

9.5.2. Continuing Calibration Verification (CCV)

9.5.2..1. Prepare CCV standard by diluting 2.5 ml of primary stock standard solution to 100 ml reagent water. The final concentration of the check standard shall be 25 mg/L.

9.5.3. Carbonate/Bicarbonate Standard

9.5.3..1. Prepare Carbonate/Bicarbonate standard by diluting 0.1 ml of Carbonate/Bicarbonate intermediate standard (1,000 mg/L) to 100 ml of reagent water. The expected value of this is 1 mg/L.

10.0 PROCEDURES

10.1. Sample Preparations

10.1.1. When Dissolved Organic Carbon (DOC) is to be determined, filter the sample prior to injection. Otherwise, aqueous sample is directly injected into the instrument.

ADD

10.2. Instrument Parameters

10.2.1. TOC-V_{CPN}

Catalyst Type	TOC High Sensitivity Catalyst
Furnace Temperature	680°C
Gas Flow Rate	150 ml/min
Tubing Diameter	0.5 min.
NDR Cell Length	Long
Range	X3
Replicate Injection	4

10.2.2. Autosampler : ASI-V

Tray Type	24 ml vial
Needle	Sample needle
Needle Wash/ flow Line Wash	2
Rack	1 - 93

10.3. Calibration

10.3.1. Analyze the ICAL standards. Refer to Section 9.4.

10.3.2. Generate the calibration curve after the multi-level ICAL analysis is completed.

10.3.3. Analyze ICV to verify the ICAL.

10.3.4. Refer to Appendix 1 for acceptance criteria.

10.4. Analysis

10.4.1. Place ICAL standards, check standards and samples in designated Auto Sampler positions.

10.4.2. Set up calibration(*.cal)\method(*.met)\template(*.tpl) parameters, refer to Shimadzu TOC-VCPN Sections 4.3 to 4.4.

- If desired calibration\method\template parameter already exists, in C:\Program Files\Shimadzu Corporation\TOC3201, save and rename the templates in their respective folders, such that, 80_9060.cal(4x injections) and/or 80_415.cal(2x injections) as TCI001.cal.
- Make sure the templates fulfill all project requirements and generate a sequence by opening a new file to include, Calibration curve, Control Calibration Checks and Auto-Generate to program sample positions.

10.4.3. Check background monitor in the instrument menu before starting the analysis. All window should display green check marks.

10.4.4. Set quantitation to average quadruple determination. Refer to NPOC/TOC Criteria Quantitation of TOC results outlined in TOC-V manual Section 5.1.3 and 5.1.5.

10.4.5. Sparge the acidified sample (ph=2~3) with zero grade air and/or high purity nitrogen gas, to eliminate the IC component. Measure the TC remaining in the sample and determine the Total Organic Carbon (NPOC).

10.4.6. The ICAL, check standards and samples must be injected four times.

10.4.7. Analytical Sequence

- ICAL – initial calibration
- ICV – initial calibration verification
- ICB – initial calibration blank
- MB – method blank
- LCS – lab control sample
- LCD – lab control sample duplicate (in the absence of MS)
- Samples – maximum of 10 field samples
- Sample Duplicate or Matrix Spike (MS)
- CCV – continuing calibration verification
- CCB – continuing calibration blank
- Samples – maximum of 10 field samples
- Sample Duplicate or Matrix Spike (MS)
- ECC – ending calibration check
- ECB – ending calibration blank
-

10.5. **Sample Result Evaluation**

10.5.1. Evaluate QC results as soon as the data is available.

✓ Check CCVs that they are within the acceptance criteria.

✓ Check that the batch QC samples met the acceptance criteria.

- ✓ Check concentration of target analytes. If the response exceeds the calibration range, dilute and reanalyze the sample until the response falls within the calibration range.
- ✓ If any of the above checkpoints indicate a problem, check the specified corrective action in Appendix 1 to determine if re-analysis is necessary. If re-analysis results are the same as the initial result, consult the Supervisor for further action.

10.6. Calculations

10.6.1. Calculate for Percent Recovery of LCS

$$\% R = \left[\frac{C_f}{C_o} \right] 100 \qquad \text{Eq.-10.6.1}$$

where:

$\%R$ - is the percent recovery

C_f - is the concentration found

C_o - is the known concentration of spiked solution

10.6.2. Calculate for Percent Recovery of MS

$$\% R = \left[\frac{(C_f - C_s)}{C_o} \right] 100 \qquad \text{Eq.-10.6.2}$$

where:

$\%R$ - is the percent recovery

C_f - is the concentration found

C_s - is the concentration of the sample

C_o - is the known concentration of spiked solution

10.6.3. Calculate for Precision

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2} \right)} \times 100 \qquad \text{Eq.-10.6.3}$$

where:

RPD – Relative Percent Difference

C_1 – Measured concentration of the first sample aliquot

C_2 – Measured concentration of the second sample aliquot

10.6.4. Calculate for Standard Deviation

$$SD = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}} \quad \text{Eq.-10.6.4}$$

where:

SD - is the standard deviation

x_i - is the result at the ith measurement

$\bar{x}$ - is the mean

N - is the number of measurements

10.6.5. Calculate for % Relative Standard Deviation (%RSD)

$$\%RSD = \left[\frac{SD}{ACF}\right] 100 \quad \text{Eq.-10.6.7}$$

where:

$\%RSD$ - is the percent relative standard deviation

SD - is the standard deviation

ACF - is the average calibration factor

10.7. **Data Reduction**

10.7.1. Make a copy of the analytical run log.

10.7.2. Print a copy of the raw data and the QC report.

10.7.3. Highlight the data to be reported.

10.7.4. Collate the reportable data separating the QC results from the sample results.

10.7.5. Keep all other data generated with the analytical folder marked with “For record only”.

10.8. **Report Generation**

10.8.1. Generate the method.txt file using WDB5N.exe

10.8.2. Generate sample results using MSRB6.exe

10.8.3. Generate the QC Summary using QCIC.exe

10.8.4. Generate the sample duplicate result file using CQ1N.exe

10.8.5. Generate the Case Narrative using CN00.exe

10.8.6. Arrange the analysis package in sequence as detailed below.

- Case Narrative
- Sample Results
- LCS/LCD Summary

- MS/MSD Summary
- Sample Duplicate Result
- Callibration Summary
- Analytical Run Log
- Non-Conformance Report (If any)

10.9. **Data Review**

10.9.1. Perform a 100% data review in accordance to EMAX-DM01 and the PSR.

10.9.2. Review the generated reports for calculation accuracy and that dilution factors are properly applied.

10.9.3. Review the attached logs that they are properly filled.

10.9.4. Check the generated reports against the raw data. Check that the analytical data generated indicating positive results are qualitatively and quantitatively correct.

10.9.5. Review the case narrative and check that it accurately describes what transpired in the analytical process. Edit as necessary to reflect essential issues not captured by the case narrative generator program.

10.9.6. Submit the analytical folder for secondary review.

10.10. **Preventive Maintenance**

10.10.1. Perform daily instrument check prior to sample analysis. Refer to Form 9060FM – Instrument Maintenance Log.

Maintenance Activity	Description	Frequency
Documentation	Record all instrument maintenance performed in the instrument maintenance log.	Daily prior to analysis
System Cleaning	Remove dust from fans and vent covers	Every 6 months
Parts Maintenance	Replace worn out parts	Every 6 months
Lubrication	Lubricate mechanical parts	Every 6 months
Flow and Waste lines	Inspect flow and waste lines and replace	Every 6 moths or as necessary
Combustion Tube	Change combustion tube	Every 6 moths or as necessary
Absorber	Change CO2 absorber	Every 6 moths or as necessary
Scrubber	Change halogen scrubber	Every 6 moths or as necessary
Humidifier	Change humidifier water	Every 6 months
Inspection	Perform general inspection of the complete system	Once a year

10.10.2. Perform daily routine check and log it on the instrument maintenance log.

10.10.3. For troubleshooting refer to the TOC analyzer operations manual or go to http://www.ssi.shimadzu.com/toc_virtualadvisor/ for virtual troubleshooting assistance.

11.0 QUALITY CONTROL

11.1. Acceptance criteria for each quality control procedure are summarized in Appendix 1.

11.2. **Preparation Batch QC**

11.2.1. A preparative batch includes a MB, LCS and a maximum of 20 field samples unless otherwise specified by the project.

11.2.2. MS is analyzed every 10 samples unless otherwise specified by the project.

11.2.3. In the absence of MS, a LCS duplicate (LCD) is prepared and analyzed.

11.2.4. Properly treat all labwares used in sample preparation as specified in EMAX-QC07.

11.3. **Analytical Batch QC**

11.3.1. Micropipettes must be calibrated prior to use. Refer to EMAX-QC06 for details.

11.3.2. Reagents are subjected to QC check prior to use. Refer to EMAX-QC01 for details.

11.3.3. All analytical standards are prepared fresh on the day the analysis is done. Follow the procedures for all analytical standard preparations as described in EMAX-QC02 and document in the analytical standard preparation log.

11.4. **Method QC**

11.4.1. A valid DL and LOD must exist prior to sample analysis. Refer to EMAX-QA04 for details.

11.4.2. All analysts conducting this analysis must have an established Demonstration of Capability (DOC) as described in EMAX-QA05.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1.

12.2. **Calibration**

12.2.1. When ICAL is not compliant, consider the following suggestions to correct the problem:

- If the correlation coefficient (r) is out of acceptance criteria, review the results and identify presence of an outlier.
- If one of the standards returns a bias-low or a bias-high on all of the analytes then that point is considered an outlier. Prepare a standard at that ICAL point and re-analyze.
- If the highest ICAL point appears to be saturated, drop the highest point and analyze a lower concentration.
- If the lowest point returns a bias low response or the peaks are not distinct and sharp, drop the point and analyze a higher concentration.

- Otherwise, optimize the instrument and repeat the ICAL.

12.2.2. When ICV or CCV is not compliant, consider the following suggestions to correct the problem:

- Rule out standard degradation. Prepare a fresh standard and re-analyzed.
- If response is low check for leak or if gas pressure is low.
- If response is high, run a blank to rule out contamination. If contamination exists, determine the source of contamination and apply necessary measures to correct the problem. Re-analyze all associated samples that had positive detections.
- Otherwise, inform the supervisor for further instruction.

12.3. Preparation / Analytical Batch QC

12.3.1. For insufficient amount of sample, inform the supervisor immediately for further action.

12.3.2. Method Blank (MB) – When MB is not compliant, consider the following suggestions to correct the problem:

- Rule-out instrument contamination by analyzing instrument blank. In the event that instrument contamination is observed perform the following:
  - ➢ Replace CO2 absorber
  - ➢ Replace the Halogen absorber
  - ➢ Clean the humidifier tubing
  - ➢ Replace the content of the dilution bottle with a freshly harvested reagent water. Purge the wash line.
  - ➢ Re-analyze the instrument blank
- If problem persist, perform the decontamination procedure as described in the operations manual or go to http://www.ssi.shimadzu.com/toc_virtualadvisor/.
- If no apparent instrument contamination is observed, re-analyze another method blank freshly harvested from the reagent water purifier. If problem persist, inform the Supervisor.
- Re-analyze all samples with positive results. Where re-analysis is not possible, flag the data as described by the PSR and discuss in the case narrative.

12.3.3. Lab Control Sample (LCS) – When LCS in is not compliant, consider the following suggestions to correct the problem:

- Rule out standard degradation. Prepare a fresh standard and re-analyze.
- If recovery is low check for leak or if gas pressure is low. Apply necessary measures to correct the problem and re-analyze all associated samples. Where re-analysis is not possible, flag the data as described by the PSR and discuss in the case narrative.
- If response is high, run a blank to rule out contamination. If contamination exists, determine the source of contamination and apply necessary measures to correct the problem. Re-analyze all associated samples positive results.
- Otherwise, inform the supervisor for further instruction.

12.3.4. Matrix Spike/ Matrix Spike Duplicate (MS/MSD) - When MS/MSD in is not compliant, consider the following suggestions to correct the problem:

- Rule out procedural error, e.g., sample was properly spiked, calculations are correct, etc. If procedural error is apparent, re-analyze MS/MSD.
- If matrix interference is suspected, discuss it in the case narrative.

12.4. A Non-Conformance Report (NCR) is required when the following circumstances occur:

- Anomalies other than specified in Appendix 1 is observed.
- Sample is out of technical holding time.

12.4.2. Refer to EMAX-QA08 for NCR details.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to the wastewater drains.

13.2. Prepare all standards in fume hoods to prevent air pollution in the work area.

14.0 WASTE MANAGEMENT

14.1. No samples maybe dumped on the laboratory sink.

14.2. Separate and properly identify all unused and expired analytical standards for proper disposal.

14.3. Place all waste generated during the analytical process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired analytical standards and other waste generated during the analytical process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. Definition of Terms

15.1.1. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents.

- **Preparation batch** - is composed of one to 20 samples of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate.
- **Analytical batch** - is compose of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices; preparation batches, and can exceed 20 samples.

15.1.2. Detection Limit (DL) – The lowest concentration or amount of the target analyte that can be identified, measured and reported with confidence that the analyte concentration is not a false positive.

15.1.3. Limit of Detection (LOD) – An estimate of the minimum amount of substance that an analytical process can reliably detect.

15.1.4. Limit of Quantitation (LOQ) – The minimum levels, concentrations or quantities of target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

15.1.5. Safety Data Sheet (SDS) – is where the physical data, toxicology and safety precaution of a certain substance is listed.

15.1.6. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.1.7. Calibration Blank – is a target-analyte-free solvent subjected to the entire analytical process to establish zero baseline or background value.

15.1.8. Instrument Method – is a file generated to contain the instrument calibration and instrument parameter settings for a particular analysis.

15.1.9. Method Blank – is a target-analyte-free sample subjected to the entire sample preparation and/or analytical to monitor contamination.

15.1.10. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyze to monitor the accuracy of the analytical system.

15.1.11. Lab Control Sample Duplicate (LCD) – is a replicate of LCS analyzed to monitor precision in the absence of MS/MSD sample.

15.1.12. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.1.13. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch. This sample is analyzed to check matrix homogeneity and precision of method in a given matrix.

15.1.14. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.1.15. Matrix – is a component or form of a sample.

15.1.16. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyze to monitor matrix effect on a method’s recovery efficiency.

15.1.17. Matrix Spike Duplicate (MSD) – is a replicate of MS analyzed to monitor precision or recovery.

15.1.18. Reagent Water – is purified water free from any target analyte or any other substance that may interfere with the analytical process.

15.2. **Application of EMAX QC Procedures**

15.2.1. The procedures and QC criteria summarized in this SOP shall be applied to all projects when performing Ion Chromatography analysis unless otherwise other directive is specified by the project requirements.

15.3. **Department of Defense (DoD) and Department of Energy (DOE)Projects**

15.3.1. Samples from DoD and DOE sponsored projects shall follow the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD Quality Systems Manual (QSM), latest update, shall be applied.

16.0 REFERENCES

16.1. SW846 Method 9060A

16.2. Standard Methods for Examination of Water and Wastewater, 21st and 22nd Editions

16.3. Methods of Chemical Analysis of Water and Wastes (EPA/600/4-79/020), Method 415.1, 1974

16.4. Title 40 Code of Federal Regulations, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, latest edition.

16.5. Instructional Manual TOC-VCSH/CSN & TOC-Control V Software TOC-VCPH/CPN

16.6. EMAX Quality Systems Manual, as updated

17.0 APPENDICES

17.1. **Figures**

17.1.1.	Figure 1	Typical Raw Data
17.1.2.	Figure 2	Typical Sample Result Summary
17.1.3.	Figure 3	Typical LCS/LCSD Summary
17.1.4.	Figure 4	Typical MS Summary
17.1.5.	Figure 5	Typical Sample Duplicate Result Summary
17.1.6.	Figure 6	Typical Case Narrative

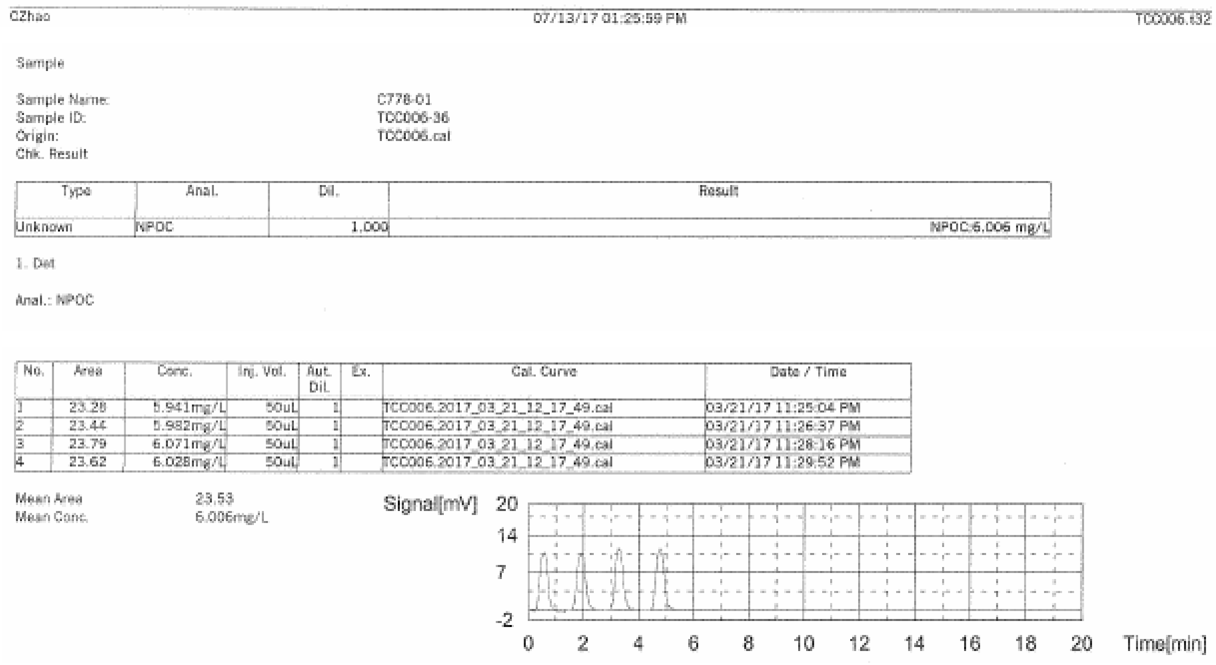
17.2. **Appendices**

17.2.1.	Appendix 1	Summary of Quality Control Procedures
17.2.2.	Appendix 2	Demonstration of Capability

17.3. **Forms**

17.3.1.	9060FA	Analytical Run Log
17.3.2.	9060FM	Instrument Maintenance Log

Figure 1: TYPICAL RAW DATA



CZhao 07/13/17 01:25:59 PM TCC006.t32

Sample

Sample Name:	C778-01
Sample ID:	TCC006-36
Origin:	TCC006.cal
Chk. Result	

Type	Anal.	Dil.	Result
Unknown	NPOC	1.000	NPOC:6.006 mg/L

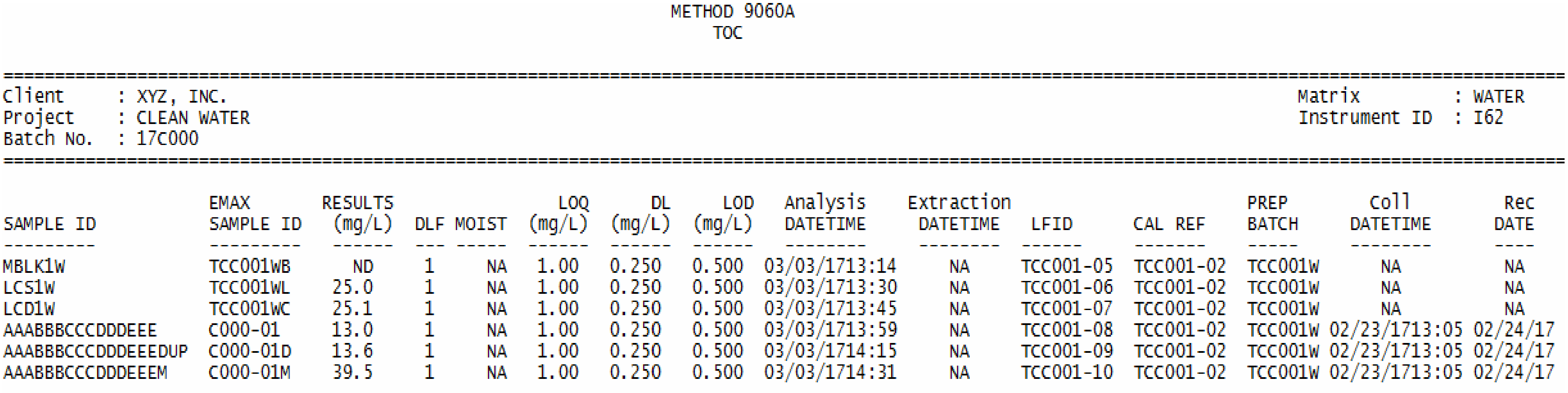
1. Det

Anal.: NPOC

No.	Area	Conc.	Inj. Vol.	Aut. Dil.	Ex.	Cal. Curve	Date / Time
1	23.28	5.941mg/L	50uL	1		TCC006.2017_03_21_12_17_49.cal	03/21/17 11:25:04 PM
2	23.44	5.982mg/L	50uL	1		TCC006.2017_03_21_12_17_49.cal	03/21/17 11:26:37 PM
3	23.79	6.071mg/L	50uL	1		TCC006.2017_03_21_12_17_49.cal	03/21/17 11:28:16 PM
4	23.62	6.028mg/L	50uL	1		TCC006.2017_03_21_12_17_49.cal	03/21/17 11:29:52 PM

