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SAMPLING AND ANALYSIS PLAN FOR MERE BROOK AND MERRICONEAG STREAM GROUNDWATER-SURFACE WATER INTERFACE INVESTIGATION NAS BRUNSWICK ME

11/1/2010

AGVIQ/CH2M HILL

Sampling and Analysis Plan

Mere Brook and Merriconeag Stream Groundwater-Surface Water Interface Investigation

Naval Air Station Brunswick, Brunswick, Maine

Contract No. N62470-08-D-1006
Task Order No. WE09

PREPARED FOR

Department of the Navy,
Naval Facilities Engineering Command
Mid-Atlantic Division

November 2010

SAP Worksheet #1—Title and Approval Page

FINAL

NAVAL AIR STATION BRUNSWICK, MERE BROOK AND MERRICONEAG STREAM GROUNDWATER-SURFACE WATER INTERFACE INVESTIGATION SAMPLING AND ANALYSIS PLAN

November 2010

Prepared for:
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
MID-ATLANTIC

Prepared by:
AGVIQ-CH2M HILL

Prepared under:
Contract No. N62470-08-D-1006
Task Order No. WE09

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Executive Summary

This Sampling and Analysis Plan (SAP) presents the technical approach for the Groundwater-Surface Water Interface Investigation Sampling to be conducted byAGVIQ-CH2M HILL at Mere Brook and Merriconeag Stream, at Naval Air Station (NAS) Brunswick, Brunswick, Maine. This investigation is being conducted for the Department of the Navy, Naval Facilities Engineering Command Mid-Atlantic Division, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan.

NAS Brunswick is located south of the Androscoggin River between Brunswick and Bath, Maine. Mere Brook and Merriconeag Stream and the associated floodplain area are located on the eastern portion of the Eastern Plume, along the eastern border of NAS Brunswick (Figure 1). NAS Brunswick is an active base owned and operated by the Federal government through the Department of the Navy. In 1987, NAS Brunswick was placed on the National Priorities List by the U.S. Environmental Protection Agency and is currently participating in the Navy's Installation Restoration Program. In 2005, NAS Brunswick was included in the Department of Defense Base Re-Alignment and Closure (BRAC) list of facilities to be closed. NAS Brunswick will be closed in May 2011 under the BRAC and transferred primarily to Midcoast Regional Redevelopment and other nonprofit entities.

This SAP has been completed under Contract Number N62470-08-D-1006, Task Order WE09, in accordance with the Navy's Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP) policy guidance to ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended purposes.

The laboratory information cited in this UFP-SAP is specific to Accutest Laboratories in Marlborough, Massachusetts. Accutest was selected based on a competitive selection process and has the necessary Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) certification required for this project (scope and certification of accreditation provided in Attachment C). If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

The primary objectives of this investigation are to determine if contaminated groundwater associated with the Eastern Plume is discharging into Mere Brook and Merriconeag Stream, as well as to evaluate the potential exposures and risks to human and ecological receptor populations to plume constituents. Data from this investigation will also be used to evaluate the potential degradation of the contaminants if groundwater if shown to be discharging, and to update the geologic and hydrologic conceptual site model (CSM).

This SAP consists of the 37 worksheets specific to the Navy's UFP-SAP guidance. Figures are included following the Worksheets. The Health and Safety Plan is provided as Attachment A, field standard operating procedures (SOPs) are included as Attachment B, the site-specific

laboratory SOPs are included as Attachment C, and an addendum to the existing Waste Management Plan for work performed at Brunswick is included as Attachment D.

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A Health and Safety Plan
B Field Standard Operating Procedures
C Laboratory Standard Operating Procedures
D Waste Management Plan Addendum
E IAVI Screening Levels

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Abbreviations and Acronyms

°C	degrees Celsius
µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
ABB-ES	ABB Environmental Services, Inc.
AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III
bgs	below ground surface
BACSE	Brunswick Area Citizens for a Safe Environment
BRAC	Base Realignment and Closure
BTAG	Biological Technical Assistance Group
C.G.	Certified Geologist
CA	corrective action
CCB	continuing calibration blank
CCC	continuing calibration check
CCV	continuing calibration verification
CD	compact disc
CDC	Center for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DEC	cis-1,2-dichloroethene
COC	contaminant of concern
CoC	chain of custody
CPR	Contractor Production Report
CQCR	Contractor Quality Control Report
CSM	conceptual site model
CV	calibration verification
DFOW	Definable Feature of Work
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
EIS	Environmental Information Specialist
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ETQLs	Ecological Target Quantitation Limits
FID	flame ionization detector
FTL	Field Team Leader
GC	gas chromatography