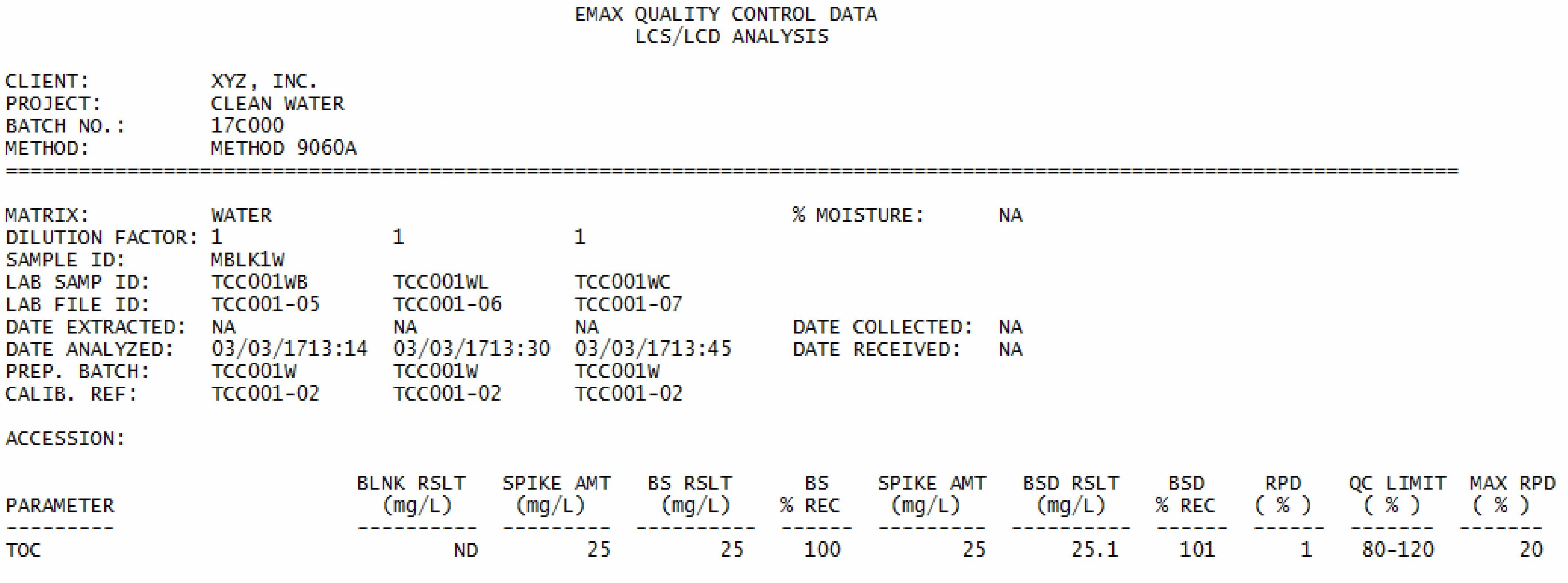
Mean Area	23.53
Mean Conc.	6.006mg/L

Figure 2: TYPICAL SAMPLE RESULT SUMMARY



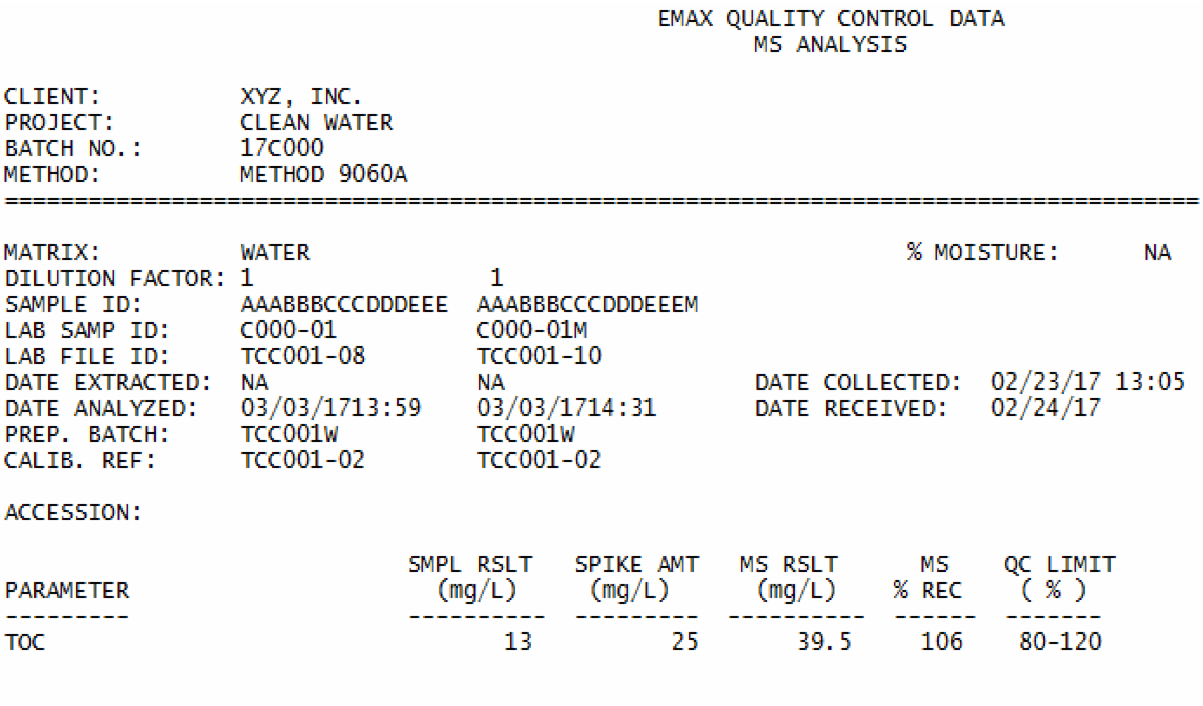
```
                                                                 METHOD 9060A
                                                                     TOC

========================================================================================================================================================
Client     : XYZ, INC.                                                                                                        Matrix         : WATER
Project    : CLEAN WATER                                                                                                      Instrument ID  : I62
Batch No.  : 17C000
========================================================================================================================================================

                    EMAX       RESULTS                LOQ      DL      LOD  Analysis    Extraction                       PREP       Coll         Rec
SAMPLE ID           SAMPLE ID   (mg/L)  DLF MOIST  (mg/L)  (mg/L)  (mg/L)   DATETIME     DATETIME   LFID      CAL REF    BATCH     DATETIME      DATE
---------           ---------   ------  --- -----  ------  ------  ------   --------     --------  ------     -------    -----     --------      ----
MBLK1W              TCC001WB       ND    1     NA   1.00   0.250   0.500  03/03/1713:14     NA     TCC001-05  TCC001-02  TCC001W      NA          NA
LCS1W               TCC001WL    25.0     1     NA   1.00   0.250   0.500  03/03/1713:30     NA     TCC001-06  TCC001-02  TCC001W      NA          NA
LCD1W               TCC001WC    25.1     1     NA   1.00   0.250   0.500  03/03/1713:45     NA     TCC001-07  TCC001-02  TCC001W      NA          NA
AAABBBCCCDDDEEE     C000-01     13.0     1     NA   1.00   0.250   0.500  03/03/1713:59     NA     TCC001-08  TCC001-02  TCC001W 02/23/1713:05 02/24/17
AAABBBCCCDDDEEEDUP  C000-01D    13.6     1     NA   1.00   0.250   0.500  03/03/1714:15     NA     TCC001-09  TCC001-02  TCC001W 02/23/1713:05 02/24/17
AAABBBCCCDDDEEEM    C000-01M    39.5     1     NA   1.00   0.250   0.500  03/03/1714:31     NA     TCC001-10  TCC001-02  TCC001W 02/23/1713:05 02/24/17
```

Figure 3: TYPICAL LCS/LCSD SUMMARY



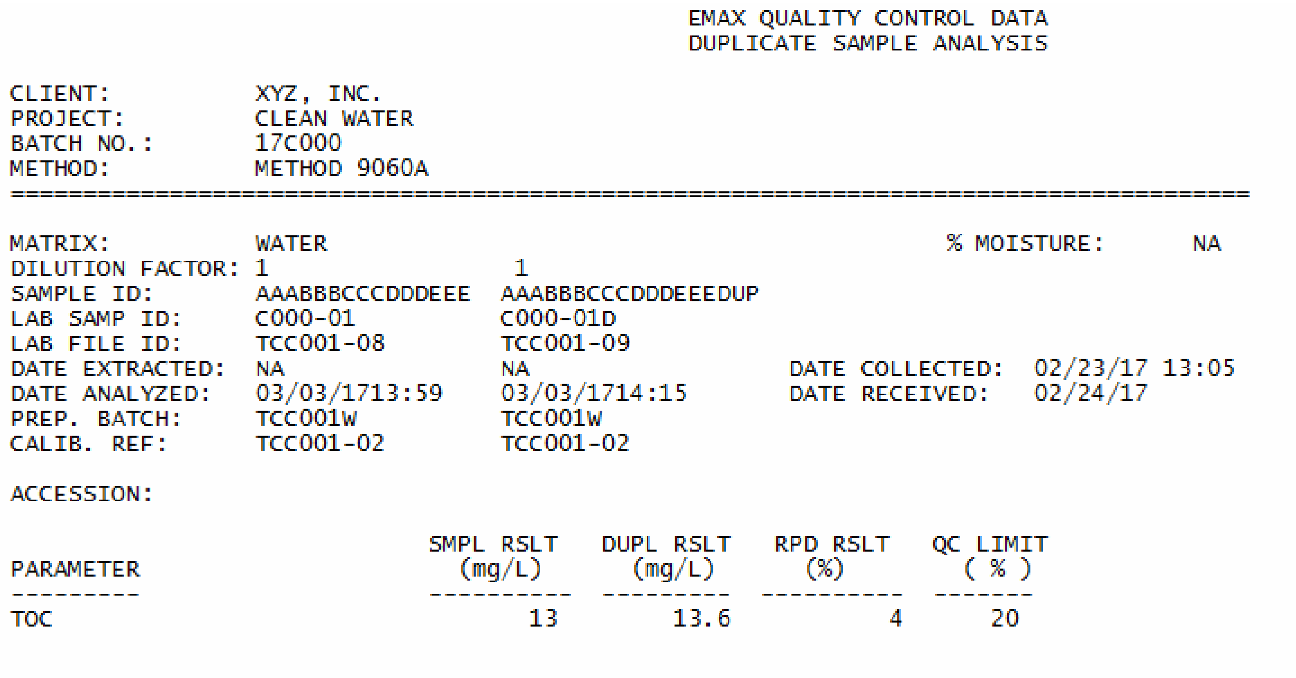
```
                                               EMAX QUALITY CONTROL DATA
                                                    LCS/LCD ANALYSIS

CLIENT:          XYZ, INC.
PROJECT:         CLEAN WATER
BATCH NO.:       17C000
METHOD:          METHOD 9060A
========================================================================================================================

MATRIX:          WATER                                           % MOISTURE:      NA
DILUTION FACTOR: 1              1              1
SAMPLE ID:       MBLK1W
LAB SAMP ID:     TCC001WB       TCC001WL       TCC001WC
LAB FILE ID:     TCC001-05      TCC001-06      TCC001-07
DATE EXTRACTED:  NA             NA             NA                DATE COLLECTED:  NA
DATE ANALYZED:   03/03/1713:14  03/03/1713:30  03/03/1713:45     DATE RECEIVED:   NA
PREP. BATCH:     TCC001W        TCC001W        TCC001W
CALIB. REF:      TCC001-02      TCC001-02      TCC001-02

ACCESSION:

                             BLNK RSLT   SPIKE AMT   BS RSLT      BS    SPIKE AMT   BSD RSLT    BSD     RPD    QC LIMIT  MAX RPD
PARAMETER                      (mg/L)     (mg/L)      (mg/L)    % REC    (mg/L)      (mg/L)    % REC   ( % )    ( % )    ( % )
---------                    ----------  ---------  ----------  ------  ---------  ----------  ------  ------  -------  -------
TOC                                  ND         25         25     100         25        25.1     101       1    80-120       20
```

Figure 4: TYPICAL MS SUMMARY



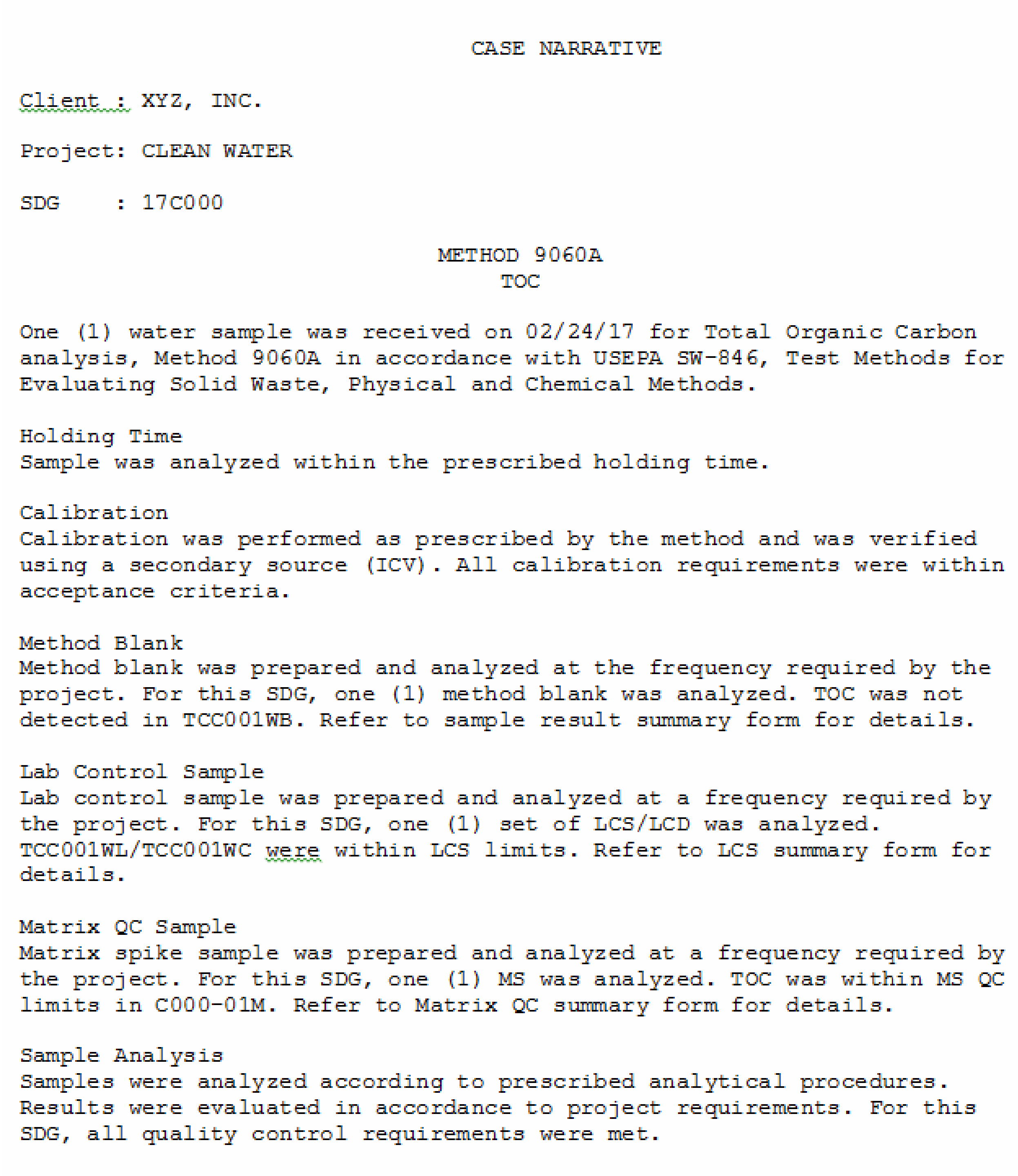
```
                                               EMAX QUALITY CONTROL DATA
                                                      MS ANALYSIS

CLIENT:          XYZ, INC.
PROJECT:         CLEAN WATER
BATCH NO.:       17C000
METHOD:          METHOD 9060A
======================================================================================

MATRIX:          WATER                                          % MOISTURE:      NA
DILUTION FACTOR: 1                  1
SAMPLE ID:       AAABBBCCCDDDEEE  AAABBBCCCDDDEEEM
LAB SAMP ID:     C000-01          C000-01M
LAB FILE ID:     TCC001-08        TCC001-10
DATE EXTRACTED:  NA               NA                   DATE COLLECTED:  02/23/17 13:05
DATE ANALYZED:   03/03/1713:59    03/03/1714:31        DATE RECEIVED:   02/24/17
PREP. BATCH:     TCC001W          TCC001W
CALIB. REF:      TCC001-02        TCC001-02

ACCESSION:

                             SMPL RSLT   SPIKE AMT   MS RSLT      MS     QC LIMIT
PARAMETER                     (mg/L)      (mg/L)      (mg/L)     % REC    ( % )
---------                    ----------  ---------  ----------  ------  -------
TOC                                 13         25        39.5     106    80-120
```

Figure 5: TYPICAL DUPLICATE SAMPLE RESULT SUMMARY



```
                                               EMAX QUALITY CONTROL DATA
                                               DUPLICATE SAMPLE ANALYSIS

CLIENT:          XYZ, INC.
PROJECT:         CLEAN WATER
BATCH NO.:       17C000
METHOD:          METHOD 9060A
=====================================================================================

MATRIX:          WATER                                               % MOISTURE:      NA
DILUTION FACTOR: 1                 1
SAMPLE ID:       AAABBBCCCDDDEEE   AAABBBCCCDDDEEEDUP
LAB SAMP ID:     C000-01           C000-01D
LAB FILE ID:     TCC001-08         TCC001-09
DATE EXTRACTED:  NA                NA                   DATE COLLECTED:   02/23/17 13:05
DATE ANALYZED:   03/03/1713:59     03/03/1714:15        DATE RECEIVED:    02/24/17
PREP. BATCH:     TCC001W           TCC001W
CALIB. REF:      TCC001-02         TCC001-02

ACCESSION:

                             SMPL RSLT   DUPL RSLT   RPD RSLT   QC LIMIT
PARAMETER                     (mg/L)      (mg/L)       (%)       ( % )
---------                    ----------  ----------  ----------  -------
TOC                                  13        13.6           4       20
```

Figure 6: TYPICAL CASE NARRATIVE



CASE NARRATIVE

Client : XYZ, INC.

Project: CLEAN WATER

SDG : 17C000

METHOD 9060A
TOC

One (1) water sample was received on 02/24/17 for Total Organic Carbon analysis, Method 9060A in accordance with USEPA SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods.

Holding Time
Sample was analyzed within the prescribed holding time.

Calibration
Calibration was performed as prescribed by the method and was verified using a secondary source (ICV). All calibration requirements were within acceptance criteria.

Method Blank
Method blank was prepared and analyzed at the frequency required by the project. For this SDG, one (1) method blank was analyzed. TOC was not detected in TCC001WB. Refer to sample result summary form for details.

Lab Control Sample
Lab control sample was prepared and analyzed at a frequency required by the project. For this SDG, one (1) set of LCS/LCD was analyzed. TCC001WL/TCC001WC were within LCS limits. Refer to LCS summary form for details.

Matrix QC Sample
Matrix spike sample was prepared and analyzed at a frequency required by the project. For this SDG, one (1) MS was analyzed. TOC was within MS QC limits in C000-01M. Refer to Matrix QC summary form for details.

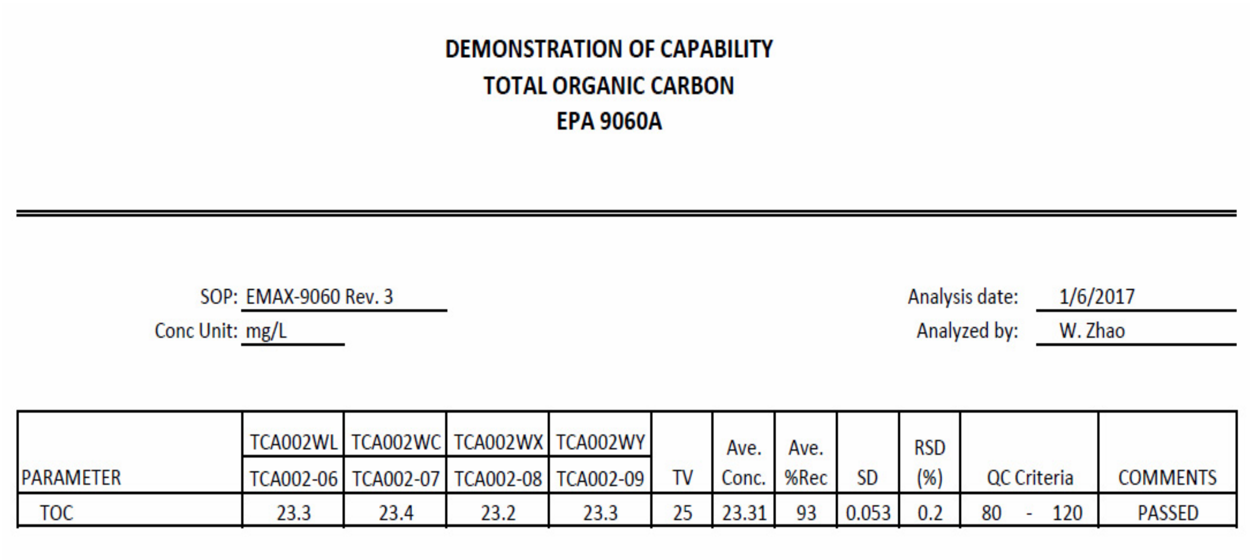
Sample Analysis
Samples were analyzed according to prescribed analytical procedures. Results were evaluated in accordance to project requirements. For this SDG, all quality control requirements were met.

Appendix 1: SUMMARY OF QUALITY CONTROL PROCEDURES

QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	1st Rvw	2nd Rvw
ICAL - Minimum of 5-point calibration	Prior to sample analysis	Correlation coefficient (r) ≥ 0.995	Correct the problem then repeat initial calibration		
Initial Calibration Verification (ICV)	Every after ICAL	%Recovery: ± 10% of expected value	Re-analyze ICV to rule out bad injection and/or standard degradation. Otherwise, repeat calibration		
Calibration verification	Every 15 samples and at the end of analysis sequence	%Recovery: ± 10% of expected value	Re-analyze CCV to rule out bad injection and/or standard degradation. Otherwise, repeat calibration and re-analyze all samples since last successful calibration verification.		
Method Blank	One per preparation batch	No analytes detected > ½ LOQ	If instrument blank is clean, re-analyze MB and all samples with positive results.		
LCS	Refer to PSR	%Rec: 80-120%	Re-prep and re-analyze the LCS and all associated samples		
Dup/MS	Refer to PSR otherwise, one set every 10 samples	%Rec: 80-120% %D ≤ 20%	If no procedural error is observed, matrix interference is suspected. Discuss finding in case narrative.		
Comments: Refer to PSR for flagging criteria.			Reviewed By:		
			Date:		

TOC

Appendix 2: DEMONSTRATION OF CAPABILITY



DEMONSTRATION OF CAPABILITY
TOTAL ORGANIC CARBON
EPA 9060A

SOP: EMAX-9060 Rev. 3

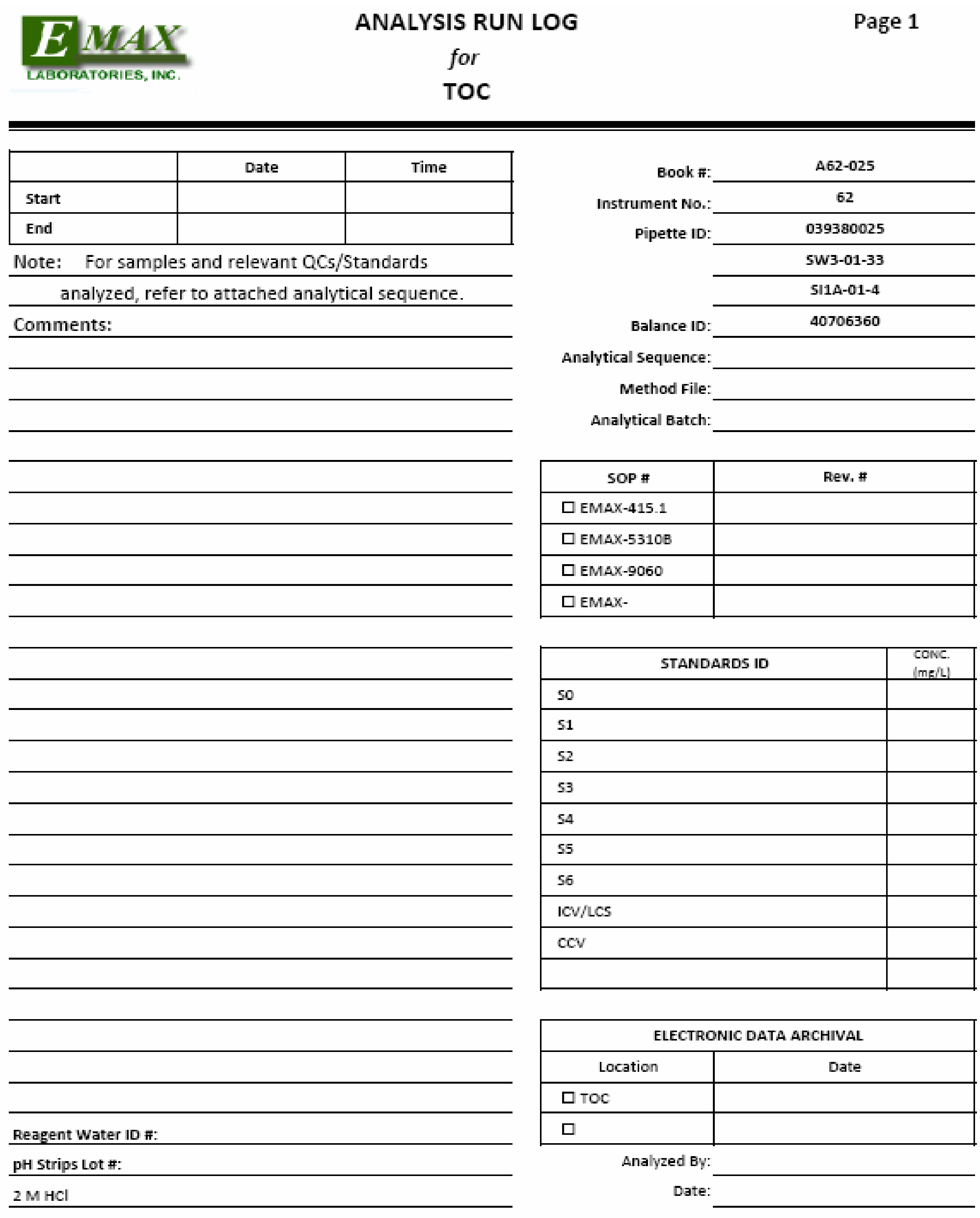
Conc Unit: mg/L

Analysis date: 1/6/2017

Analyzed by: W. Zhao

PARAMETER	TCA002WL	TCA002WC	TCA002WX	TCA002WY	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	QC Criteria	COMMENTS
	TCA002-06	TCA002-07	TCA002-08	TCA002-09							
TOC	23.3	23.4	23.2	23.3	25	23.31	93	0.053	0.2	80 - 120	PASSED

9060FA: ANALYTICAL RUN LOG



EMAX LABORATORIES, INC.

ANALYSIS RUN LOG
for
TOC

Page 1

	Date	Time
Start		
End		

Note: For samples and relevant QCs/Standards analyzed, refer to attached analytical sequence.

Comments:

Reagent Water ID #:

pH Strips Lot #:

2 M HCl

Book #: A62-025

Instrument No.: 62

Pipette ID: 039380025
SW3-01-33
SI1A-01-4

Balance ID: 40706360

Analytical Sequence:

Method File:

Analytical Batch:

SOP #	Rev. #
☐ EMAX-415.1	
☐ EMAX-5310B	
☐ EMAX-9060	
☐ EMAX-	

STANDARDS ID	CONC. (mg/L)
S0	
S1	
S2	
S3	
S4	
S5	
S6	
ICV/LCS	
CCV	

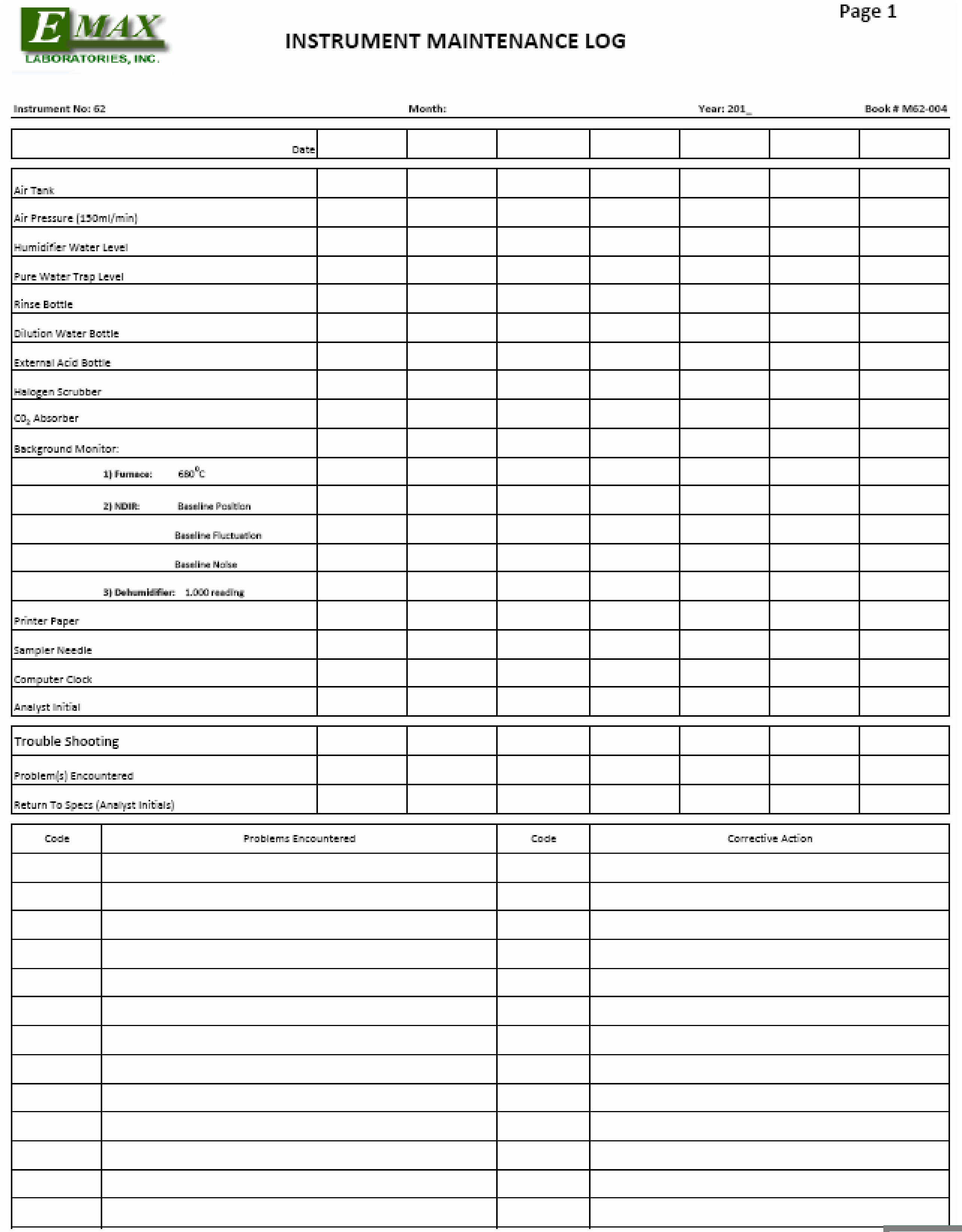
ELECTRONIC DATA ARCHIVAL	
Location	Date
☐ TOC	
☐	

Analyzed By:

Date:

TOC

9060FM: INSTRUMENT MAINTENANCE LOG



EMAX LABORATORIES, INC.

Page 1

INSTRUMENT MAINTENANCE LOG

Instrument No: 62 Month: Year: 201_ Book # M62-004

Date							

Air Tank							
Air Pressure (150ml/min)							
Humidifier Water Level							
Pure Water Trap Level							
Rinse Bottle							
Dilution Water Bottle							
External Acid Bottle							
Halogen Scrubber							
CO_2 Absorber							
Background Monitor:							
1) Furnace: 680°C							
2) NDIR: Baseline Position							
Baseline Fluctuation							
Baseline Noise							
3) Dehumidifier: 1.000 reading							
Printer Paper							
Sampler Needle							
Computer Clock							
Analyst Initial							

Trouble Shooting							
Problem(s) Encountered							
Return To Specs (Analyst Initials)							

Code	Problems Encountered	Code	Corrective Action

PRINT DRF

ANNUAL REVIEW FORM

TOTAL ORGANIC CARBON

SOP#: EMAX-9060 **Rev** 4 **Effective Date:** 11-Oct-17

COMMENTS	Reviewed By	Review Date
No update needed per DRF by TKosaka dtd 10/2/18		10/2/18
No update needed per Y. Aquino 11/19/2019		11/19/2019
No update needed per DRF by T. Kosaka 10/26/2020.		10/26/2020
No technical update needed. Update standard sources, EMAX address.		11/5/21
Revise SOP to update Sec. 3.0 (detection limits to the browser)		
and update EMAX physical location. No technical update needed.		11/2/22
No technical update needed per DRF by T. Kosaka 1/10/2024. Need to update Sec. 3.0 and EMAX address		1/10/2024

STANDARD OPERATING PROCEDURES

DISSOLVED GASES

SOP No.: EMAX-RSK175 Revision No. 5 Effective Date: 28-Sep-22

Prepared By: Larisa Ermolova Date: 9/28/22

Approved By: Farina Madamba, QA Manager Date: 09/28/22

Approved By: Caspar Pang, Laboratory Director Date: 9/28/22

Control Number: RSK175-05-

1.0 SCOPE AND APPLICATION

1.1. This method is used to determine dissolved methane, ethane, ethane, propane and acetylene in aqueous samples. This SOP is an adaptation of Dissolved Oxygen and Methane in Water by GC Headspace Equilibrium Technique published by R.S. Kerr Research Laboratory, commonly known as RSK 175.

1.2. This method is also used for carbon dioxide determination using an unpreserved sample and a Thermal Conductivity Detector (TCD).

1.3. This method is also amenable to propene, isobutene and any other gases of similar structure, upon meeting all quality control criteria.

2.0 SUMMARY OF METHOD

2.1. A known volume of inert gas is injected into the sample contained in a septum cap vial, which subsequently displaces the same volume of sample into an injected empty disposable syringe. The injected gas is allowed to equilibrate with the sample by wrist mixing. Subsequently, a known amount of gas is aspirated from the headspace by a tight syringe with a locking device is analyzed for the target gases by GC with FID detector.

2.2. **Interferences**

2.2.1. Glassware must be cleaned scrupulously as these can be a potential source of contamination.

2.2.2. Carry-over from a highly concentrated sample can be a potential source of contamination. Instrument performance must be observed keenly for possible carry-over. If this is apparent, inject solvent blank until no trace of carry-over is observed.

2.2.3. Deposits may adhere in the injection port/glass liner over a period of time and can cause interference. The injection port and glass liner must be routinely cleaned.

3.0 DETECTION LIMITS

3.1. **Detection Limit (DL), Limit of Detection (LOD) and Limit of Quantitation (LOQ)**

3.1.1. Refer to EMAX-QA04 for generation, validation and verification of DL, LOD and LOQ.

3.1.2. Refer to EMAX Browser for established DL, LOD and LOQ.

4.0 DYNAMIC RANGE

4.1. The highest quantifiable range requiring no dilution is equal to the concentration of the highest calibration point (See Sec. 9.2). Samples analyzed above this concentration are considered "over-range" and shall require dilution for proper quantitation.

4.2. The lowest quantifiable range of diluted samples is equal to the lowest calibration point (See Sec. 9.2). Samples analyzed below this concentration are considered “under-range” and shall require a lower dilution factor for proper quantitation.

5.0 SAMPLE HOLDING TIME AND PRESERVATION

5.1. Preservation

5.1.1. Water samples are received in 40 mL vials with teflon-lined septa with zero headspace. The size of bubble caused by degassing upon cooling the sample should not exceed 6 mm.

5.1.2. Except for samples requiring carbon dioxide analysis, samples are preserved with concentrated HCl to pH < 2. Samples for carbon dioxide analysis must be analyzed from a sample with no chemical preservative.

5.1.3. All samples are stored at ≤ 6°C without freezing.

5.2. Holding Time

5.2.1. Holding time is 14 days from the time of collection.

5.2.2. For unpreserved water samples, the holding time is 7 days from collection date.

6.0 ASSOCIATED SOPs

6.1.	EMAX-QA04	Detection Limit (DL)
6.2.	EMAX-QA08	Corrective Action
6.3.	EMAX-QC02	Analytical Standard Preparation
6.4.	EMAX-QC05	Calibration of Thermometers
6.5.	EMAX-QC06	Volumetric Labware and Micropipette Verification
6.6.	EMAX-DM01	Data Flow and Review
6.7.	EMAX-SM02	Sample Receiving
6.8.	EMAX-SM03	Waste Disposal
6.9.	EMAX-SM04	Analytical and QC Sample Labeling

7.0 SAFETY

7.1. Read all SDS for chemicals listed in this SOP.

7.2. Treat all reagents, standards, and samples as potential hazards. Observe the standard laboratory safety procedures. Wear protective gear, i.e., lab coat, safety glasses, gloves, at all times when performing this procedure. Perform all sample and standard handling in the fume hood.

7.3. If for any reason, solvent and/or other reagents get in contact with the skin or any other part of the body, rinse the affected body part thoroughly with copious amount of water. If irritations persist, inform your supervisor immediately so that proper action can be taken.

8.0 INSTRUMENTS, CHEMICALS AND REAGENTS

8.1. Instruments and Supplies

8.1.1. Gas Chromatography – HP 5890 with FID or equivalent. For CO_2, HP HP 5890 Series II w/ TCD or equivalent.

8.1.2. Column – Rt-QS-Bond 30 m x 0.53 mm ID, 20 µm thickness (Restek) or equivalent

8.1.3. Data System - EZ-Chrom, HP Chem Station, or equivalent

8.1.4. Syringes

8.1.4.1. Standard Syringes – 25 µL, 100 µL, 250µL, 500 µL, 5 mL Luerlock gas tight syringe with shut-off valve, or equivalent

8.1.4.2. Helium Syringes – 3 mL and 5 mL Luerlock gas tight syringe with shut-off valve, or equivalent

8.1.4.3. Displacement Syringe – 5 mL Luerlock disposable syringe

8.1.5. Microsyringes - 25, 100, 250 µL and 500 µL with a 0.006 mm ID needle (Hamilton 702N or equivalent) for dilution purposes

8.1.6. Tedlar Bags - 1 Liter (7” x 7”), with polypropylene 2-N-1 combination fitting

8.1.7. pH strips - pH 0-14

8.1.8. Thermometer - 0-100°C

8.2. Chemicals and Reagents

8.2.1. Solvent: Organic-free water

8.2.2. Gas - Ultra-high purity helium; ultra-high purity hydrogen

9.0 STANDARDS

9.1. Stock Standard

9.1.1. Purchase Stock Standards as certified solutions as suggested below (or equivalent).

Standard Name	Source	Concentration	Intended Use
Gas mixture of ethane, ethylene and methane, propane, acetylene and CO_2 in Helium	Scotty Gases	500 mg/L, 10% CO_2 (v/v)	ICAL, DCC*
Propylene in Helium	Scotty Gases	500 mg/L	ICAL, DCC*
Gas mixture of ethane, ethylene and methane, propane, acetylene and CO_2 in Helium	Matheson	500 mg/L, 10% CO2 (v/v)	ICV, LCS, MS*
Propylene in Helium	Matheson	500 mg/L	ICV, LCS, MS*

*Note: * Stock standards may be interchanged to meet the intended use during calibration.*

9.2. Initial Calibration Standard (ICAL)

9.2.1. Prepare the ICAL points at suggested concentration levels with helium to a final volume of 4 mL, as shown below.

Standard		**1**	**2**	**3**	**4**	**5**	**6**
Preparation of ICAL Standards							
Primary Stock Std. (500 mg/L) Aliquot (mL)		0.08	0.4	1.0	1.6	3.0	4.0
Solvent		Helium	Helium	Helium	Helium	Helium	-
Final Volume (mL)		4	4	4	4	4	4
Final Concentrations							
CH_4	(µL/L)	10	50	125	200	375	500
	(µg/L)*	0.6800	3.402	8.504	13.60	25.51	34.01
C_2H_2	(µL/L)	10	50	125	200	375	500
	(µg/L)*	1.105	5.528	13.82	22.11	41.45	55.27
C_2H_4	(µL/L)	10	50	125	200	375	500
	(µg/L)*	1.190	5.953	14.88	23.81	44.64	59.52
C_2H_6	(µL/L)	10	50	125	200	375	500
	(µg/ml)*	1.275	6.378	15.95	25.51	47.83	63.77
C_3H_8	(µL/L)	10	50	125	200	375	500
	(µg/L)*	1.870	9.350	23.39	37.41	70.15	93.53

Note: Conversion of concentration from µL/L to µg/L is shown in Eq.- 10.5.1.1 with V_h/V_w *= 4/39 and T = 21 °C.*

9.2.2. For propylene calibration, prepare the ICAL points at suggested concentration levels with Helium to a final volume of 4 mL, as shown below.

Standard		**1**	**2**	**3**	**4**	**5**	**6**
Preparation of ICAL Standards							
Primary Stock Std (500 mg/L), Aliquot (mL)		0.08	0.4	1.0	1.6	3.0	4.0
Solvent		Helium	Helium	Helium	Helium	Helium	-
Final Volume (mL)		4	4	4	4	4	4
Final Concentration							
C_3H_6	(µL/L)	10	50	125	200	375	500
	(µg/L)*	1.785	8.929	22.32	35.71	66.96	89.28

Note: Conversion of concentration from µL/Lto µg/L is shown in Eq. 10.5.1.1 with V_h/V_w *= 4/39 and T = 21°C.*

9.2.3. For carbon dioxide calibration, prepare the ICAL points at suggested levels with Helium to a final volume of 4 mL, as shown below.

Standard		**1**	**2**	**3**	**4**	**5**	**6**
Preparation of ICAL Standards							
Primary Stock Std (10%) Aliquot (mL)		0.25	0.5	1.0	2.0	3.0	4.0
Solvent		Helium	Helium	Helium	Helium	Helium	-
Final Volume (mL)		4	4	4	4	4	4
Final Concentration							
CO_2	(μL/L)	6250	12500	25000	50000	75000	100000
	(μg/L)*	1200	2300	4700	9300	14000	19000

Note: Conversion of concentration from μL/L to μg/L is shown in Eq. 10.5.1.1 with V_h/V_w = 4/39 and T = 21°C.

9.3. Initial Calibration Verification Standard (ICV) & LCS/MS Spike Standard

9.3.1. Using secondary stock standard, prepare ICV standard to final volume of 4 mL as suggested below.

Preparation			**Final Concentration**				
Secondary Stock Std (500 mg/L), Aliquot (mL)	Solvent	Final Vol. (mL)	CH_4	C_2H_2	C_2H_4	C_2H_6	C_3H_8
1.6	Helium	4	200 μL/L	200 μL/L	200 μL/L	200 μL/L	200 μL/L
			13.60 μg/L	22.11 μg/L	23.81 μg/L	25.51 μg/L	37.41 μg/L

9.3.2. For propylene, prepare as suggested below.

Preparation			**Final Concentration**
Secondary Stock Std (500 mg/L), Aliquot (mLl)	Solvent	Final Vol. (mL)	C_3H_6
1.6	Helium	4	200 μL/L
			35.71 μg/L

9.3.3. For carbon dioxide, prepare as suggested below.

Preparation			**Final Concentration**
Secondary Stock Std (10%), Aliquot (mL)	Solvent	Final Vol. (mL)	CO_2
2	Helium	4	50000 μL/L
			9300 μg/L

9.4. Continuing Calibration Standard (DCC)

9.4.1. Using primary stock standard, prepare DCC to final volume of 4 mL as suggested below.

Preparation			Final Concentration				
Primary Stock Std (500 mg/L), Aliquot (mL)	Solvent	Final Vol. (ml)	CH_4	C_2H_2	C_2H_4	C_2H_6	C_3H_8
1.6	Helium	4	200 μL/L	200 μL/L	200 μL/L	200 μL/L	200 μL/L
			13.60 μg/L	22.11 μg/L	23.81 μg/L	25.51 μg/L	37.41 μg/L

9.4.2. For propylene, prepare as suggested below.

Preparation			Final Concentration
Primary Stock Std (500 mg/L), Aliquot (mLl)	Solvent	Final Vol. (mL)	C_3H_6
1.6	Helium	4	200 μL/L
			35.71 μg/L

9.4.3. For carbon dioxide, prepare as suggested below.

Preparation			Final Concentration
Primary Stock Std (10%), Aliquot (mL)	Solvent	Final Vol. (mL)	CO_2
2	Helium	4	50000 μL/L
			9300 μg/L

10.0 PROCEDURES

10.1. Sample Preparation

10.1.1. Let the samples sit on a water bath (maintained in room temperature at 21 ± 2 °C) for at least an hour. For LCS, prepare reagent water in 4 mL vial. If MS is required, prepare an extra vial of designated sample.

10.1.1.1. Check that the thermometer has a valid calibration. Record the thermometer ID and temperature of the water bath in the sample preparation log.

10.1.2. Place the sample vial upside down and secure with a three finger clamp. Insert the sample displacement syringe, set for dead volume, into the sample by penetrating the septum to expose about one centimeter of the syringe needle into the sample.

10.1.3. From a freshly helium-filled tedlar bag, using the helium syringe, measure 4mL of helium into a gas tight Luerlock syringe, lock then insert into the vial septum. For LCS and MS, spike LCS/MS standard as suggested in Sec. 9.3.

10.1.4. Open the syringe lock and inject the helium into the sample. As the helium is injected, sample is displaced from the vial into the empty syringe, creating a headspace equivalent to the volume of helium injected.

10.1.5. Check the pH of the discarded sample. Record the pH and pH lot # in the sample preparation log.

10.1.6. Shake the vial for five minutes by quick wrist motion to allow gas to equilibrate between the liquid and gas phases.

10.1.7. The gas contained in the vial headspace is ready for analysis. Perform the analysis immediately upon completion of a preparative batch.

10.2. Instrument Parameters

10.2.1. Gas Chromatography Condition (FID)

Gases Setting:	
H_2	30 psi
Helium	30 psi
Air	120 psi
GC Setting	
Signal	90-110 mV
Injection Temperature	240 ˚C
Detector Temperature	240 ˚C
Injection Volume	100 µL
Head Pressure	16 psi
Carrier & Make-up gases + Air	300 mL/min

Temperature Program	Temperature (°C)	Rate/min (˚C)	Time (min)
Column	50	25	1
	200	0	0

10.2.2. Gas Chromatography Condition CO_2 (TCD)

Gases Setting:	
H_2	30 psi
Helium	30 psi
Air	120psi
GC Setting	
Injection Temperature	230°C
Detector Temperature	230°C
Injection Volume	100 µL
Head Pressure	12 psi

Temperature Program	Temperature (°C)	Rate/min (°C)	Time (min)
Column	80	0	1
	225	24	1

10.2.3. Instrument parameters setup stipulated in this SOP are instrument suggested parameters. Fine tune the instrument to obtain optimum instrument condition.

10.2.4. Print and staple a copy of the current instrument parameter on the instrument log for easy access when performing daily instrument routine check.

10.2.5. In the event that instrument parameters necessitate a change, replace the instrument parameter printout with the new parameter setup. Archive the previous instrument parameters at the back of the instrument maintenance log.

10.3. Calibration

10.3.1. Initial Calibration

10.3.1.1. Carefully fill a 40 mL VOA vial with purged HPLC grade. Care should be taken to avoid any trapped bubbles.

10.3.1.2. Setup the vial as described in Sec. 10.1.2.

10.3.1.3. Using a Luerlock gas tight syringe measure the desired amount of standard (refer to Sec. 9.2) and lock it. Using the helium syringe, measure the corresponding amount of helium to make a total of 4mL final volume of gas (standard plus helium) and lock it.

10.3.1.4. Insert the standard syringe and the helium syringe into the vial septum. Simultaneously inject the standard and helium (as described in Sec. 10.1.4) into the vial to displace 4mL of reagent water into the displacement syringe. Lock the syringe after injection was completed to prevent sample backflow.

10.3.1.5. Remove the syringes and shake the vial for five minutes by quick wrist motion to allow gas to equilibrate between the liquid and gas phases.

10.3.1.6. With the vial positioned upright, withdraw 100 µL gas from the headspace and analyze by GC.

10.3.1.7. Calculate the mean calibration factor and the relative standard deviation (%RSD) according to Eq.- 10.5.1.3 and Eq.- 10.5.1.5.

10.3.1.8. Refer to Appendix 1 for acceptance criteria. If results are non-compliant, refer to Sec. 12 for corrective action.