GPS	global positioning system
GSI	groundwater/surface water interface
H&S	health and safety
HI	hazard index
HQ	hazard quotient
HSP	Health and Safety Plan
IA	indoor air
ICAL	initial calibration
ICP	inductively coupled plasma
IDW	investigation-derived waste
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
LTM	long-term monitoring
LTMP	Long-Term Monitoring Plan
MCL	maximum contaminant limit
MDEP	Maine Department of Environmental Protection
MEGs	Maximum Exposure Guidelines
mg/kg	milligrams per kilogram
MIDLANT	Mid-Atlantic
MNA	monitored natural attenuation
MPC	measurement performance criteria
MS	mass spectroscopy
MS/MSD	matrix spike/matrix spike duplicate
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NFESC	Naval Facilities Engineering Service Center
NIRIS	Navy Installation Restoration Information System
NRWQC	National Recommended Water Quality Criteria
ORP	oxygen reduction potential
PAL	project action limit
PCE	tetrachloroethene
PDB	passive diffusion bag
PDF	portable document format
PIL	project indicator limit
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PQL	project quantitation limit
PQM	Program Quality Manager
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan

QC	quality control
QL	quantitation limit
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RSL	Regional Screening Levels
S&A	Sampling and Analytical
SAP	Sampling and Analysis Plan
SCV	secondary chronic value
SOP	Standard Operating Procedure
SSC	Site Safety Coordinator
T&D	transport and disposal
TBD	to be determined
TCE	trichloroethene
TOC	total organic carbon
UFP-SAP	Uniform Federal Policy Sampling and Analysis Plan
VC	vinyl chloride
VOC	volatile organic carbon
VTSR	Validated Time of Sample Receipt

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Mere Brook and Merriconeag Stream

Operable Unit: Not applicable (N/A)

Contractor Name: AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III (AGVIQ-CH2M HILL)

Contract Number: N62470-08-D-1006, Task Order No. WE09

Contract Title: Naval Facilities Engineering Command, Mid-Atlantic (NAVFAC MIDLANT) Small Business Remedial Action Contract

1. **This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of:**

   Uniform Federal Policy for Quality Assurance Project Plans, EPA-505-B-04-900A (U.S. Environmental Protection Agency [EPA], 2005)

   Guidance for Quality Assurance Project Plans, EPA QA/G-5 (EPA, 2002)

   Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (EPA, 2006).

2. **Identify regulatory program:**

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

3. **This SAP is specific to:**

   Mere Brook and Merriconeag Stream Groundwater-Surface Water Interface Investigation

4. **List dates of scoping sessions that were held:**

Scoping Session	Date
Sampling Design	July 29, 2010
Sampling Techniques	August 11, 2010

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

   None

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

   Maine Department of Environmental Protection (MDEP) – regulatory stakeholder

   EPA Region I – regulatory stakeholder

7. **Lead organization (see Worksheet #7 for detailed list of data users):**

   Department of the Navy (Navy) – Lead Agency

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Todd Bober	Remedial Project Manager (RPM)	NAVFAC MIDLANT	215-897-4911	todd.bober@navy.mil
Paul Burgio	Base Environmental Coordinator	NAVFAC MIDLANT	215-897-4915	paul.burgio@navy.mil
Mike Fagan	Environmental Engineer	NAS Brunswick	207-921-1720	TBD
Joe Gallant	Construction Manager	NAS Brunswick	207-921-1720	TBD
David Barclift	Technical Support Branch	NAVFAC BRAC PMO NE	215-897-4913	david.barclift@navy.mil
Jennifer Wright	Biologist, Environmental Technical Support	NAVFAC Atlantic	757-322-8428	jennifer.h.wright@navy.mil
Ken Bowers	Chemist/ Quality Assurance Officer (QAO)	NAVFAC MIDLANT	757-322-8341	ken.bowers@navy.mil
Michael J. Daly	RPM	EPA Region 1	617-918-1386	daly.mike@epa.gov
Bill Brandon	Stakeholder	EPA Region 1	617-918-1386	Brandon.Bill@epamail.epa.gov
Claudia B. Sait	RPM	MEDEP	207-287-7713	claudia.b.sait@maine.gov
Chris Evans	Project Geologist	MEDEP	207-287-7656	Gordon.C.Evans@maine.gov
Carolyn Lepage	Technical Advisor to Brunswick Area Citizens for a Safe Environment (BACSE)	BACSE	207-777-1049	calpage@roadrunner.com
Victoria Boundy	Planning and Environmental Manager	Maine Resource Recovery Association	207-798-6512	TBD
Venky Venkatesh	Project Manager (PM)	AGVIQ-CH2M HILL	216-235-8613	venky.venkatesh@ch2m.com
Theresa Rojas	Program Quality Manager (PQM) and Quality Assurance Manager (QAM)	AGVIQ-CH2M HILL	678-530-4297	theresa.rojas@ch2m.com
Mike Niebauer	Hydrogeologist/ Maine C.G.	AGVIQ-CH2M HILL	414-847-0254	mike.niebauer@ch2m.com
Kyle Block	Project Geologist	AGVIQ-CH2M HILL	617-626-7013	kyle.block@ch2m.com
Daniel Lavoie	Ecological Risk Assessor	AGVIQ-CH2M HILL	202-290-1455	daniel.lavoie@ch2m.com
Hiroshi	Human Health Risk	AGVIQ-	281-721-	hiroshi.awata@ch2m.com