10.3.2. Initial Calibration Verification

10.3.2.1. Prepare and analyze an ICV standard (refer to Sec.9.3) applying the same procedure as described in Sec.10.3.1.

10.3.2.2. Refer to Appendix 1 for acceptance criteria. If results are non-compliant, refer to Sec. 12 for corrective action.

10.3.3. Daily Continuing Calibration (DCC)

10.3.3.1. Analyze a continuing calibration standard (refer to Sec. 9.4) to check the validity of the ICAL, at the beginning of the batch, every 12 hours thereafter and at the end of the batch.

10.3.3.2. Calculate the percent difference using Eq.- 10.5.1.6.

10.3.3.3. Refer to Appendix 1 for acceptance criteria. If results are non-compliant, refer to Sec. 12 for corrective action.

10.4. Analysis

10.4.1. Prepare analytical sequence as suggested below.

10.4.1.1. Instrument blank – inject 100 µL of helium to confirm absence of contamination from the system and the helium to be used for analysis.

10.4.1.2. DCC – to check the validity of the ICAL prior to sample analysis.

10.4.1.3. Method Blank – to confirm absence of contamination from the reagent water used for the standard preparation as well as the naturally occurring gases from the atmosphere.

10.4.1.4. LCS – to confirm the accuracy of the preparation process

10.4.1.5. Samples not to exceed 12 hours

10.4.1.6. MS/MSD – as required by the project.

10.4.1.7. DCC – after 12 hours and at the end of the batch

10.4.2. Sample Result Evaluation

10.4.2.1. Check QC parameters as soon as the data is available.

10.4.2.2. When a chromatographic peak falls in the retention time window (Sec. 10.4.4) of an analyte, it is considered as qualitatively identified. Calculate the concentration according to Eq.- 10.5.2.

10.4.2.3. Check the concentration of identified target analytes. If the response exceeds the calibration range, re-analyze the sample to bring the response of the target analyte within the calibration range guided by the options below.

- If less than 10% of the original sample headspace was used in the sample analyses, a smaller injection from the same headspace can be made.
- Otherwise, a new sample is prepared at an appropriate dilution.

10.4.2.4. Rule out carryover. Refer to Sec. 10.4.5.

10.4.3. Manual Integration

10.4.3.1. When manual integration is necessary, follow the procedures described in EMAX-DM01.

10.4.4. Retention Time Windows

10.4.4.1. **Establishing RTW**

10.4.4.1.1. Run RTW standard over a period of 72 hours.

10.4.4.1.2. Calculate the standard deviation (SD) of the obtained retention time for each analyte according to Eq.-10.5.1.4.

10.4.4.1.3. The width of RTW is defined by ± 3xSD.

10.4.4.2. **Evaluating RTW**

10.4.4.2.1. If the SD is equal to 0.0, default to the previous study until historical data is obtained to define the RTW of the current instrument.

10.4.4.2.2. For new instruments, use the established retention time of another instrument having the same instrument parameters (e.g., detector, temperature program and column). If there are no instruments with the same instrument parameter, use 0.03 minutes as the default RTW until historical data is obtained to define the RTW for the current instrument parameters condition.

10.4.4.3. **Application of RTW**

10.4.4.3.1. Establish the center of the absolute retention time for each analyte from the daily calibration check at the beginning of the analytical shift then apply the established RTW.

10.4.4.3.2. Whenever the observed retention time is outside the established RTW, the analyst is advised to determine the cause and perform necessary corrective action before continuing analysis.

10.4.4.4. **Updating RTW**

10.4.4.4.1. Re-establish the RTW as described in Sec. 10.4.4.1 when the following conditions occur:

- Yearly RTW update
- Significant shifting is observed (e.g., succeeding calibration checks or LCS are out of the RTW)
- Major instrument maintenance (e.g., replacements of detector or column, temperature program change, etc.)

10.4.4.4.2. If the calculated new RTW is significantly narrower than the previously established RTW, default to the previously established RTW.

10.4.5. Dealing with Carryover

10.4.5.1. Check the sample analyzed after a sample having target analyte concentrations exceeding the calibration range.

10.4.5.2. If there is no target analyte detected as found in the preceding high-concentration sample, proceed with data reduction.

10.4.5.3. If there is any target analyte detected as found in the preceding high-concentration sample, re-analyze the sample to rule-out carryover. If carryover is confirmed, proceed with data reduction and report the data from re-analysis.

10.5. Calculations

10.5.1. Calibration

10.5.1.1. **Standard Concentration from µL/L to µg/L**

$$C = \frac{V_H}{V_W} \times C_V \left(\frac{273}{273 + T_C} \right) \times \frac{1}{22.4} M_{wt}$$

Eq.- 10.5.1.1

where:

C – Concentration of gas in water in µg/L

V_H – Head space volume (4mL)

V_W – Sample volume (39 mL)

C_V – Concentration of gas in µL/L

T_C – Room temperature (21°C ±2°C)

M_{wt} – Molecular Weight of gases:

CH_4 – 16

C_2H_2 – 26

C_2H_4 – 28

C_2H_6–30

C_3H_6–42

C_3H_8–44

CO_2 – 44

10.5.1.2. **Calculate for Calibration Factor (CF)**

$$CF = \frac{R_a}{C_a} \qquad \text{Eq.- 10.5.1.2}$$

where:

R_a – Response for analyte measured in peak area

C_a – Concentration of analyte to be measured, µg/L

10.5.1.3. **Calculate for Average Calibration Factor (ACF)**

$$ACF = \frac{\sum CF}{n} \qquad \text{Eq.- 10.5.1.3}$$

where:

ACF – Average calibration factor

$\sum CF$ – Sum of calibration factors

n – Number of calibration points

10.5.1.4. **Calculate for Standard Deviation**

$$SD = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}} \qquad \text{Eq.- 10.5.1.4}$$

where:

SD – Standard deviation

x_i – Result at i^th^ measurement

$\bar{x}$ – Mean of the n measurements

N – Number of measurements

10.5.1.5. **Calculate for % Relative Standard Deviation (%RSD)**

$$\%RSD = \frac{SD}{ACF} * 100\% \qquad \text{Eq.- 10.5.1.5}$$

where:

SD – Standard deviation

ACF – Average calibration factor

10.5.1.6. **Calculate for Percent Difference (%D)**

$$\%D = \frac{Ck - Cf}{Ck} * 100\% \qquad \text{Eq.-10.5.1.6}$$

where:

% D – Percent difference

Ck – Known concentration of analyte, µg/L

Cf – Concentration found, µg/L

10.5.2. Sample Results

$$C = \frac{R_a}{ACF} * D \qquad \text{Eq.-10.5.2}$$

where:

C – Concentration of analyte, µg/L

R_a – Response for analyte measured in peak area

ACF – Average calibration factor of analyte

D – Dilution factor

10.5.3. Accuracy and Precision

10.5.3.1. **Calculate for Percent Recovery (%R)**

$$\%R = \frac{C_f - C}{C_s} * 100 \qquad \text{Eq.-10.5.3.1}$$

where:

C_f – Concentration found

C – Sample concentration; for LCS, C=0

C_s – Concentration of spike

10.5.3.2. **Calculate for Relative Percent Difference (RPD)**

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100\% \qquad \text{Eq.-10.5.3.2}$$

where:

C_1 – Measured concentration of the first aliquot

C_2 – Measured concentration of the second aliquot

10.6. **Data Reduction**

10.6.1. Make a copy of the analytical run log.

10.6.2. Make a copy of the sample preparation log.

10.6.3. Print a copy of the raw data and the QC report.

10.6.4. Highlight the data to be reported.

10.6.5. Collate the reportable raw data separating the QC results from the sample results.

10.6.6. Keep all other data generated with the analytical folder marked with "For record only".

10.7. **Report Generation**

10.7.1. Generate the method.txt file using METXT.exe.

10.7.2. Generate the sample results using F1NV3C.exe or F1NV3C4.exe.

10.7.3. Generate the QC summary using QCV3CN.exe or QCV3CN4.exe.

10.7.4. Generate Lab Chronicle using LABCHRN1.exe

10.7.5. Generate case narrative using CN00.exe

10.8. **Data Review**

10.8.1. Arrange the analysis package in sequence as detailed below using section separators. Attach all raw data to every form generated, to include manual integration and re-analyses.

- Case Narrative
- Lab Chronicle
- Sample Results
- Method Blank Results
- LCS/ LCSD Summary
- MS/MSD Summary
- ICAL Summary
- ICV Summary
- DCC Summary
- Analytical Run Log
- Sample Preparation Log
- Non-Conformance Report (if any)

10.8.2. Perform a 100% data review in accordance to EMAX-DM01and the PSR.

10.8.2.1. If any of the checkpoints below indicate a problem, re-analysis is required.

- Check the qualitative identification is done properly.

- Check calibrations for accuracy, completeness and compliance to requirements.
- Check that sample results are integrated properly and results above calibration range are diluted and re-analyzed within the calibration range.
- Where manual integration was performed, check that it was done properly and documentation was retained in accordance to EMAX-DM01 (Manual Integration Section).
- Check that saturated peaks are diluted and quantitated properly.
- Check that suspected carry-overs are re-analyzed and results are reported accordingly.
- Check that method blank is compliant to PSR.
- Check that LCS and LCSD are within the project QC limits.
- Check that MS and MSD are within the project QC limits.

10.8.2.2. Review that the attached logs are properly filled.

10.8.2.3. Check the generated reports against raw data. Check that the analytical data that indicate positive results are qualitatively and quantitatively correct.

10.8.2.4. Review the case narrative and check that it accurately describes what transpired in the analytical process. Edit as necessary to reflect essential issues not captured by the case narrative generator program.

10.8.3. Submit the analysis package for secondary review.

10.9. Preventive Maintenance

10.9.1. Perform routine instrument preventive maintenance and record on the instrument-specific maintenance log (Refer to Form RSK175FM). Routine maintenance ensures that all Instruments are operating under optimum condition, thus reducing the possibility of instrument malfunction that may affect data quality.

10.9.2. The table below lists suggested routine maintenance schedule.

Maintenance Activity	Description	Frequency
GC Verification	Inspect and clean syringe. Check instrument parameters to ensure normal operating conditions. Change liner as necessary. Clean injection port as necessary. Check instrument performance (e.g., Daily calibration check, instrument blank)	Daily prior to analysis.
System Cleaning	Remove dust from fans and vent covers, inspect and clean inlet and detector. Check septa and replace as necessary.	Every 6 months or as necessary
Check Flow Path Components	Check and replace the following as necessary: tubing assembly, union, column	Once a year as necessary
Complete Inspection	Perform general inspection of the complete system. Inspect autosampler cabling and configuration setting.	Once a year

Maintenance Activity	Description	Frequency
Documentation	Record all instrument maintenance performed in the instrument maintenance log.	Daily prior to analysis

11.0 QUALITY CONTROL

11.1. Method QC

11.1.1. Establish DL, LOD and LOQ prior to using this method. Refer to EMAX-QA04 for evaluation and verification.

11.1.2. All analysts performing the method should have a valid Demonstration of Capability (DOC).

11.2. Analytical Batch

11.2.1. Perform sample analysis with a valid ICAL. Analyze ICV to verify the concentration of the ICAL standards.

11.2.2. An instrument blank shall be performed prior to the first daily continuing calibration. The acceptance criteria shall be the same as the method blank.

11.2.3. Analyze DCC at a frequency and acceptance criteria as described in Appendix 1 to validate the ICAL.

11.2.4. Update the Retention Time Window at least once a year or when a major instrument repair is done.

11.3. Sample Preparation

11.3.1. All samples must be analyzed within the holding time.

11.3.2. The maximum number of original field samples in a preparation batch shall be 20 unless otherwise specified by the project.

11.3.3. Prepare and analyze method blank, LCS (when required by the project), and MS/MSD (when designated by the project) for each every analytical batch applying the same analytical process as the field samples (Section 10.0).

11.3.4. Use organic-free water for method blank and LCS.

11.3.5. In the absence of any project designation, a sample duplicate with detected analytes or a LCS duplicate may be analyzed to establish precision.

11.3.6. Clean the purge needles thoroughly with high purity helium, after every use to ensure that there are no particulates adhering to it.

11.3.7. Check the Tedlar bags (by lot) are free of any contamination.

11.4. Refer to Appendix 1 for all related Quality Control parameters, frequency and acceptance criteria.

12.0 CORRECTIVE ACTION

12.1. Corrective action for each Quality Control procedure is summarized in Appendix 1.

12.2. Calibration

12.2.1. If the % RSD is out of acceptance criteria, review the results and identify presence of an outlier.

- If one of the standards returns bias low or bias high response on all of the analytes, the point is considered an outlier. Prepare a standard at that ICAL point and re-analyze.
- If the highest ICAL point appears to be saturated, drop the highest point.
- If the lowest point returns a bias low response or the peaks are not distinct and sharp, drop the point.

Note: The lowest calibration point identifies the limit of quantitation (LOQ). Therefore, check that the LOQ is in conformance to the current projects where the ICAL will be used.

12.2.2. If ICV is non-compliant, consider the following to correct the problem:

- If all analytes are bias low or bias high, the amount of standard injected could be inaccurate. Prepare another standard and re-analyze the ICV.
- If standard degradation is observed, prepare from a new standard lot and re-analyze the ICV.
- If the problem persists, perform instrument troubleshooting. Check leaks, check gas flow rates and refer to GC troubleshooting manual to correct the problem. Repeat the initial calibration and ICV.

12.2.3. If DCC is non-compliant, consider the suggestions in Sec. 12.3.2 to correct the problem:

12.2.4. If suggested corrective actions do not correct the problem, consult with the Supervisor for further advise prior to performing a new ICAL.

12.3. Instrument Blank

12.3.1. When instrument blank is non-compliant, fill a new tedlar bag with helium, clean the injection syringe and analyze the helium by direct injection. If the problem persists, either the injection port is contaminated or the helium source is contaminated. Consider the following suggestions to correct the problem.

- Check the helium source to make sure that the helium grade is ultra-high purity.
- Change the GC injector septa.
- Cut the column.

12.4. Method Blank

12.4.1. If method blank is non-compliant, consider the following suggestions to investigate the source of the problem.

- Check for possible contamination from the reagent water. If contamination is due to reagent water, change the filter at the source.
- Check for possible contamination from the vial.
    - ➢ Analyze the vial septa. Cut the septa in half and place in a new vial. Add 2 drops of HCl and fill the vial with reagent water. Let it stand for at least 1 hour. Analyze like a regular sample.
    - ➢ If contamination is from the vial, use another lot or vial manufacturer.
- If the analyte found in the method blank is not detected in any of the field samples, consult the Supervisor and the PM if the result can be reported. Otherwise, re-extract and re-analyze the method blank prior to sample analysis.

12.5. **Laboratory Control Sample**

12.5.1. If LCS/LCSD recovery fails, check that spike amount is correct and proper injection was achieved. Correct the problem and then re-extract and reanalyze the LCS and all associated samples.

12.6. **Matrix Spike**

12.6.1. If MS/MSD recovery fails, consider the following suggestions:

- Review the chromatogram and check if matrix interference is observed. Discuss in the case narrative.
- Check that the spike amount is correct and proper injection was achieved. Correct the problem, re-extract and reanalyze.

12.7. For insufficient amount of sample, note it in the sample preparation log and inform the PM immediately and discuss it in the case narrative.

12.7.1. When sample chemical preservation is insufficient (samples labeled preserved but the pH is >2), note it in the analytical run log comment section and discuss it in the case narrative.

12.8. **Method QC**

12.8.1. If LOD and LOQ verifications failed to meet the acceptance criteria, consider instrument maintenance prior to re-analyzing LOD/LOQ verification. Otherwise, perform new detection limit study.

12.8.2. If retention time has significantly shifted, check the carrier gas flow or check for leaks. Perform RTW study and apply as necessary.

12.9. **Non-Conformance Report (NCR)**

12.9.1. A Non-Conformance Report (NCR) is required when the following circumstances occur:

- Anomalies other than specified in Appendix 1 are observed.
- Sample is out of technical holding time.

12.9.2. Refer to EMAX-QA08.

13.0 POLLUTION PREVENTION

13.1. Observe all necessary precautions to avoid spillage of solvent that may go to the wastewater drains.

13.2. Prepare all the standards in the fume hood.

14.0 WASTE MANAGEMENT

14.1. No samples should be dumped into the laboratory sink.

14.2. Separate and properly identify all unused and expired analytical standards for proper disposal.

14.3. Place all wastes generated during the analytical process in properly labeled satellite waste containers for proper collection.

14.4. Dispose all unused samples, expired analytical standards and other wastes generated during the analytical process in accordance to EMAX-SM03.

15.0 SUPPLEMENTARY NOTES

15.1. A study of 40mL vials supplied by VWR International was conducted to establish the sample amount used for analysis. It was established that the sample amount is 39 mL. In the event that vials are purchased from another supplier, a similar study shall be conducted to establish the sample amount used in this analysis.

15.2. Definition of Terms

15.2.1. Batch – is a group of samples that are prepared and/or analyzed at the same time using the same lot of reagents. Preparation batch is composed of one to 20 sample of the same matrix, a method blank, a lab control sample and matrix spike/matrix spike duplicate. Analytical batch is composed of prepared samples (extracts, digestates, or concentrates), which are analyzed together as a group using an instrument in conformance to the analytical requirement. An analytical batch can include samples originating from various matrices, preparation batches and can exceed 20 samples.

15.2.2. Calibration – is a determinant measured from a standard to obtain the correct value of an instrument output.

15.2.3. Instrument Method – is a file generated to contain the instrument calibration and instrument parameter settings for a particular analysis.

15.2.4. Instrument Blank – is target-free solvent subjected to the entire analytical process to establish zero baseline or background value.

15.2.5. Lab Control Sample (LCS) – is a target-analyte-free sample spiked with a verified known amount of target analyte(s) or a reference material with a certified known value subjected to the entire sample preparation and/or analytical process. LCS is analyzed to monitor the accuracy of the analytical system

15.2.6. Lab Control Duplicate Sample (LCD) – is a replicate of LCS analyzed to monitor precision when MS/MSD sample is not analyzed.

15.2.7. Matrix – is a component or form of a sample.

15.2.8. Matrix Spike (MS) – is a sample spiked with a verified known amount of target analyte(s) subjected to the entire sample preparation and/or analytical process. MS is analyzed to monitor matrix effect on a method's recovery efficiency.

15.2.9. Matrix Spike Duplicate – is a replicate of MS analyzed to monitor precision or recovery.

15.2.10. Method Blank – is a target-analyte-free sample subjected tot he entire sample preparation and/or analytical to monitor contamination.

15.2.11. Sample – is a specimen received in the laboratory bearing a sample label traceable to the accompanying COC. Samples collected in different containers having the same field sample ID are considered the same and therefore labeled with the same lab sample ID unless otherwise specified by the project.

15.2.12. Sample Duplicate – is a replicate of a sub-sample taken from one sample, prepared and analyzed within the same preparation batch.

15.2.13. Sub-sample – is an aliquot taken from a sample for analysis. Each sub-sample is uniquely identified by the sample preparation ID.

15.3. Application of EMAX QC Procedures

15.3.1. The procedures and QC criteria summarized in this SOP applies to all projects requiring Dissolved Gases. In instances where there is a project or program QAPP, the requirements given in the project takes precedence over this SOP.

15.4. Department of Defense (DoD) and Department of Energy (DOE) Projects

15.4.1. Samples from DoD and/or DOE sponsored projects follows the Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and/or client's quality control directive. In the absence of QAPP, the DoD and DOE Consolidated Quality Systems Manual (QSM), latest update, is applied.

16.0 REFERENCES

16.1. DH Kampbell, JJ Wilson and S.A. Vandegrift. "Dissolved Oxygen and Methane in Water by a GC Head space Equilibration Technique". International Journal Environ Analytical Chem., Vol. 30, pp. 249-257, 1989

16.2. EMAX Quality Systems Manual, as updated.

17.0 APPENDICES

17.1. Figures

17.1.1.	Figure 1	Peak Evaluation Technique
17.1.2.	Figure 2	Typical Chromatograms
17.1.3.	Figure 3	Typical ICAL Summary
17.1.4.	Figure 4	Typical Calibration Verification Summary
17.1.5.	Figure 5	Typical Sample Result Summary
17.1.6.	Figure 6	Typical LCS/LCSD Summary
17.1.7.	Figure 7	Typical Matrix Spike Summary
17.1.8.	Figure 8	Typical Case Narrative

17.2. Appendices

17.2.1.	Appendix 1	Summary of Quality Control Procedures
17.2.2.	Appendix 2	Demonstration of Capability

17.3. Forms

17.3.1.	RSK175FS	Sample Preparation Log
17.3.2.	RSK175FA	Analysis Run Log
17.3.3.	RSK175FM	Instrument Maintenance Log

Figure 1: PEAK EVALUATION TECHNIQUE

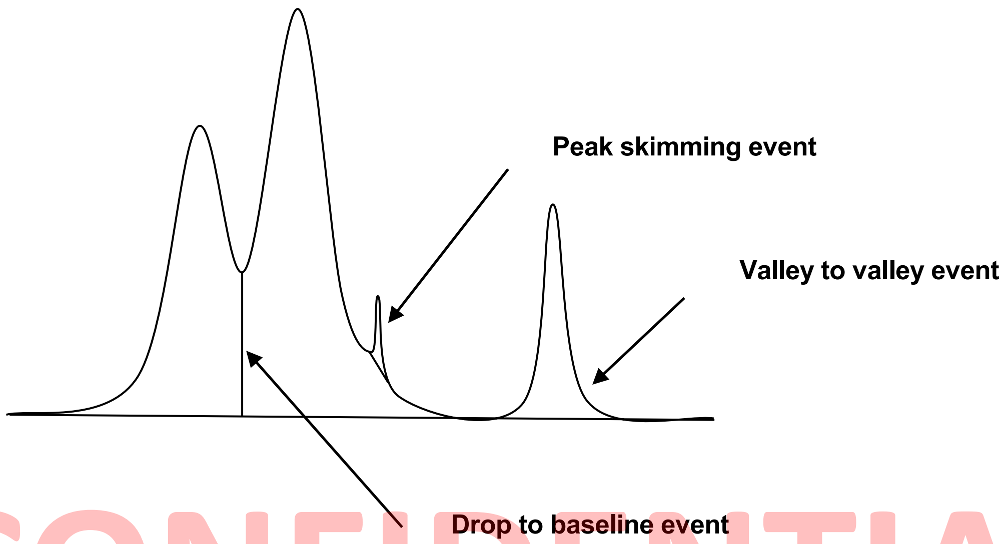


Figure 2: TYPICAL CHROMATOGRAMS

```
                         METHOD EPA DGAS by GC/FID
                       EMAX Analytical Laboratories, Inc.

File          : c:\ezchrom\chrom\ bm27\bm27008
Method        : c:\ezchrom\methods\ dg72m27.met
Sample ID     : IDG72M27001
Acquired      : Mon dd,yyyy  hh:mm:ss
Printed       : Mon dd,yyyy  hh:mm:ss
User          : JDoe



Channel A Results

 #  Peak Name              Ret.Time(Min)  Area       Ave. CF     ESTD Conc.(ppb)
 -- ---------------------  -------------  ---------- ----------  ---------------
  2 Methane                        0.508      37939     3056.74           12.412
  3 Ethylene                       0.758      42227     1929.26           21.888
  4 Acetylene                      0.833      10663      492.10           21.668
  5 Ethane                         0.892      63672     2674.68           23.805
  6 Propane                        2.417      93886     2786.10           33.698
```

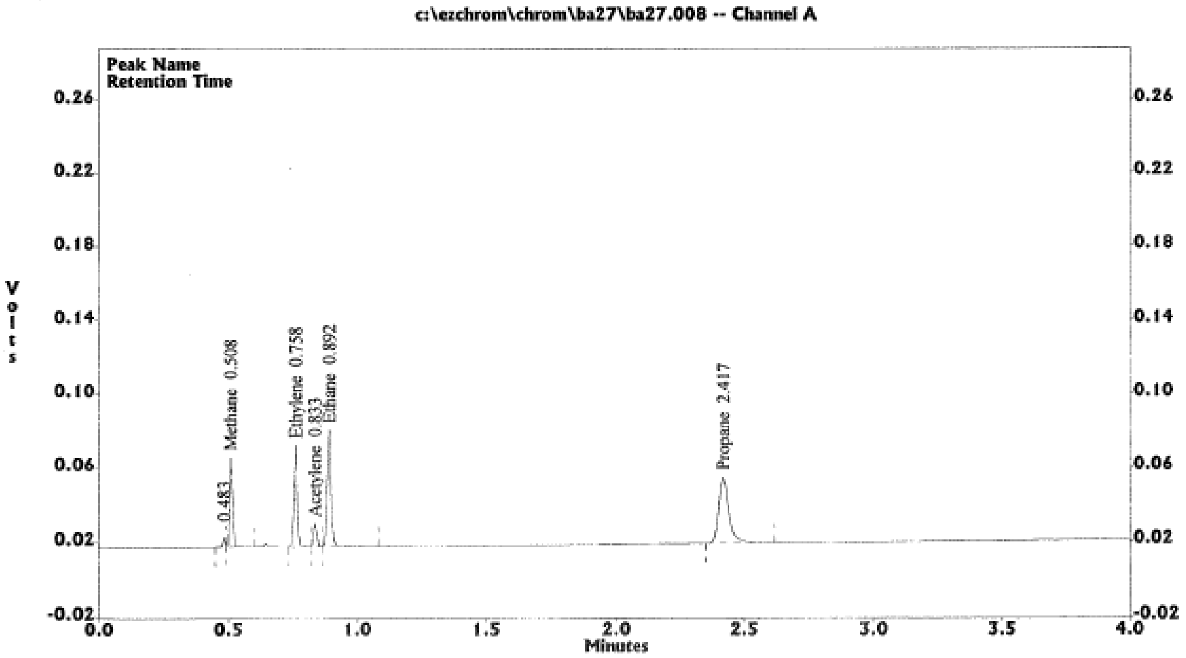


Figure 2: TYPICAL CHROMATOGRAMS

```
                    METHOD EPA DGAS by GC/FID
               EMAX Analytical Laboratories, Inc.

File          : c:\ezchrom\chrom\ bml6\bml6.008
Method        : c:\ezchrom\methods\ dg72ml6p.met
Sample ID     : TDG72M16P01
Acquired      : Mon dd, yyyy  hh:mm:ss
Printed       : Mon dd, yyyy  hh:mm:ss
User          : JDoe



Channel A Results

 #  Peak Name              Ret.Time(Min)  Area        Ave. CF     ESTD Conc.(ppb)
 -- --------------------   -------------  ----------  ----------  ---------------
  3 Propylene                      2.283       60710     1709.26           35.518
```

c:\ezchrom\chrom\ bml6\bml6.008 Channel A

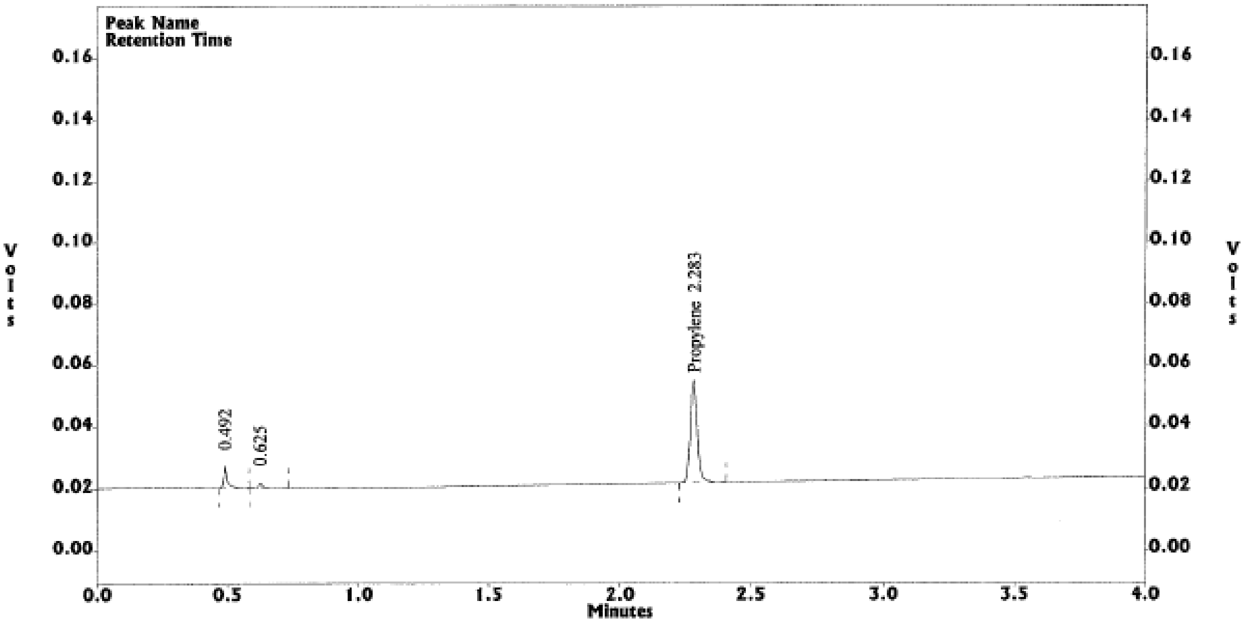
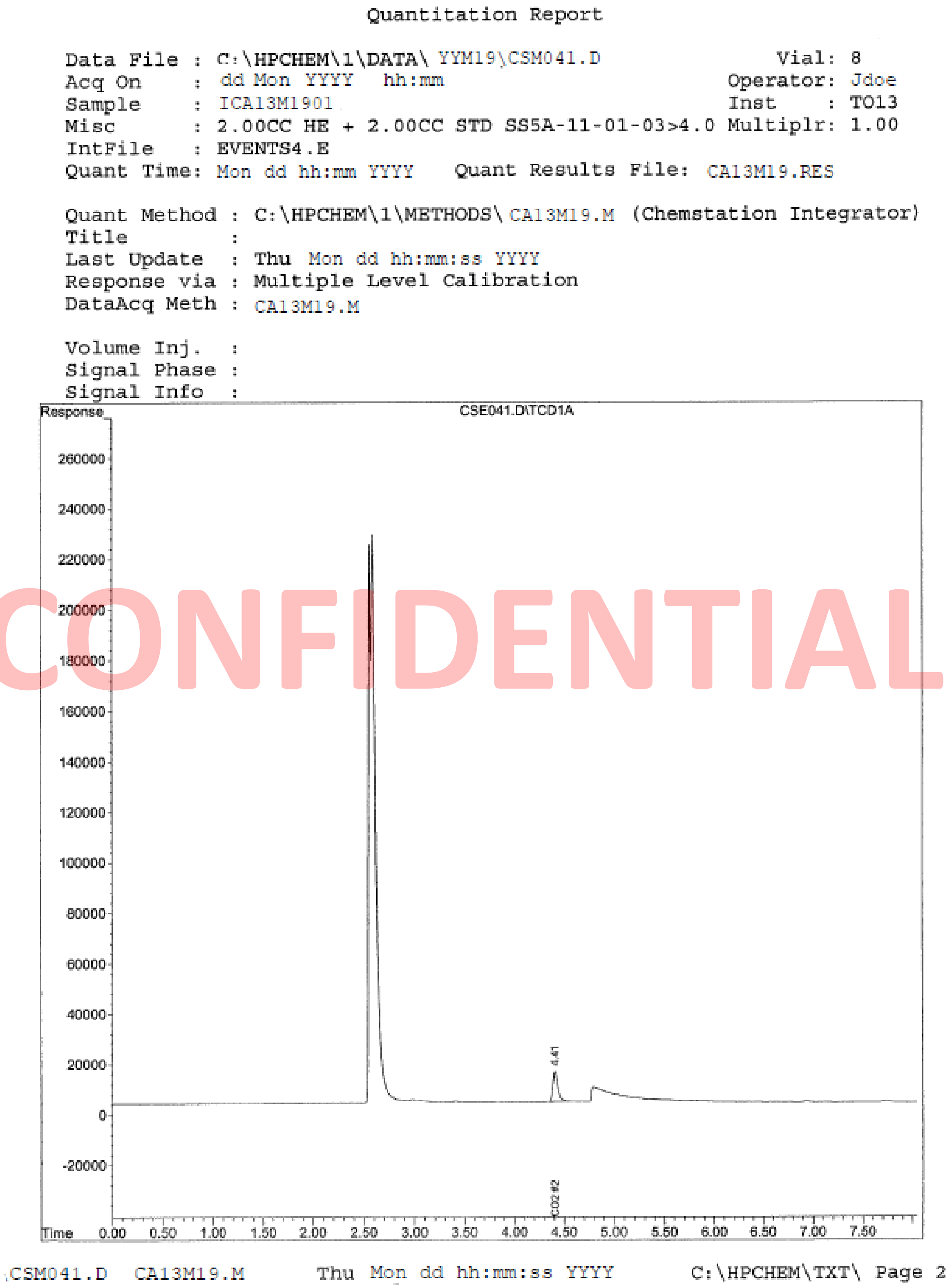


Figure 2: TYPICAL CHROMATOGRAM



```
                        Quantitation Report

Data File : C:\HPCHEM\1\DATA\ YYM19\CSM041.D                 Vial: 8
Acq On    :  dd Mon  YYYY   hh:mm                        Operator: Jdoe
Sample    :  ICA13M1901                                  Inst    : TO13
Misc      : 2.00CC HE + 2.00CC STD SS5A-11-01-03>4.0 Multiplr: 1.00
IntFile   : EVENTS4.E
Quant Time: Mon dd hh:mm YYYY   Quant Results File: CA13M19.RES

Quant Method  : C:\HPCHEM\1\METHODS\ CA13M19.M (Chemstation Integrator)
Title         :
Last Update   : Thu  Mon dd hh:mm:ss YYYY
Response via  : Multiple Level Calibration
DataAcq Meth  : CA13M19.M

Volume Inj.   :
Signal Phase  :
Signal Info   :
```

```
CSM041.D   CA13M19.M       Thu  Mon dd hh:mm:ss YYYY      C:\HPCHEM\TXT\  Page 2
```

Figure 3: TYPICAL ICAL SUMMARY

```
                          INITIAL CALIBRATION
                            DISSOLVED GASES

Lab Name          :  EMAX Inc
Instrument ID     :  GCT072
GC Columm         :  RT-QS-BOND
Column size ID    :  30MX0.53MM
LFID & Datetime:     BM27002A MM/DD/YY   HH:MM
LFID & Datetime:     BM27003A MM/DD/YY   HH:MM
LFID & Datetime:     BM27004A MM/DD/YY   HH:MM
LFID & Datetime:     BM27005A MM/DD/YY   HH:MM
LFID & Datetime:     BM27006A MM/DD/YY   HH:MM
LFID & Datetime:     BM27007A MM/DD/YY   HH:MM
CONC UNIT:         ppb

 _____________________________________________________________________________________________________________________________
|                                 |  CONC   |           CALIBRATION FACTORS             (AREA)/UNIT                |         |    |
|            COMPOUND             |    X    |   2.00X|  10.00X|  25.00X|  40.00X|  75.00X| 100.00X|   MEAN   |%RSD|
|=================================|=========|========|========|========|========|========|========|==========|====|
|Methane__________________________|     0.34|    3604|    3456|    3034|    2776|    2700|    2770|    3056.7|12.7|
|Acetylene________________________|     0.55|     528|     510|     485|     478|     468|     484|     492.1| 4.5|
|Ethylene_________________________|     0.60|    2166|    2050|    1885|    1820|    1796|    1857|    1929.3| 7.6|
|Ethane___________________________|     0.64|    2995|    2841|    2596|    2532|    2508|    2576|    2674.7| 7.4|
|Propane__________________________|     0.94|    3202|    2923|    2698|    2601|    2599|    2694|    2786.1| 8.5|
|_________________________________|_________|________|________|________|________|________|________|__________|____|

 DG72M27.MET
```

```
                           INITIAL CALIBRATION
                             DISSOLVED GASES

Lab Name          :  EMAX Inc
Instrument ID     :  GCT072
GC Columm         :  RT-QS-BOND
Column size ID    :  30MX0.53MM
LFID & Datetime:     BM27002A MM/DD/YY   HH:MM
LFID & Datetime:     BM27003A MM/DD/YY   HH:MM
LFID & Datetime:     BM27004A MM/DD/YY   HH:MM
LFID & Datetime:     BM27005A MM/DD/YY   HH:MM
LFID & Datetime:     BM27006A MM/DD/YY   HH:MM
LFID & Datetime:     BM27007A MM/DD/YY   HH:MM

 _____________________________________________________________________________________________________________________________
|                                 |             RT OF STANDARDS  (MIN)              | MEAN  |  RT WINDOW    |RTWINDOW|
|            COMPOUND             |  2.0X | 10.0X| 25.0X| 40.0X| 75.0X|100.0X|  RT   | FROM  |  TO   | WIDTH  |
|=================================|=======|======|======|======|======|======|=======|=======|=======|========|
|Methane__________________________| 0.500| 0.508| 0.508| 0.508| 0.508| 0.517| 0.508| 0.465| 0.551|   0.043|
|Acetylene________________________| 0.825| 0.833| 0.833| 0.833| 0.833| 0.842| 0.833| 0.718| 0.948|   0.115|
|Ethylene_________________________| 0.750| 0.758| 0.758| 0.758| 0.758| 0.758| 0.757| 0.642| 0.872|   0.115|
|Ethane___________________________| 0.883| 0.892| 0.892| 0.892| 0.892| 0.892| 0.891| 0.787| 0.995|   0.104|
|Propane__________________________| 2.417| 2.417| 2.417| 2.417| 2.417| 2.417| 2.417| 2.247| 2.587|   0.170|
|_________________________________|_______|______|______|______|______|______|_______|_______|_______|________|

 DG72M27.MET
```

Figure 3: TYPICAL ICAL SUMMARY

```
                              INITIAL CALIBRATION
                                  PROPYLENE

Lab Name         :  EMAX Inc
Instrument ID    :  GCT072
GC Columm        :  RT-QS-BOND
Column size ID   :  30MX0.53MM
LFID &  Datetime:  BM16002A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16003A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16004A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16005A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16006A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16007A MM/DD/YY  HH:MM
CONC UNIT:       ppb

 ____________________________________________________________________________________________________________________
|                                  |  CONC   |         CALIBRATION FACTORS            (AREA)/UNIT             |    |
|             COMPOUND             |    X    |   2.00X|  10.00X|  25.00X|  40.00X|  75.00X| 100.00X|  MEAN    |%RSD|
|==================================|=========|========|========|========|========|========|========|==========|====|
|Propylene_________________________|     0.89|    1775|    1816|    1627|    1632|    1748|    1658|    1709.3| 4.7|
|__________________________________|_________|________|________|________|________|________|________|__________|____|


DG72M16P.MET
```

```
                               INITIAL CALIBRATION
                                    PROPYLENE

Lab Name         :  EMAX Inc
Instrument ID    :  GCT072
GC Columm        :  RT-QS-BOND
Column size ID   :  30MX0.53MM
LFID &  Datetime:  BM16002A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16003A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16004A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16005A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16006A MM/DD/YY  HH:MM
LFID &  Datetime:  BM16007A MM/DD/YY  HH:MM

 ___________________________________________________________________________________________________________________
|                                  |          RT OF STANDARDS  (MIN)              | MEAN |  RT WINDOW  |RTWINDOW|
|             COMPOUND             | 2.0X | 10.0X| 25.0X| 40.0X| 75.0X|100.0X|  RT  | FROM |  TO  | WIDTH  |
|==================================|======|======|======|======|======|======|======|======|======|========|
|Propylene_________________________| 2.283| 2.275| 2.275| 2.275| 2.283| 2.275| 2.278| 2.262| 2.294|   0.016|
|__________________________________|______|______|______|______|______|______|______|______|______|________|


DG72M16P.MET
```

Figure 3: TYPICAL ICAL SUMMARY

```
                                INITIAL CALIBRATION SUMMARY
                                      DISSOLVED GASES

Lab Name        : EMAX Laboratories, Inc.
Instrument ID   : T013
GC Column       : Carboxen 1006 PLOT
GC Column Size  : 30mX0.53mm
LFID & DateTime: CSM035 MM/DD/YY HH:MM
LFID & DateTime: CSM036 MM/DD/YY HH:MM
LFID & DateTime: CSM037 MM/DD/YY HH:MM
LFID & DateTime: CSM038 MM/DD/YY HH:MM
LFID & DateTime: CSM039 MM/DD/YY HH:MM
LFID & DateTime: CSM040 MM/DD/YY HH:MM
Conc Unit       : ug/L


 ____________________________________________________________________________________________
|                  |         CALIBRATION FACTORS (Area/ICAL Conc.)          | AVERAGE|        |
|    PARAMETER     |    1200|    2300|    4700|    9300|   14000|   19000|   CF   |   RSD  |
|==================|========|========|========|========|========|========|========|========|
|Carbon Dioxide    |   38.37|   40.42|   42.16|   47.36|   47.65|   45.07|   43.51|    8.73|
|__________________|________|________|________|________|________|________|________|________|

 ______________________________________________________________________________________________________________
|                  |           RETENTION TIME OF ICAL STDS (MIN)            | AVERAGE|    RT WINDOW    |   RT   |
|    PARAMETER     |    1200|    2300|    4700|    9300|   14000|   19000|   RT   |  FROM  |   TO   |  WIDTH |
|==================|========|========|========|========|========|========|========|========|========|========|
|Carbon Dioxide    |    4.43|    4.41|    4.41|    4.40|    4.39|    4.39|    4.41|    4.36|    4.45|  0.0455|
|__________________|________|________|________|________|________|________|________|________|________|________|

 CA13M19.MET
```

Figure 4: TYPICAL CALIBRATION VERIFICATION SUMMARY

INITIAL CALIBRATION VERIFICATION
DISSOLVED GASES

Lab Name : EMAX Inc
Instrument ID : GCT072
GC Columm : RT-QS-BOND
Column size ID : 30MX0.53MM
Mid Conc Init LFID & Datetime: BM27005A MM/DD/YYYY HH:MM
Conc Cont LFID & Datetime: BM27008A MM/DD/YYYY HH:MM
CONC UNIT : ppb

COMPOUND	RT MINUTES	RT WINDOW FROM	TO	TRUE CONC	AVERAGE CF	RESULT AREA	CONC	%D	QL	%D LIMITS
Methane	0.508	0.465	0.551	13.6	3056.7	37939	12.41	-9		15
Acetylene	0.833	0.718	0.948	22.1	492.100	10663	21.67	-2		15
Ethylene	0.758	0.643	0.873	23.8	1929.3	42227	21.89	-8		15
Ethane	0.892	0.788	0.996	25.5	2674.7	63672	23.81	-7		15
Propane	2.417	2.247	2.587	37.4	2786.1	93886	33.70	-10		15

DG72M27.MET

INITIAL CALIBRATION VERIFICATION
PROPYLENE

Lab Name : EMAX Inc
Instrument ID : GCT072
GC Columm : RT-QS-BOND
Column size ID : 30MX0.53MM
Mid Conc Init LFID & Datetime: BM16005A MM/DD/YY HH:MM
Conc Cont LFID & Datetime: BM16008A MM/DD/YY HH:MM
CONC UNIT : ppb

COMPOUND	RT MINUTES	RT WINDOW FROM	TO	TRUE CONC	AVERAGE CF	RESULT AREA	CONC	%D	QL	%D LIMITS
Propylene	2.283	2.267	2.299	35.7	1709.3	60710	35.52	-1		15

DG72M16P.MET

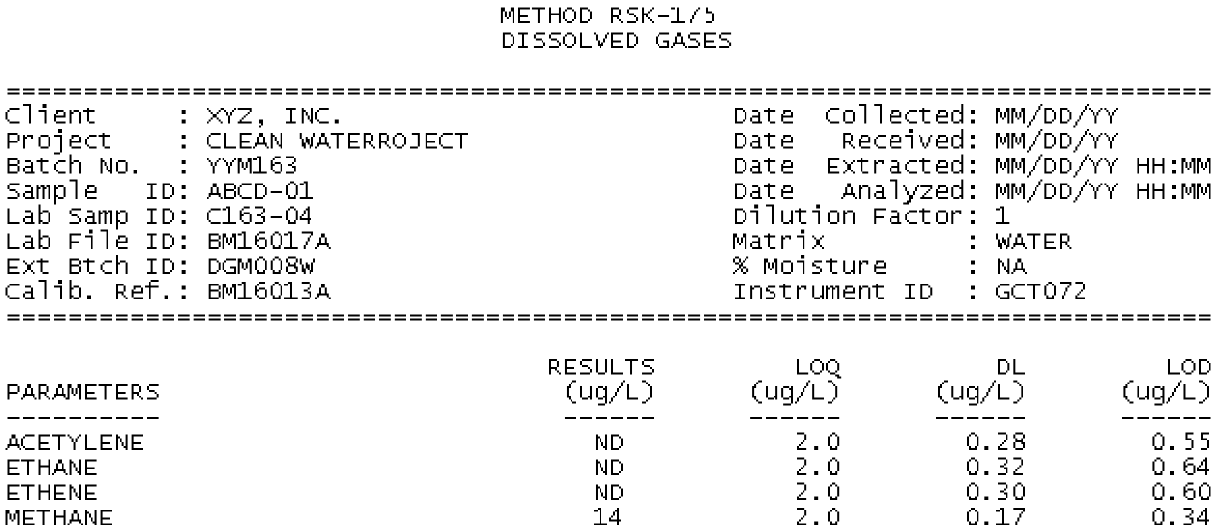
INITIAL CALIBRATION VERIFICATION

Lab Name : EMAX Laboratories, Inc.
Instrument ID : TO13
GC Column : Carboxen 1006 PLOT
GC Column Size : 30mx0.53mmICAL MID LFID & DateTime: CSM038 MM/DD/YY HH:MM
ICV LFID & DateTime : CSM041 MM/DD/YY HH:MM

PARAMETER	RT MINUTES	RT WINDOW FROM	TO	EXPECTED CONC	AVERAGE CF	RESULT AREA	CONC	%D	QL	%D LIMITS
Carbon Dioxide	4.41	4.36	4.45	9300	43.51	396353	9110	2		15