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Awata	Assessor	CH2M HILL	8487	
Megan Morrison	Project Chemist	AGVIQ-CH2M HILL	703-376-5053	megan.morrison@ch2m.com
Monica Martin	UFP-SAP Coordinator	AGVIQ-CH2M HILL	314-335-3026	monica.martin@ch2m.com
TBD	Field Team Leader (FTL)	AGVIQ-CH2M HILL	TBD	TBD
TBD	Field Team Members	AGVIQ-CH2M HILL	TBD	TBD
Mark Warren	QAO	Accutest	508-481-6200	markw@accutest.com
Kristen Blanchard	PM	Accutest	508-481-6200	kristenb@accutest.com
TBD	PM	Drilling Subcontractor	TBD	TBD
TBD	PM	Transportation and Disposal (T&D) Subcontractor	TBD	TBD

SAP Worksheet #4—Project Personnel Sign-Off Sheet

Each organization will read the SAP and provide an original copy of the sign-off sheet to the PM for maintenance in the central project file.

Name	Title/Role	Telephone Number	Signature/E-mail Receipt	Date SAP Read
Accutest				
Kristen Blanchard	PM	508-481-6200		
Mark Warren	Laboratory QAO	508-481-6200		
Drilling Subcontractor (TBD)				
TBD	PM	TBD		
T&D Subcontractor (TBD)				
TBD	PM	TBD		
AGVIQ-CH2M HILL				
Venky Venkatesh	PM	216-235-8613		
Theresa Rojas	PQM and QAM	678-530-4297		
Mike Niebauer	Hydrogeologist/Maine C.G.	414-847-0254		
Dan Lavoie	Ecological Risk Assessor	202-290-1455		
Hiroshi Awata	Human Health Risk Assessor	281-721-8487		
Megan Morrison	Project Chemist	703-376-5053		
Monica Martin	UFP-SAP Coordinator	314-335-3026		
FTL/Site Safety Coordinator (SSC)		TBD		
Field Team Members		TBD		