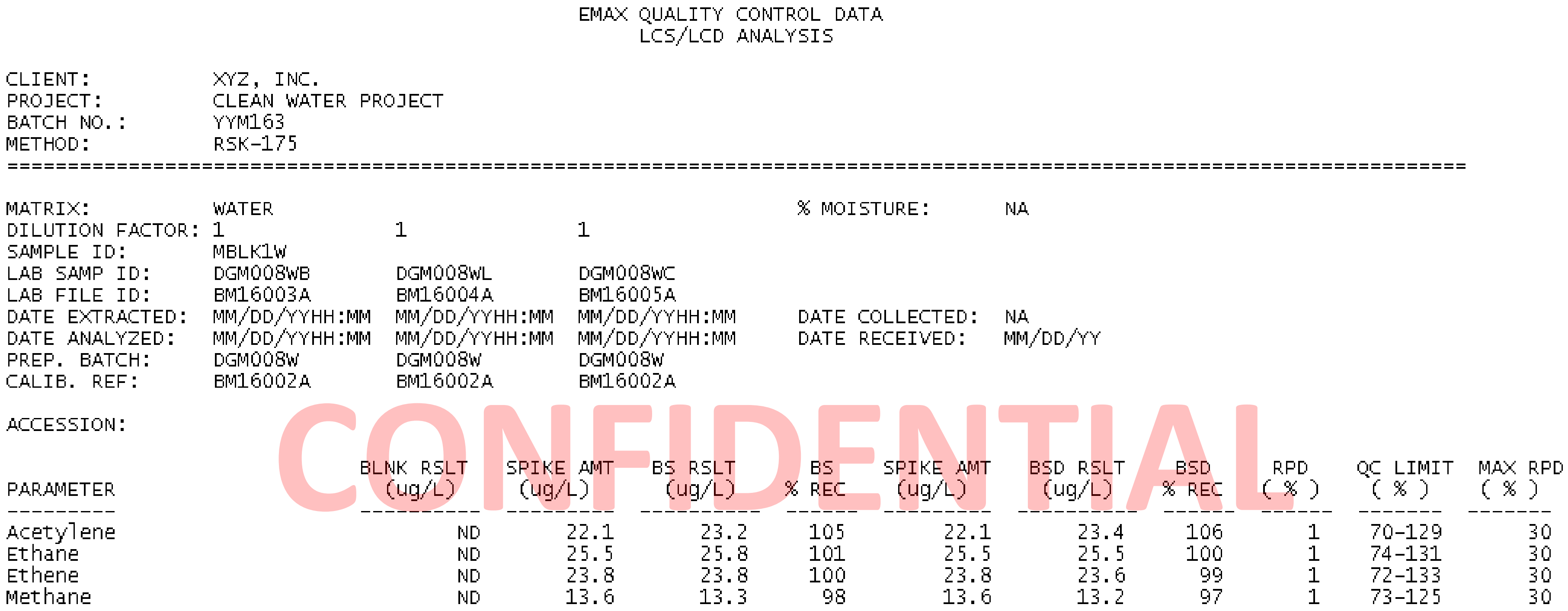
CA13M19.MET

Figure 5: TYPICAL SAMPLE RESULT SUMMARY



```
                              METHOD RSK-175
                              DISSOLVED GASES

==============================================================================
Client      : XYZ, INC.                         Date  Collected: MM/DD/YY
Project     : CLEAN WATERROJECT                 Date   Received: MM/DD/YY
Batch No.   : YYM163                            Date  Extracted: MM/DD/YY HH:MM
Sample   ID: ABCD-01                            Date   Analyzed: MM/DD/YY HH:MM
Lab Samp ID: C163-04                            Dilution Factor: 1
Lab File ID: BM16017A                           Matrix         : WATER
Ext Btch ID: DGM008W                            % Moisture     : NA
Calib. Ref.: BM16013A                           Instrument ID  : GCT072
==============================================================================

                                   RESULTS        LOQ         DL        LOD
PARAMETERS                          (ug/L)      (ug/L)     (ug/L)     (ug/L)
----------                         -------     -------    -------    -------
ACETYLENE                             ND         2.0        0.28       0.55
ETHANE                                ND         2.0        0.32       0.64
ETHENE                                ND         2.0        0.30       0.60
METHANE                               14         2.0        0.17       0.34
```

Figure 6: TYPICAL LCS/LCSD SUMMARY

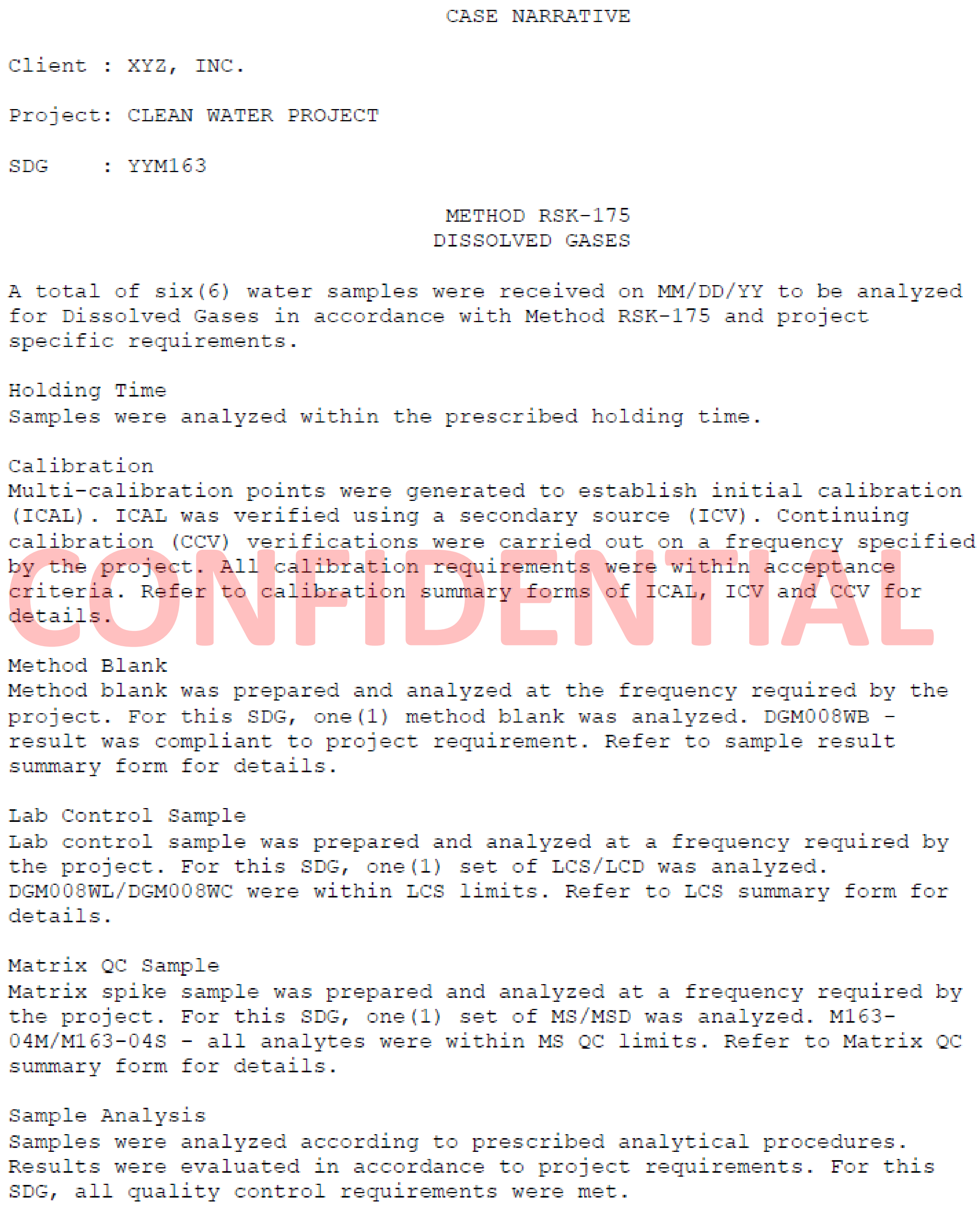


```
                                        EMAX QUALITY CONTROL DATA
                                            LCS/LCD ANALYSIS

CLIENT:          XYZ, INC.
PROJECT:         CLEAN WATER PROJECT
BATCH NO.:       YYM163
METHOD:          RSK-175
========================================================================================================================

MATRIX:          WATER                                               % MOISTURE:      NA
DILUTION FACTOR: 1              1              1
SAMPLE ID:       MBLK1W
LAB SAMP ID:     DGM008WB       DGM008WL       DGM008WC
LAB FILE ID:     BM16003A       BM16004A       BM16005A
DATE EXTRACTED:  MM/DD/YYHH:MM  MM/DD/YYHH:MM  MM/DD/YYHH:MM     DATE COLLECTED:  NA
DATE ANALYZED:   MM/DD/YYHH:MM  MM/DD/YYHH:MM  MM/DD/YYHH:MM     DATE RECEIVED:   MM/DD/YY
PREP. BATCH:     DGM008W        DGM008W        DGM008W
CALIB. REF:      BM16002A       BM16002A       BM16002A

ACCESSION:

                            BLNK RSLT  SPIKE AMT  BS RSLT     BS    SPIKE AMT  BSD RSLT    BSD     RPD    QC LIMIT  MAX RPD
PARAMETER                    (ug/L)     (ug/L)     (ug/L)   % REC    (ug/L)     (ug/L)   % REC   ( % )    ( % )    ( % )
---------                   ---------- --------- ---------- ------ ---------- ---------- ------ ------  -------  -------
Acetylene                          ND       22.1       23.2    105       22.1       23.4    106      1   70-129       30
Ethane                             ND       25.5       25.8    101       25.5       25.5    100      1   74-131       30
Ethene                             ND       23.8       23.8    100       23.8       23.6     99      1   72-133       30
Methane                            ND       13.6       13.3     98       13.6       13.2     97      1   73-125       30
```

Figure 7: TYPICAL MATRIX SPIKE SUMMARY

```
                                               EMAX QUALITY CONTROL DATA
                                                    MS/MSD ANALYSIS

CLIENT:          XYZ, INC.
PROJECT:         CLEAN WATER PROJECT
BATCH NO.:       YYM163
METHOD:          RSK-175
========================================================================================================================

MATRIX:          WATER                                           % MOISTURE:      NA
DILUTION FACTOR: 1              1              1
SAMPLE ID:       ABCD-01
LAB SAMP ID:     M163-04        M163-04M       M163-04S
LAB FILE ID:     BM16017A       BM16018A       BM16019A
DATE EXTRACTED:  MM/DD/YYHH:MM  MM/DD/YYHH:MM  MM/DD/YYHH:MM     DATE COLLECTED:  MM/DD/YY
DATE ANALYZED:   MM/DD/YYHH:MM  MM/DD/YYHH:MM  MM/DD/YYHH:MM     DATE RECEIVED:   MM/DD/YY
PREP. BATCH:     DGM008W        DGM008W        DGM008W
CALIB. REF:      BM16013A       BM16013A       BM16013A

ACCESSION:

                             SMPL RSLT   SPIKE AMT   MS RSLT      MS    SPIKE AMT   MSD RSLT    MSD     RPD    QC LIMIT  MAX RPD
PARAMETER                      (ug/L)     (ug/L)      (ug/L)    % REC    (ug/L)      (ug/L)    % REC   ( % )    ( % )    ( % )
---------                    ----------  ---------  ----------  ------  ---------  ----------  ------  ------  -------  -------
Acetylene                             ND      22.1       22.4     101        22.1       21.2      96       6   70-129       30
Ethane                                ND      25.5       25.6     100        25.5       24.6      96       4   74-131       30
Ethene                                ND      23.8       23.8     100        23.8       22.7      95       5   72-133       30
Methane                            14.2       13.6       30.1     117        13.6       28.4     104       6   73-125       30
```

Figure 8: TYPICAL CASE NARRATIVE



CASE NARRATIVE

Client : XYZ, INC.

Project: CLEAN WATER PROJECT

SDG : YYM163

METHOD RSK-175
DISSOLVED GASES

A total of six(6) water samples were received on MM/DD/YY to be analyzed for Dissolved Gases in accordance with Method RSK-175 and project specific requirements.

Holding Time
Samples were analyzed within the prescribed holding time.

Calibration
Multi-calibration points were generated to establish initial calibration (ICAL). ICAL was verified using a secondary source (ICV). Continuing calibration (CCV) verifications were carried out on a frequency specified by the project. All calibration requirements were within acceptance criteria. Refer to calibration summary forms of ICAL, ICV and CCV for details.

Method Blank
Method blank was prepared and analyzed at the frequency required by the project. For this SDG, one(1) method blank was analyzed. DGM008WB - result was compliant to project requirement. Refer to sample result summary form for details.

Lab Control Sample
Lab control sample was prepared and analyzed at a frequency required by the project. For this SDG, one(1) set of LCS/LCD was analyzed. DGM008WL/DGM008WC were within LCS limits. Refer to LCS summary form for details.

Matrix QC Sample
Matrix spike sample was prepared and analyzed at a frequency required by the project. For this SDG, one(1) set of MS/MSD was analyzed. M163-04M/M163-04S - all analytes were within MS QC limits. Refer to Matrix QC summary form for details.

Sample Analysis
Samples were analyzed according to prescribed analytical procedures. Results were evaluated in accordance to project requirements. For this SDG, all quality control requirements were met.

Appendix 1: SUMMARY OF QUALITY CONTROL PROCEDURES

QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	1st Rvw	2^{nd} Rvw
Five-point initial calibration for all analytes	Initially; as needed	% RSD for all analytes ≤ 20%	Correct the problem then repeat initial calibration		
Initial Calibration verification - ICV (Second-source)	After initial calibration	All analytes within ±25% of expected value	Correct the problem then repeat initial calibration		
Calibration verification	Bracket every 12 hours and at the end of the analytical run.	All analytes within ±15% of expected value	Correct the problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification		
Method blank	One per preparation batch (≤ 20 samples per matrix)	No analytes detected ≥ ½ LOQ	If sample results are ND or sample result >10X than the contamination level, consult with the PM if results are reportable. Otherwise, re-extract and reanalyze method blank and all samples processed with the contaminated blank. If re-extraction/re-analysis is not possible, apply B to specific analyte(s) on all associated.		
LCS	As required by the project. One LCS per preparation batch (≤ 20 samples per matrix)	In the absence of project QC Limits use EMAX QC limits	Re-extract and reanalyze the LCS and all associated samples		
MS/MSD	As required by the project.	In the absence of project QC Limits use EMAX QC limits	If chromatogram exhibits matrix interference narrate observation in the case narrative. Otherwise, check that spike value added is appropriately accounted. If anomaly is suspected, re-extract and re-analyze the matrix spike samples.		
Comments: Refer to PSR for Flagging Criteria.			Reviewed by:		
			Date:		

Appendix 2: DEMONSTRATION OF CAPABILITY

DEMONSTRATION OF CAPABILITY

METHOD RSK175

Conc Unit: µg/L
Sample Amount(ml): 39
Extract Amount (mL): 4

PARAMETER	BM04004A	BM04005A	BM04006A	BM04007A	TV	Ave. Conc.	Ave. %Rec	SD	RSD (%)	Accuracy Acceptance Limits (%	RSD (%) Criteria	COMMENTS
	DGM001WL	DGM001WC	DGM001WX	DGM001WY								
Methane	12.4	12.7	12.8	12.2	13.6	12.5	92	0.256	2	70 - 130	≤ 20	Passed
Acetylene	21.9	22.5	23.3	22.2	22.1	22.5	102	0.613	3	70 - 130	≤ 20	Passed
Ethylene	20.5	21.1	21.4	20.5	23.8	20.9	88	0.451	2	70 - 140	≤ 20	Passed
Ethane	22.6	23.4	23.4	22.6	25.5	23.0	90	0.475	2	70 - 140	≤ 20	Passed
Propane	32.7	33.6	33.8	32.6	37.4	33.2	89	0.620	2	70 - 130	≤ 20	Passed

REFERENCE:
A72-025, Page 11

Conc Unit µg/L
Sample Amount(ml): 39
Volume Extracted(ml): 4

PARAMETER	CSM004	CSM005	CSM022	CSM023	TV	Ave. Conc.	Ave. % Rec.	SD	RSD (%)	Accuracy Acceptance Limits (%	RSD (%) Criteria	Comments
	CA13M01L	CA13M01C	CA13M02L	CA13M02C								
Carbon Dioxide	9275	9230	9036	9176	9300	9179	99	104	1	60 - 130	≤ 20	Passed

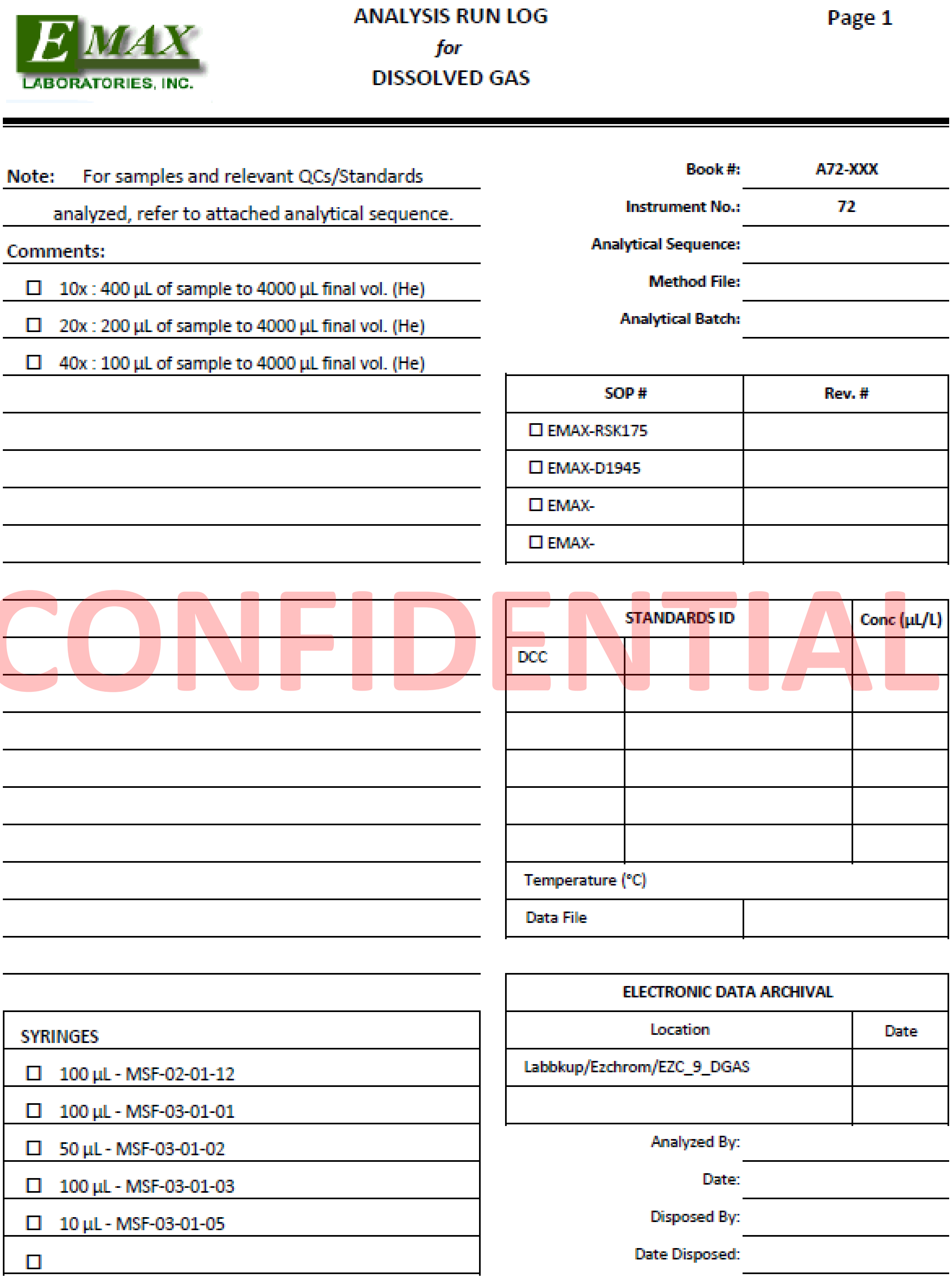
REFERENCE:
A13-015, Page 15

Conc Unit µg/L
Sample Amount(ml): 39
Volume Extracted(ml): 4

PARAMETER	BM12004A	BM12005A	BM12006A	BM12007A	TV	Ave. Conc.	Ave. % Rec.	SD	RSD (%)	Accuracy Acceptance Limits (%	RSD (%) Criteria	Comments
	DGM009WL	DGM009WC	DGM009WX	DGM009WY								
PROPENE	38.4	37.3	36.6	37.0	35.7	37.3	105	0.796	2	50 - 150	≤ 20	Passed

REFERENCE:
A72-025, Page 40

RSK175FA: ANALYTICAL RUN LOG



EMAX LABORATORIES, INC.

ANALYSIS RUN LOG
for
DISSOLVED GAS

Page 1

Note: For samples and relevant QCs/Standards analyzed, refer to attached analytical sequence.

Comments:

☐ 10x : 400 µL of sample to 4000 µL final vol. (He)

☐ 20x : 200 µL of sample to 4000 µL final vol. (He)

☐ 40x : 100 µL of sample to 4000 µL final vol. (He)

Book #:	A72-XXX
Instrument No.:	72
Analytical Sequence:	
Method File:	
Analytical Batch:	

SOP #	Rev. #
☐ EMAX-RSK175	
☐ EMAX-D1945	
☐ EMAX-	
☐ EMAX-	

	STANDARDS ID	Conc (µL/L)
DCC		
Temperature (°C)		
Data File		

SYRINGES
☐ 100 µL - MSF-02-01-12
☐ 100 µL - MSF-03-01-01
☐ 50 µL - MSF-03-01-02
☐ 100 µL - MSF-03-01-03
☐ 10 µL - MSF-03-01-05
☐

ELECTRONIC DATA ARCHIVAL	
Location	Date
Labbkup/Ezchrom/EZC_9_DGAS	

Analyzed By:

Date:

Disposed By:

Date Disposed:

RSK175FS: SAMPLE PREPARATION LOG

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EXTRACTION LOG FOR DISSOLVED GAS

SOP ☐ EMAX-RSK175 Rev. __ ☐ Propylene ☐ Room Temp. (°C): Book #: EDG-XXX

Start Date: Time: End Date: Time:

PREPARATION BATCH* ____________

Sample Prep ID	Lab Sample ID	Sample Amount (ml)	Extract Volume (ml)	pH (< 2)	Notes
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Standards	ID	Amount Added (ul)
LCS/MS		

Reagent	Source
H_2O	
He	
Thermometer ID #:	
Tedlar Bag Lot#:	
pH Strips:	
Vial Manufacturer:	

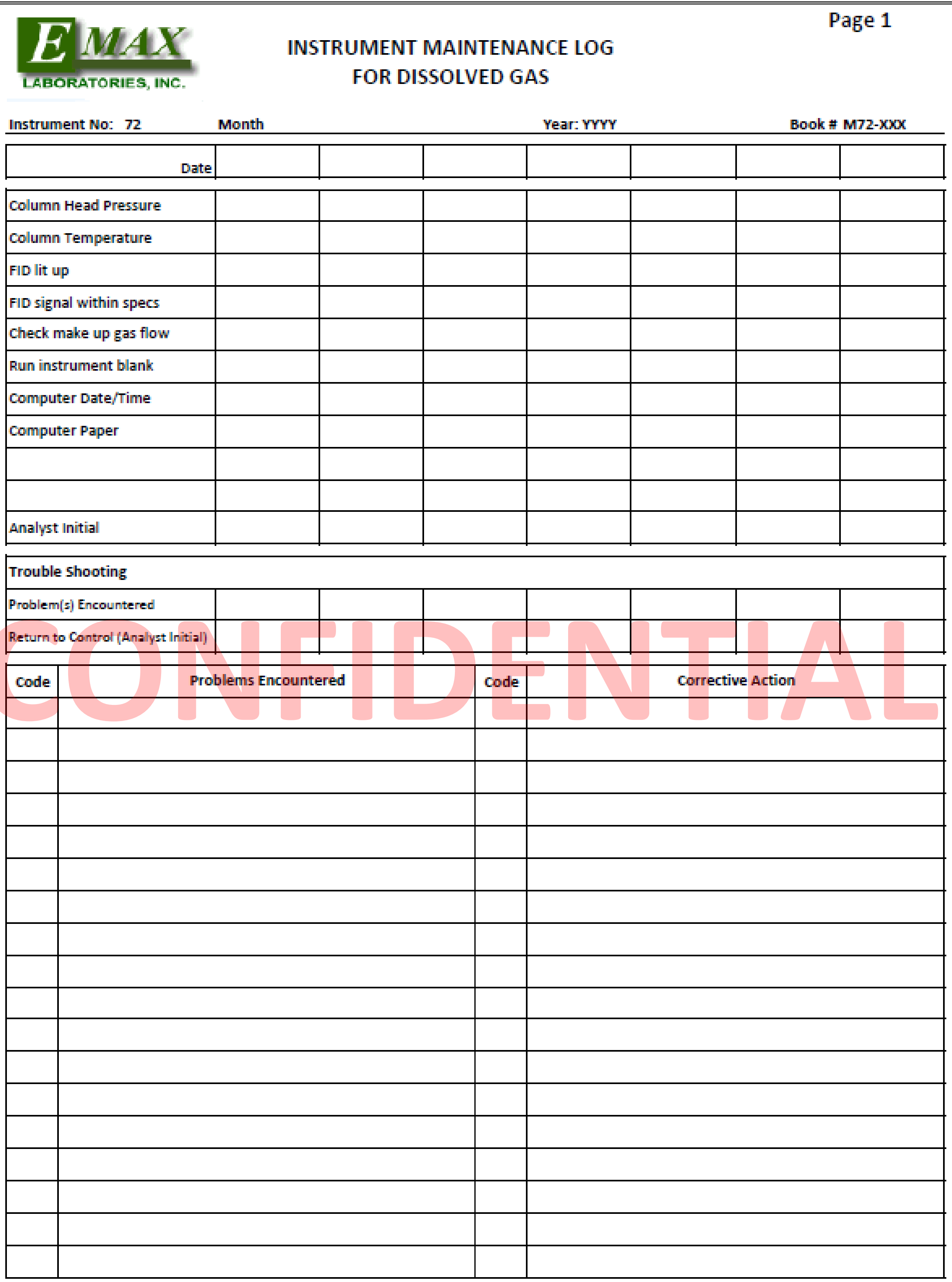
Syringes

☐ 10 mL - MSF-01-01-24
☐ 5 mL - MSF-01-03-06
☐ 5 mL - MSF-01-01-12
☐ 1 mL - MSF-01-03-14
☐ 1 mL - MSF-01-02-24
☐

Comments: ____________

Prepared By: ____________
Standard Added By: ____________

RSK175FM: INSTRUMENT MAINTENANCE LOG



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Page 1

INSTRUMENT MAINTENANCE LOG
FOR DISSOLVED GAS

Instrument No: 72 Month Year: YYYY Book # M72-XXX

Date							
Column Head Pressure							
Column Temperature							
FID lit up							
FID signal within specs							
Check make up gas flow							
Run instrument blank							
Computer Date/Time							
Computer Paper							
Analyst Initial							

Trouble Shooting							
Problem(s) Encountered							
Return to Control (Analyst Initial)							

Code	Problems Encountered	Code	Corrective Action

SOP REVIEW FORM

DISSOLVED GASES

SOP#: EMAX-RSK175 **Rev** 5 **Effective Date:** 28-Sep-22

COMMENTS	Reviewed By	Review Date
No update needed per DRF by LErmolova dated 09/19/23		09/19/23

UNCONTROLLED

ENVIROFLUX

PFM Standard Operation Procedure

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1.0. PFM Construction, Storage, and Transport

1.1. Description of PFM

The PFM is a self-contained permeable unit that is inserted into a well or boring such that it intercepts groundwater flow but does not retain it (See Figure 1-1).

The interior composition of the flux meter is a matrix of hydrophobic and hydrophilic permeable sorbents that retain dissolved organic and/or inorganic contaminants present in fluid intercepted by the unit. The sorbent matrix is also impregnated with known amounts of one or more fluid soluble 'resident tracers'. These tracers are leached from the sorbent at rates proportional to fluid flux.

After a specified period of exposure to groundwater flow, the flux meter is removed from the well or boring. Next, the sorbent is carefully extracted to quantify the mass of all contaminants intercepted by the flux meter and the residual masses of all resident tracers. The contaminants masses are used to calculate cumulative and time-averaged contaminant mass fluxes, while residual resident tracer masses are used to calculate cumulative or time- average fluid flux. Depth variations of both water and contaminant fluxes can be measured in an aquifer from a single flux meter by vertically segmenting the exposed sorbent packing, and analyzing for resident tracers and contaminants. Thus, at any specific well depth, an extraction from the locally exposed sorbent yields the mass of resident tracer remaining and the mass of contaminant intercepted. Note that multiple tracers with a range of partitioning coefficients are used to determine variability in groundwater flow with depth that could range over orders of magnitude. This data is used to estimate local cumulative water and contaminant fluxes.

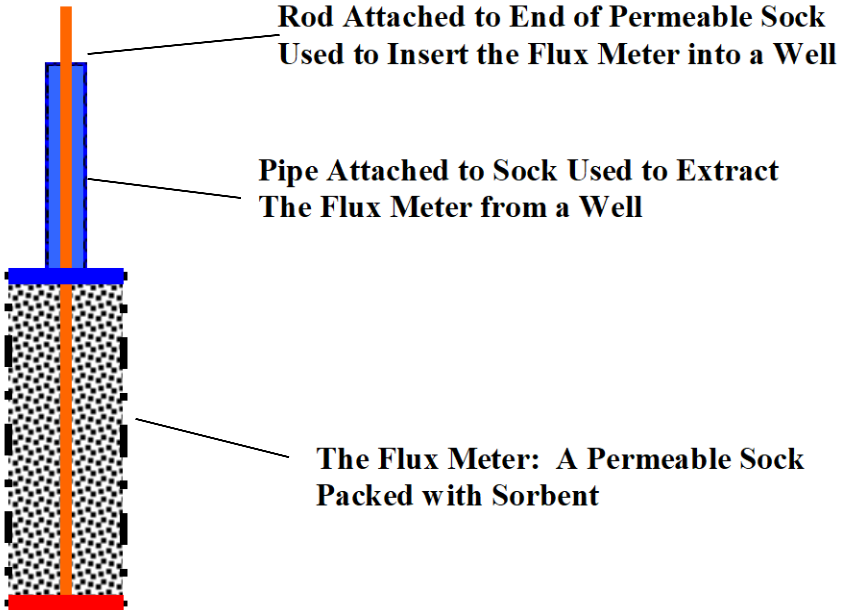

Figure 1-1. Schematic of a Flux meter comprised of a permeable sock filled with a selected sorbent.

1.2. Assembly of PFMs

The passive flux meters are constructed in a pipe having the same diameter as the well screen. The exception is for stainless steel well screen nylon for which a mesh material is added. In this case the pipe used for construction should be slightly (0.1 inch) smaller diameter than the well screen. The pipe length is 5 feet.

Prior to packing the PFMs with AC or AC with resin, the sock is attached to the center tube of the PFM. The center tube for 2-inch wells consists of 1/2 inch CPVP pipe cut to 5 feet lengths. The bottom of the sock is clamped to the CPVC pipe using a SS worm drive clam (pipe band clamp). The sock and tube are then placed in the packing pipe. AC (or resin) is transferred into the PFM sock. After adding the required amount of AC or AC with resin up to the desired sampling interval, a thin viton washer is placed. This process is continued until completing. At the top of the PFM a thick viton washer is added followed by a sponge cut to the same size as the viton washer. The sponge is used to minimize AC loss from the top of the PFM. At this point the top of the sock is attached to the retrieval collar with a wire loop on which PFM retrieval rope is attached using a carabineer connector. During this period, an initial AC sample is collected and placed in a 40ml vial.

1.3. PFM Storage

If the PFMs are constructed for transport to the field site, the PFMs will be stored in tubes and cooled. PFM storage tubes are constructed using PVC pipe the same diameter as the packing tube. The PFM is then extruded from the packing tube into the storage tube. A section of threaded rod or PVC pipe is used to push the PFM out of the packing tube and into the storage tube. The top of the storage tube is then sealed using gas tight mechanical plugs. The PFMs are then placed in cooled environment, under air conditioner or storage (4 °C), until transport.

1.4. PFM Transport

The PFMs are transported in cardboard boxes to the site.

2.0. PFM Deployment

2.1. PFM Insertion

At the field site the PFM in the transport tube is prepared for PFM insertion into the well casing. A rope is attached to the top of the PFM using a safety carabineer connector. The tube is lined up with the top of the well casing and section of push rod (or by hand) is used to push the PFM from the tube into the top section of well casing. Once the PFM is placed on the top of well and insert the tip of weight into the PVC center tube of PFM. Then lower the PFM with a weight to the bottom of the well. Another option could be pushing PFM into position in the well using Geoprobe rods while holding retrieval rope. If multiple PFMs are deployed on a single line, short sections of cable (about 5.2ft long) are thread through the upper PFM to link the PFMs together well. When inserting the PFM some back pressure may build since the water in the well casing must flow through the center tube as the PFM is inserted. Proceed slowly as pressure builds. The weight should be retrieved back when done and used for next PFM installation. The PFM retrieval rope is then secured to the well lid using cable ties or others to ensure that it will not be lost to the well head.

2.2. PFM Retrieval

PFMs are retrieved using the rope. The top PFM in the well is extracted first by gently pulling up on the rope (heavy work gloves should be worn when pull on rope). The PFM should be pulled to the top of the well casing. The PFM will occasionally catch on joints in the well screen. Simply apply more pressure to overcome. If the PFM will not move look at troubleshooting options below. When the PFM is at the top of the well casing untangle any rope (or wires) that are twisted at the well head. Thread the retrieval cable through a 5ft transport PVC pipe and place the pipe over the well to guide and contain the extruded PFM. Move the PFM to the sampling work station.

2.3. PFM Sampling

A tarpaulin acts as a ‘protective flooring’ for the work zone. A portable table is used as a work zone for sampling the PFMs. Nitrile protective gloves and necessary other protective clothing will be worn by all samplers. A lined bucket (5gal) is placed under the work area to capture un-sampled residual activated carbon from the retrieved PFM. The sock is extruded from the PVC pipe to the sampling interval extent. The flexible mesh packing material is cut and the sorbent (activated carbon or resin) captured in plastic or stainless steel mixing bowls for homogenization using a stainless steel spatula. A sub-sample is then transferred into 120 mL jars for GAC (or HDPE bottles for resin). The jars (or HDPE bottles) are stored in a cooler for transport back to the laboratory for analysis. The center tube and viton washers are measured to obtain the sample interval lengths in the PFM. Sampling materials, spatula, scissors, mixing bowls are wiped clean to remove carbon particles prior to retrieving the next PFM.

2.4. Transportation and Storage of PFM samples: Sorbent (GAC or GAC/resin) samples are stored on-site in coolers then shipped via overnight air express (e.g., FedEx) to the EnviroFlux laboratory. Samples are stored in a cold storage room or refrigerator at 4^{o}C until extraction and analysis.

2.5. Troubleshooting PFM extraction

In the event that the PFM is difficult to remove from the well the following steps might be considered. If available, use metal rods or pvc pipes, push down to move the PFM below the obstruction. In this case it is useful to attach a viton 2 inch (or other size) washer at the end of the push rod to center the rod in the well. Holding both the retrieval wire and the push rod, surge the PFM up and down to attempt to overcome the obstacle.

In the event that the wire breaks or becomes detached from the PFM, a corkscrew attachment can be added to the rod to attempt to "grab" the top of the PFM and advance it upwards. If this fails the corkscrew can be used to dig into the AC and viton washers again in an attempt to "grab" the PFM. Finally, a pump with tubing lowered to the top of the PFM can be used to extract the AC. This slow process obviously destroys the PFM, but can be successful in clearing the well.

3. Standard operating procedure for extraction and analysis of analytes from passive flux meter sorbents

3. 1. Scope and application

3.1.1. This SOP describes the sample procedures used by EnviroFlux LLC., for extraction and analysis of target analytes (including tracers) from sorbents used in Passive flux meter (PFM) inserted in monitoring wells.

3.1.2. The Passive flux meter (PFM) contains a permeable sorbent (GAC or GAC with resin) which allows groundwater flow through the device. The sorbent matrix should be preloaded with five resident tracers. The tracers are displaced from the sorbent at rates proportional to groundwater flux. Simultaneously the sorbent retains dissolved contaminants such as TCE in the GW flowing through PFM. After a 2-3 weeks period of exposure to GW, the PFMs are removed from the well. The sorbent (GAC) samples from the PFM are sub-sampled into a 125ml of glass jars and the resin samples are transferred into 120 mL HDPE (or PP) bottles in the field and transferred to the EF lab or the client's lab for analysis. The sorbent is then extracted to quantify the residual masses of all resident tracers and contaminants. The extracted samples are analyzed for Darcy and contaminants fluxes.

3.1.3. The selected constituents should be target field contaminants and alcohol tracers:
The alcohol tracers are methanol, ethanol, iso-propanol, t-butanol, and 2,4-dimethyl-3-pentanol and the contaminants could be CVOCs, semi-VOCs, PFAS, pesticides, PAH, metals, nutrients, others.

3.1.4. The method involves liquid extraction in 40 ml VOA vials using liquid solvents or others.

3.2. Purpose

The purpose of this SOP is to: (1) insure reliable and reproducible results, and (2) track possible sources of error in the extraction of alcohol tracers and contaminants from the PFM sorbents and the subsequent analysis by analytical methodology.

3.3. Procedures

3.3.1. Transportation and Sample Process

Transportation and Storage: The field samples should be shipped to the Enviroflux laboratory packed in coolers containing "blue ice or ice" via overnight air express (e.g., FedEx) and stored in the refrigerator.

Sample Process: As received the PFM samples from the field site should be extracted to quantify the residual masses of all resident tracers and contaminants. If not, the PFM samples should be stored in a refrigerator at 4C, until extraction/analysis, but no more than 1 week. 40 ml VOA vials are used for AC sampling. The vials are weighed empty (nearest 0.01 g) and recorded. A few grams of PFM sorbent samples from 125 ml sample jars should be subsampled into the pre-weighed 40-ml VOA vials. Following addition of AC, the vials are weighed. The vials weights are then recorded. The vials are then filled with extraction solvent using a fixed volume dispenser and sealed. Then the sample vials will be rotated, set at 20% rotation speed, for about 24 hours on a rotator (Glas-Col model RD 4512) and then refrigerated for several hours to allow suspended particulate matter to settle out.

3.3.2. Sub-sampling

When the suspended particle completely settled out, the supernatant should be taken into two separate 2-ml GC vials, one for alcohol tracer analysis and another for contaminants. Note that if the suspended particulate matter does not settle out, a syringe filter (0.22 micron) should be used to remove the suspended GAC or resin particles from the samples to protect analysis instruments. Then PFM samples will be sub-sampled into 2 ml GC vials. Pipets will be used to transfer samples from 40-mL sample vials to the 2-mL GC vials.

3.3.3. Chemicals and Laboratory Supplies and Materials

Certified ACS grade pure alcohols and solvent should be purchased from one or more of the following vendors; Fisher Scientific, VWR and/or Sigma-Aldrich and used as received. Alcohol tracers (methanol, ethanol, iso-propanol, tert-butanol, 2,4-dimethyl-3-pentanol) and extraction solvents are purchased from Sigma-Aldrich, all with purities >98%.

Volumetric class ‘A’ pipettes and volumetric class ‘A’ flasks for preparation of calibration standards and sample dilutions. Disposable Pasteur glass pipettes for sub-sampling. GC vials (2 mL) with Teflon-faced caps for GC analysis.

3.3.4. Calibration and Stock Standard Solutions

Contaminant stock standard solutions are purchased from Restek or Sigma Aldrich. If needed, individual alcohol tracer and some contaminant stock standard solutions are prepared in reagent solvent using volumetric glassware and stored in 20 or 40mL glass vials with Teflon-lined caps. Stock solutions should be kept in a refrigerator at 4o C. Fresh stock standards should be prepared every six months and follow protocols outlined in the Federal Register, Rules and Regulations, "Standard Stock Solutions".

Mixed calibration standards should be prepared by diluting stock standards in reagent solvent using volumetric glassware. A minimum of four standards should be prepared and should bracket the expected concentration range.

3.3.5. Quality Control (QC) Blank Spike/Matrix Spike

A blank spike should be prepared by the addition of 1 mL of calibration standard to 1mL of extraction solvent. A matrix spike should be prepared by the addition of 1mL of calibration standard to 1 mL of extracted sample. Spike recoveries should be calculated using the difference between the two measured concentrations and the known spike concentration.

3.3.6. Analytical Instrumentation

A Shimadzu GC/MS-QP2010 SE and Perkin Elmer Clarus 590 Gas Chromatograph equipped with FID and ECD detectors, autosampler, a temperature-programmable oven, heated auto-injector and detector zones, a 30 meter or greater capillary separations column, nitrogen carrier gas, standard compressed air and hydrogen flame gases and controlled by a PC-based data acquisition/analysis software system.

3.3.7. Sample Analysis

All analyses should be performed consistent with the quality assurance program of Enviroflux. Individual alcohol tracer and contaminant identification should be based on absolute retention times compared to calibration standards. Alcohol tracer and contaminant concentrations should be calculated on chromatographic peak area response converted to units of concentration in ug/L or mg/L based on standard calibration curves.

3.3.8. Interferences

Contamination by carry-over may occur when high-level and low-level samples are sequentially analyzed. Subsequent dilution and reanalysis should be completed on samples identified as outside the standard concentration bracket. Samples analyzed immediately following a ‘high-concentration sample’ should be reanalyzed. In an attempt to minimize carryover, samples suspected of being in a higher concentration range should be isolated and bracketed by the analysis of reagent solvent samples.

3.3.9 Safety

Gloves and eye protection will be worn during all extraction activities. The Materials Safety Data Sheets (MSDS) will be kept in the lab for information on toxicity, flammability, and other hazard data.

4.0. Quality Assurance Project Plan

4.1. Purpose and Scope of the Plan

This Quality Assurance plan focuses on field installation, sampling and processing of data from the Flux Meters.

4.2. Quality Assurance Responsibilities

The responsibility for QA should be by the Lab Manager/Project Manager of EnviroFlux.

4.3. Data Quality Parameters

This section discusses measures to be taken to ensure the representativeness, completeness, comparability, accuracy, and precision of the data.

Accuracy

Accuracy is defined as the closeness of the results to the true value.

The percent recoveries of surrogates, QC check standards, and matrix-spiked analytes are used to evaluate the accuracy of an analysis. The percent recovery represented by X can be calculated using the following equations:

For surrogates and QC check standards:

$$X = \frac{SSR}{SA} x\,100 \qquad 1$$

For matrix spikes:

$$X = \frac{SSR - SS}{SA} \text{ x } 100$$

where:

SSR = Spiked sample result
SS = Sample result
SA = Spike added from spiking mix

The mean percent recovery (X) is defined by:

$$\overline{X} = \frac{\sum_{i=1}^{N} X_i}{N} \qquad 2$$

where:

X_i = The percent recovery value of a spike replicate
N = Number of spikes

Precision

Precision is a measure of the mutual agreement among individual measurements of the same parameters under prescribed similar conditions.

The analytical precision is determined using results from duplicate or replicate analyses of samples and from matrix spike results for a given matrix. The Relative Percent Difference (RPD) is used to evaluate the precision of duplicate analyses. Relative Percent Difference is defined in the following equation:

$$\%RPD = \frac{2(X1 - X2)}{\overline{x}} x\ 100 \qquad 3$$

X1 = First duplicate value
X2 = Second duplicate value

When replicate analyses are performed, precision is measured in terms of the Standard Deviation (SD) which is defined in the following equation:

$$S = \sum_{i=1}^{N} \left[\frac{(X_i - \overline{X})^2}{N - 1} \right]^{\text{‰}} \qquad 4$$

where:

X_i = The recovery value of a spike replicate
X = Arithmetic average of the replicate values
N = Number of spikes

Completeness

Completeness is defined as the percent of parameters falling within acceptance criteria and the results subsequently reported. A goal of 95 percent completeness has been set for all samples.

The general requirement of this quality assurance program is to analyze a sufficient number of standards, replicates, blanks, and spike samples to evaluate results adequately against numerical QA objectives.

4.4. Calibration Procedures, Quality Control Checks, and Corrective Action

The focus of the following section is to describe initial and continuing calibration procedures for analytical instrumentation, duplicate and control testing and data reduction, validation, and reporting.

Supplies and Quality Control Materials

All supplies (i.e., glassware, chemicals, reagents) used will be of the best possible quality to ensure proper instrument calibration and avoid contamination. All reagents used are prepared from Analytical Reagent Grade (AR) chemicals or higher purity grades, unless such purity is not available. The preparation of all reagents will be documented, including source, mass, and dilutions. Each reagent will be clearly labeled with the composition, concentration, date prepared, initials of preparer, expiration date, and special storage requirements, if any.

Reagents

Reagent solutions are stored in appropriate glass, plastic, or metal containers. Reagents are stored under conditions designed to maintain their integrity (refrigerated, dark, etc.). Shelf life is listed on the label and the reagent is discarded after it has expired. Dry reagents such as sodium sulfate, silica gel, alumina, and glass wool are either muffled at 400°C or extracted with solvent before use for organic chemical analyses. Water used in the laboratory is glass distilled or deionized, and periodically checked for purity. In addition, water used in the organics area is carbon-filtered or purchased as HPLC grade. All organic solvents used are either glass-distilled or pesticide grade. Solvents and reagent solutions are checked for contamination by employing reagent blanks, before use in any analysis.

Quality Control Reference Materials

All Quality Control Reference Materials are acquired only from authorized vendors or sources commonly used by U.S. EPA Regional Laboratories.

Standards Traceability

When standard reference materials arrive at the laboratory, they are registered in a bound log book, "Standards Notebook for Neat Materials and Primary Solutions." An example of a logging sequence is used to illustrate this process.

(1-S-XXX-12-4) (label and log sequence)

where:
1 = Notebook log number
S = Standard Notebook--"Neat and Primary Standards"
XXX = Receiving analyst's initials
12 = Notebook page

4 = Entry number on notebook page

All working standards prepared at the site lab are logged in the "Standards Notebook for Intermediate and Working Standards." A similar labeling convention has been adopted for classifying these working standard materials. An example is given below.

1-W-XXX-6-5 (label and log)
Where:
1 = Number of notebook
W = Standards notebook - "Intermediate and Working" Standard
XXX = Analyst's initial
6 = Page Number
5 = Page entry number in sequence

Instrument Calibration

Every instrument used to analyze samples must pass the calibration criteria established in the appropriate SOP. Initial calibration criteria for instrument linearity, sensitivity, resolution, and deactivation must be met before samples can be analyzed. Sustained performance is monitored periodically during sample analyses by the use of continuing calibration check standards.

GC Section

Initial Calibration

The linear calibration range of the instrument must be determined before the analysis of any samples. Gas chromatographic conditions used for sample analyses are used during calibration.

The calibration is performed in accordance with the SOP derived from the methods used. For most GC analyses, a 5-level calibration is run. The concentrations of the standards must bracket the linear range of the instrument. Calibration using fewer than 5-levels is done only when specifically allowed by the method.

Relative Retention Times and Relative Response Factors

Instrument calibration and sample analysis must be performed using appropriate internal standards to establish relative retention times (RRT) and relative response factors (RRF) where required. Internal standards appearing in a chromatogram will establish primary search windows for those target compounds nearby in the chromatogram. RRT are calculated using this equation:

$$RRT = \frac{RT^{target}}{RT^{is}} \qquad 5$$

The RRF may be calculated as follows:

Absolute Response Factor = RF = $\frac{\text{Area}}{\text{Amount}}$

Note: Amount in this equation refers to the mass (e.g. ug) of compound mixed into the solution injected.

Each calibration standard is analyzed and the RRF is calculated for each analyte according to the following equation:

$$RRF = \frac{A_s \; x \; C_{is}}{A_{is} \; x \; C_s} \qquad 6$$

A_s = Area of analyte
A_{is} = Area of internal standard
C_{is} = Concentration of internal standard
C_s = Concentration of analyte

Note: Certain data processors may calculate
the RRF differently.

The standard deviation (SD) and the % coefficient of variation (CV) of RRFs for the compounds are calculated using the following equations:

$$S = \sum_{i=1}^{N} \left[\frac{(RRF_i - RRF_m)^2}{N - 1} \right]^{\text{‰}} \qquad 7$$

Where:

RRF_i = Individual RRF
RRF_m = Mean RRF
N = Number of RRFs

and

$$\%CV = \frac{S \; x \; 100}{RRF_m} \qquad 8$$

Coefficient of Variation

The %CV of each compound must be less than 30 percent. This criterion must be achieved for the calibration to be valid.

If the %CV is less than 20 percent, the RRF of the compound can be assumed to be invariant, and the average RRF can be used for calculations.

If the %CV is between 20 percent and 30 percent, calculations must be made from the calibration curve. Both the slope and the intercept of the curve must be used to perform calculations.

Initial Calibration Verification

The calibration curve must be validated further by analyzing a QC check sample. The QC check sample must be obtained from EPA, another vendor, or it must be from another lot number. The QC check sample verifies the validity of the concentrations of the standards used to obtain the initial calibration.

All analytes in the QC check standard must be recovered within 80 to 100 percent. If any analyte exceeds this criterion, then a new calibration curve must be established. All sample results for a target analyte can be reported only from valid initial calibrations.

Continuing Calibration

The working calibration curve or RRF for each analyte must be verified daily by the analysis of a continuing calibration standard. The ongoing daily continuing calibration must be compared to the initial calibration curve to verify that the operation of the measurement system is in control.

The continuing calibration check must be performed during each day of analysis to verify the continuing calibration of the instrument. A day is defined as 24 hours from the start run time of the last valid continuing calibration. Generally, a continuing calibration check sample is injected every 10 samples.

Verification of continuing calibration is performed by the analysis of a midpoint standard containing all of the analytes of interest. Verification of continuing calibration of the measurement system is done by calculating the percent difference (%D) of the continuing calibration RRF from the mean RRF from the initial calibration curve using the following equation:

$$\%D = \frac{(RRF_m - RRF) \times 100}{RRF_m} \qquad 9$$

where:

RRF_m = The mean relative response factor from the initial calibration curve

RRF = The relative response factor from the continuing calibration standard

The %D must meet the acceptance criteria established in the appropriate SOP. If these criteria are exceeded, a new calibration curve must be established.

Other Calibrations

Weekly calibrations are performed for equipment such as balances, thermometers, pH meter that are required in analytical methods, but which are not recorded in a dedicated QA instrument log.

Balances

Balances are checked with Class S weights on a daily basis. Before a weighing session, the analyst is required to perform at least one calibration check in the range of the material to be weighed. This value is also recorded on the specific balance control chart and must be within the control limit. The criteria for calibration checks are given in Table 4.1.

Table 4-1.

CRITERIA FOR BALANCE CALIBRATION CHECKS

Class S Weight (grams)	Warning Level (grams)	Control Level (grams)
Analytical Balances		
0.0100	0.0098-0.0102	0.0097-0.0103
0.1000	0.098-0.102	0.097-0.103
1.000	0.995-1.005	0.990-1.010
10.000	9.995-10.005	9.990-10.010
50.00	49.98-50.02	49.95-50.05
Top Loading Balances		
1.00	0.95-1.05	0.90-1.10
10.0	9.9-10.1	9.8-10.2
50.0	49.7-50.3	49.5-50.5

pH meters

The pH meter is standardized daily using buffers at pH of 4, 7, and 10.

Refrigerators

Refrigerators are maintained at 4°C, with control levels ranging from 1°C to 10°C. A temperature reading is taken each workday morning immediately after unlocking the refrigerator.

The temperature reading is recorded and entered on the control chart posted on the door of the refrigerator. If a trend is apparent or if the temperature is outside the acceptable range, the Lab Manager is notified so that corrective action can be initiated if required.

Freezers

Freezers are maintained at -10°C, with control levels ranging from 0°C to -35°C. A temperature reading is taken each workday morning immediately after unlocking the freezer. The temperature reading is recorded and entered on the control chart posted on the door of the freezer. If a trend is apparent, or if the temperature is outside the acceptable range, the Lab Manager is notified so that corrective action can be initiated if required.

Calibration Standards

All calibration standards, including internal standards, are obtained from chemical suppliers with certificates of high purity and concentration.

Traceability

All standards are traceable to the National Institue of Standards and Testing (NITS) Standard Reference Materials (SRM) or to the U.S. EPA Reference Standards.

Working Standards

The commercial standards are used as stock standards. Working standards are made from the stock standards at appropriate concentrations to cover the linear range of the calibration curve. The working standards are used for initial calibration curves, continuing calibration checks, and preparation of analyte spiking solutions as appropriate for a particular analysis. All stock and working solutions are uniquely identified, dated, labeled, and initialed.

Standards Logbook

All stock solutions are given a unique code number and are entered into a bound "Primary Standards" logbook. The name of the compound and other pertinent information, including concentration, date of receipt, and analyst's name, are also entered.

Working standards are given a unique code number that allows them to be traced to a specific stock solution. The working standard is entered in a "Working Standards" logbook with analyst's name, date and method of preparation, and other pertinent information.

CORRECTIVE ACTIONS

Laboratory Imposed

Corrective actions will be initiated if the quality control criteria indicate an analysis is out of control.

- Check calculations for accuracy
- Check instrumentation to ensure it is operating properly. Recalibrate if necessary.
- Remake standards and reagents and reanalyze samples.
- Re-prep and re-analyze samples.

The analyst is responsible for initiating corrective actions for analytical problems encountered during analysis of samples. Most problems which occur and are corrected during the analytical run will be explained in the run log or analytical bench sheet for that run. A corrective action report (CAR) may be necessary for some problems encountered, such as complete system failure, chronic calibration failure, or severe matrix interferences.

During data review, the reviewer may initiate corrective actions based on problems or questions arising from the review. A CAR will be initiated.

The Laboratory Manager may initiate corrective actions if a problem is noticed during a QC review of data, a system audit, or a performance audit. A CAR will be initiated.

CARs are signed and dated by Project Manager, and by the Laboratory Manager. CARs will be filed in appropriate department files and in the Lab Manger's files.

Agency Imposed

Any actions deemed necessary by regulatory agencies, such as EPA, will be taken. These actions are most likely to arise from a systems or performance audit, or from data review conducted by the agency.

Corrective Action Reports

The laboratory will have a Corrective Action System that ensures the proper documentation and dispositions of conditions requiring corrective action. The system will also ensure that the proper corrective action is implemented to prevent recurrence of the condition.

Situations Requiring Corrective Action Reports

The Corrective Action System applies to all situations that affect data quality. These situations include, but are not limited to, quality control criteria being exceeded, statistically out-of-control events, deviations from normally expected results, suspect data, deviations from the standard operating procedure, and special sample handling requirements. Corrective actions may also be initiated as a result of other QA activities, such as performance audits, systems audits, laboratory/interfield comparison studies, and QA project-related requirements of certifying agencies such as EPA.

Corrective Action Procedures

The procedure requires documenting the condition requiring corrective action on a Corrective Action Report and implementing corrective action based on the results of the investigation performed to determine the cause of the condition (Table 4-1 and 4-2).

When a condition requiring corrective action arises, the Corrective Action Report is initiated. The initiator describes the condition requiring corrective action. An investigation, if necessary, is conducted to determine the cause of the condition. A corrective action is recommended based on the results of the investigation. The Corrective Action Report is reviewed by the Project Manager and the Lab Manager who either approve the recommended corrective action or indicate a different corrective action. The originator has the responsibility of following up to be sure that the corrective action is implemented. Implementation of the corrective action is documented by the Corrective Action Report being signed and dated by the person who implemented the corrective action.

Table 4-1. Corrective Actions

QC Activity	Acceptance Criteria	Recommended Corrective Action
Initial instrument blank	Instrument response <MDL response	Prepare another blank, if same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc.
Initial calibration standards	Coefficient of variation >0.99995 or standard concentration value ± 10% of expected value	Reanalyze standards. If still unacceptable, then remake standards
QC Check Standard	± 10% of expected value	Reanalyze standard. if still unacceptable, then remake standards, or use new primary standards if necessary
Continuing calibration Standards	± of expected value	Reanalyze standard. If still unacceptable, then recalibrate and rerun samples from the last cc stnd. Check
Method blank	<MDL	Reanalyze blank. If still positive, determine source of contamination. If necessary, reprocess (i.e., digest or extract) sample set
Initial calibration Standards (GC/MS)	RRF <30%	Reanalyze standards. If still unacceptable, prepare new standards.

Surrogate recovery (GC/MS Semivolatiles)	0 or 1 outside CLP criteria	Re-extract and/or re-analyze
Surrogate recovery (GC/MS volatiles)	0 outside criteria	Re-analyze

Table 4-2. Corrective Action Report Criteria for Control Charts

Criteria	Corrective Action
A point outside ±3 standard deviations	Attempt to determine the source of the problem. Verbally report the deviation and results of preliminary investigation to the Field Site Manager, who will decide jointly what action to take. After implementing corrective action, complete the Corrective Action Report and submit it to the Project Manager and the Field Site Manager for approval.
Three consecutive points accuracy outside ± standard deviation	Conduct investigation. Check accuracy of data input, calculations, instrument, standards, etc., to locate the source of the problem. Document results in a Corrective Action Report. Have the report approved by the supervisor. No results can be reported until the Corrective Action Report has been approved. Send a copy of the Corrective Action Report and a copy of the QC chart to the Field Site Manager.
Obvious outlier.	Conduct investigation. Check accuracy of data input, calculations, dilutions, instrument, standard, etc.. present initial findings to the Field Site Manager. They will jointly decide what actions need to be taken. Document the results in a Corrective Action Report and have it approved by the Field Site Manager. No results can be reported until the Corrective Action Report is approved. Send a copy of the Corrective Action report and a copy of the control chart to the Field Site Manager.
Obvious shift in the mean.	Conduct investigation. Check calculations, data entry, standards, instrument, calibrations, etc. Document results in a Corrective Action Report. Have the Corrective Action Report approved by the Field Site Manager. No results can be reported until the report is approved. Send a copy of the Corrective Action Report and a copy of the QC chart to the Field Site Manager.

4.5. Demonstration Procedures

Maintenance Schedule

Preventive maintenance, such as lubrication, source cleaning, and detector cleaning, is performed according to the procedures delineated in the manufacturer's instrument manuals.

The frequency of preventive maintenance varies with different instruments. Routine maintenance performed includes cleaning and/or replacement of various instrument components.

In general, the frequency recommended by the manufacturer is followed. In addition to the regular schedule, maintenance is performed as needed. Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance is performed when an instrument begins to degrade as evidenced by the degradation of peak resolution, shift in calibration curves, decreased ion sensitivity, or failure to meet one or another of the quality control criteria. GC injector septa is changed every 100 to 150 injections, or sooner if instrument performance deteriorates. Injection port glass liner is cleaned or changed after 100 to 150 injections or sooner if instrument performance deteriorated. A method blank is analyzed at the beginning of each sample set and after every 20 samples to monitor instrument background.

Instrument maintenance logbooks are maintained in the laboratory at all times. The logbook contains a complete history of past maintenance, both routine and nonroutine. The nature of work performed, the date, and the signature of the person who performed the work are recorded in the logbook. Preventive maintenance is scheduled according to each manufacturer's recommendation. Instrument downtime is minimized by keeping adequate supplies of all expendable items on hand. Expendable items are those with an expected lifetime of less than one year. Routine instrument preventive maintenance is handled by the instrument operator. Repair maintenance is performed by a full-time electronics technician, or by the manufacturer's service personnel.

4.6. Calculation of Data Quality Indicators

The focus of this section is to present methods of calculating data quality that will be used for this project.

Control Samples

The laboratory will employ control samples to assess the validity of the analytical results of the field samples. Determination of the validity of field sample results is based on the acceptance criteria being met by the control sample. The acceptance criteria for each type of control sample are delineated in the appropriate SOP. These acceptance criteria are based on the laboratory's statistical process capabilities determined from historical data, and meet the EPA CLP acceptance criteria as a minimum. Often, in-house criteria are more stringent than required by CLP. The control samples are analyzed in the same manner as the field samples. They are interspersed with the field samples at frequencies that are specified by the appropriate SOP.

Method Blank Analyses

A method blank is a "clean" sample (i.e., containing no analyte of concern), most often deionized water, to which all reagents are added and analytical procedures are performed. Method blanks are analyzed at a rate of one per sample lot or at least every 20 samples. The blank is analyzed in order to assess possible contamination from the laboratory or the procedure. If the analyte of interest is found in the blank at above reporting levels, inorganic analysis is suspended until the source of contamination is found and corrective action is taken. The Laboratory Manager is notified when blank results are unacceptably high, and may assist in the investigation.

Surrogate Spike Analyses

For certain analyses such as those performed by GC/MS, each sample and blank is spiked with one or more surrogate compounds before preparatory operations such as purging or extraction. These surrogate standards are chosen for properties similar to sample analytes of interest, but are usually absent from the natural sample.

Surrogate spikes evaluate the efficiency of the analytical procedure in recovering the true amount of a known compound.

The results of surrogate standard determinations are compared with the true values spiked into the sample matrix prior to extraction and analysis, and the percent recoveries of the surrogate standards are determined. Recoveries should meet the upper and lower control limits as specified for each compound. If control limits are exceeded for surrogate standards, the following sequence of actions is taken:

a. The sample is re-injected.

b. Raw data and calculations are checked for errors.

c. Internal standards and surrogate spiking solutions are checked for degradation, contamination, or solvent evaporation.

d. Instrument performance is checked.

e. If a, b, and c fail to reveal the cause of the noncompliance surrogate recoveries, the sample is re-purged or re-extracted.

f. If all the measures listed above fail to correct the problem for laboratory blank surrogate analyses, the analytical system is considered out of control, and the instrument must be recalibrated and examined for mechanical faults.

g. If all the measures listed above fail to correct the problem for field sample surrogate analyses, the deficiency probably is due to sample interferences, and not due to any procedural or mechanical problems in the laboratory. The surrogate spike recovery data and the sample data from both extractions are reported and are flagged. The Laboratory Manager is notified with an exceptions report and the corrective actions taken.

Matrix Spike/Matrix Spike Duplicate Analyses

To evaluate the effect of the sample matrix on the analytical methodology, two separate aliquot samples may be spiked with a standard mix of compounds appropriate to a given analysis. The matrix spike and the matrix spike duplicate (MS/MSD) are analyzed at a frequency of one per lot or one per 20 samples, whichever is more frequent. The percent recovery for each of the spiking compounds is calculated. The relative percent difference (RPD) between the MS/MSD is also calculated.

The observed percent recoveries (%R) and relative percent differences (RPD) between the MS/MSD are used to determine the accuracy and the precision of the analytical method for the sample matrix. If the percent recovery and RPD results exceed the control limits as specified for each spiking compound, the sample is not reanalyzed. Poor recovery in matrix spiked samples does not necessarily represent an analytical system out of control. It is possible that unavoidable interferences and matrix effects from the sample itself preclude efficient recoveries. The poor recovery is documented for the Lab Manager.

Internal Standards Analysis

Once an instrument has been calibrated, it is necessary to confirm periodically that the analytical system remains in calibration. The continuing calibration and precision of the organics analytical system are checked for each sample analysis by monitoring the instrument response to internal standards. When internal standard addition is not appropriate to a particular method, other means of accuracy checks, such as standard addition, are used. Results from internal standard analyses are compared to the mean calibrated value. Deviation from this mean beyond a predetermined magnitude, depending on the type of analysis, defines an out-of-control condition. The system must then be brought back into control by:

- Checking the quality of the internal standards and reanalyzing the sample
- Recalibrating the system
- Correcting the malfunctions causing the instrument to fall out of calibration

Duplicate Sample Analyses

Duplicate analyses are performed for cations analyses and upon special request for selected other parameters to evaluate the reproducibility of the method. Results of the duplicate analyses are used to determine the RPD between replicate samples. For each parameter analyzed, at least one duplicate sample is run per group of 20 samples.

The precision value, RPD, is reviewed by the section supervisor and the division manager. If the precision value exceeds the control limit or the established protocol criteria for the given parameter, the sample set is reanalyzed for the parameter in question unless it is determined that heterogeneity of the sample has caused the high RPD.

QC Check Standard Analyses

Analysis of QC check standards is used to verify the preparation process or the standard curve, and is performed with each group of samples. Results of these data are summarized, evaluated, and presented to the section supervisor and the division manager for review.

The results of the QC check standard analysis are compared with the true values, and the percent recovery of the check standard is calculated. If correction of a procedure or instrument repair is done, the check standard is reanalyzed to demonstrate that the corrective action has been successful.

At least twice a year, a QC check standard for each parameter group is analyzed as a double-blind sample. Samples are prepared, submitted, and evaluated by the Laboratory Manager.

Other Quality Control Samples

Under some sampling analysis, additional quality control samples may be required. These may include:

a. **Blank/Spike--**Analyte of interest or surrogate is spiked into blank water rather than into a sample. The blank/spike goes through the entire analytical procedure, and percent recovery is calculated with no likelihood of matrix effect. For many contracts, an externally provided LCS sample (EPA) serves as a blank/spike sample.

b. **Trip Blank--**A sample bottle filled with laboratory blank water travels with the sample kit to the sampling site, and is sent back to the laboratory packed in the same container as any volatile samples collected. Trip blank analyses check for possible volatile contamination during shipping or sampling.

c. **Field Blank--**A field blank can be a sample container filled with laboratory blank water and sent to the sampling site, or it may be filled at the site with purchased distilled water or decontamination water. The field blank analysis checks for possible contamination by the sampling team.

d. **Equipment Rinsates--**After equipment has been cleaned in the field, many contracts require that the equipment be rinsed and the rinsate analyzed for the same parameters requested on the samples. The rinsate analysis proves the equipment has been cleaned properly and will not contaminate the next samples taken.

Instrument Detection Limits, Method Detection Limits, and Reporting Limits

Instrument Detection Limits (IDL)

Instrument Detection Limit (IDL) studies are performed for inorganic parameters when an instrument is installed, when major maintenance or repair work has been done, and routinely once per calendar quarter.

To determine IDL, seven consecutive measurements per day are made on a prepared standard solution (in reagent water) of an analyte at a concentration 3 to 5 times the instrument manufacturer's suggested IDL. Each measurement is performed as though it were a separate analytical sample. This procedure is repeated on three nonconsecutive days. The standard deviation is calculated for each set of seven replicates and the average of the standard deviations is obtained. This average is multiplied by 3 to give the instrument detection limit (IDL).

Method Detection Limits (MDL)

The Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the value is above zero. The sample must be carried through the entire method under ideal conditions. MDL is determined according to the method outlined in 40 CFR 136, Appendix B. MDLs are determined at least annually for all parameters. MDL studies are also conducted for new methods introduced in the lab, after major maintenance or modification to an instrument, and as part of the training of new analysts.

To determine MDL, seven replicate analyses are made of analytes spiked into blank water at 1 to 5 times the estimated method detection limit. The spiked samples must be carried through the entire analytical procedure, including any extraction, digestion, or distillation process, for MDL calculation. The SD of these replicates is calculated. Where: t = The student t value for a 99% confidence interval

$MDL = t\ x\ S$ 10

S = Standard deviation of the replicate analyses

Reporting Limits

In most cases, final report forms list reporting limits rather than either IDL or MDL. Reporting limits are taken from EPA SW846 published limits or from historical data. Matrixes or analyte concentrations which require dilution will change the detection limits for that sample.

4.7. Performance and System Audits

In this section information is provided on performance audits.

Performance Evaluation Samples

Performance evaluation samples are analyzed throughout the project for all parameters, as a constant check on accuracy and precision for all analyses.

Audits

Internal audits of the laboratory are conducted in two phases. The first phase is conducted by the Laboratory Quality Assurance Coordinator during the fourth quarter of the year. This is usually a 2-day systems audit which covers all sections of the laboratory. An audit report is issued within 2 weeks of completion. The Lab Manager has the responsibility for coordinating all responses to the audit finding and for following up on the required corrective action. A followup audit is made when deemed necessary by the Lab Manager.

The second phase consists of quarterly audits performed by the Lab Manager. These are half-day or day-long audits, and are concentrated on specific areas that are deemed problem areas by the Lab Manager. An audit report is issued at the completion of the audit. Responses and followup corrective action to the audit findings are required, and are monitored by the Field Site Manager.

All audit reports are issued to management and circulated to all staff. Copies are filed with the Laboratory Manager.

4.8. Quality Assurance Reports

The performance of the laboratory as assessed by the quality monitoring systems in place is reported by the Lab Manager to management quarterly and as needed. Copies of all quality reports are maintained in the Laboratory Manager files.

Quality assurance reports to management include, but are not limited to, the following:

- Results of performance and systems audits
- Status of corrective actions
- Periodic assessment of data accuracy, precision, and completeness
- Significant QA problems and recommended solutions

In addition to the quarterly reports, a final report summarizing items covered in the quarterly reports is provided by the Lab Manager to the Project Manager.

4.9. Data Format

Introduction

In order to provide analytical data which is technically sound and defensible, a system of data management will be implemented in the laboratory. All activities which pertain to a sample are documented.

All data generated during the demonstration, except those that are generated by automated data collection systems, will be recorded directly, promptly, and legibly in ink. All data entries will be dated on the day of entry and signed or initialed by the person entering the data. Any change in entries will not obscure the original entry, will indicate the reason for such change, and will be dated and signed or identified at the time of the change.

In automated data collection systems, the individual responsible for direct data input will be identified at the time of data input. Any change in automated data entries will not obscure the original entry. Updated entries will indicate the reason for the change, the date, and the person responsible for making the change.

Data Tracking in the Laboratory

The Lab Manager is responsible for developing a system for tracking and maintaining sample identity between the collection point, analysis and reporting. This process will be periodically reviewed by the Project Manager.

Analyses and Data Reduction

The Lab Manager is responsible for the reduction of raw data when such steps are required to produce the correct data format for reporting. Data reduction may be done manually or through one of a number of computer programs used in the laboratory.

Chromatogram Identification

In the GC section computer software is used to identify chromatograms. A system-supplied file name (a hexadecimal date-time) and a user-supplied file name (related to an entry in the injection log) identify each acquisition.

Data Reduction Formulas

Linear regression formulas are used in a computer software system to calculate samples values for many general inorganic parameters and metals analyses. These programs use the general formula for linear regression:

$$Y' = a + bx \qquad 11$$

where:

Y' = The predicted value of y for a selected value of x

a = The value of y when x = 0
b = The slope of the straight line
x = Any value of x selected

Sample values for GC/MS parameters are calculated by systems software using the general formula:

$$\frac{Area_{Target} \ x \ Amount_{IS}}{Area_{IS} \ x \ Response \ Factor} \qquad 12$$

GC data is calculated using either an internal or an external standard. For internal standards:

$$Concentration = \left(\frac{A_x^{sample}}{A_x^{standard}} \right) \left(\frac{A_{IS}^{standard}}{A_{IS}^{sample}} \right) \left(amt_x^{standard} \right) \left(\frac{P}{T} \right) \left(\frac{amt_{IS}^{Sample}}{Amt_{IS}^{standard}} \right) \qquad 13$$

where: P = 1/fraction of extract to which IS is added

For calculations using an external standard:

$$Concentration = \left(\frac{A_x^{sample}}{A_x^{standard}} \right) \left(C_x^{standard} \right) \left(\frac{V}{T} \right) \qquad 14$$

where: C = concentration of x in standard
V = volume of final extract
T = total sample extracted

4.10. Data Storage and Archiving Procedures.

Data from GC's will be saved and archived in P&E Turbochrom format. All data will be backed-up on portable hard disks. This data will be batch processed into an Excel .csv file that can be easily converted to an Excel Worksheet. These files will be backed-up and transferred to individuals responsible for calculating flux results. All data related to the project will be organized for rapid retrieval and transfer to other interested parties.