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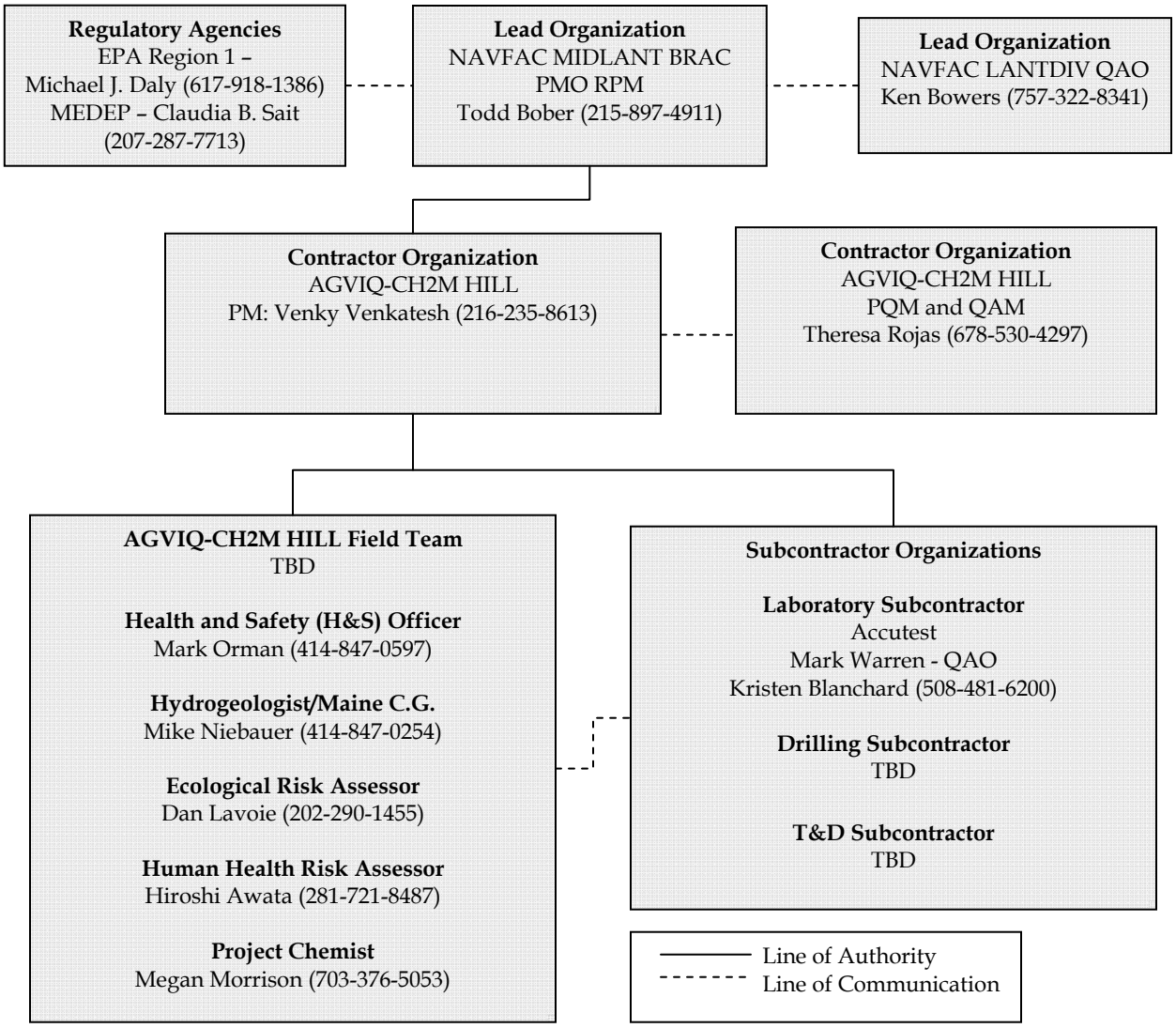
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication with Navy (lead agency)	RPM	Todd Bober	215-897-4911	Primary point of contact (POC) for Navy; can delegate communication to other internal or external points of contact. Any issue that may impact project work should be reported to Todd immediately.
Communication with USEPA (regulatory agency)	RPM	Michael Daly	617-918-1386	Primary POC for EPA; can delegate communication to other internal or external points of contact. Upon notification of field changes, EPA will have 24 hours to approve or comment on the field changes.
Communication with MEDEP (regulatory agency)	RPM	Claudia Sait	207-287-7713	Primary POC for MEDEP; can delegate communication to other internal or external points of contact. Upon notification of field changes, MEDEP will have 24 hours to approve or comment on the field changes.
Management of Investigation Implementation	PM	Venky Venkatesh	216-235-8613	Primary modes of communication are phone, email, letter, document submittal; timing dependent on nature of communication and predefined schedules as applicable and as requested by stakeholder agencies.
Oversight of Navy SB RAC Program implementation	PQM/QAM	Theresa Rojas	678-530-4297	PQM disseminates Program quality management procedures to PMs. PM is responsible for implementation of Program quality management at project level. Provides project delivery support and program level approval of UFP-SAP; responsible for performing or reviewing audit results and CAs.
Technical communications for UFP-SAP implementation, data interpretation	Hydrogeologist/ Maine C.G.	Mike Niebauer	414-847-0254	Contact senior consultants regarding questions/issues encountered in the field, input on data interpretation, as needed. Senior consultants will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via email or phone.
	Ecological Risk Assessor	Dan Lavoie	202-290-1455	
	Human Health Risk Assessor	Hiroshi Awata	281-721-8487	
Health and Safety (H&S)	SSC	TBD		Responsible for the adherence of team members to the site safety requirements described in the Health and Safety Plan (HSP). Will report H&S incidents and near losses to PM.
Quality Assurance Project Plan (QAPP) Field Changes	FTL	TBD		Notify the PM by phone and email of changes to the SAP made in the field and the reasons within 24 hours. Documentation of deviations from the Work Plan will be kept in the field logbook; deviations made only with the approval of the contractor PM.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Data tracking from collection through upload to database	Project Chemist	Megan Morrison	703-376-5053	Project Chemist will track data from sample collection through upload to the database, ensuring Work Plan requirements are met by laboratory and field staff. Project Chemist will act as main POC for laboratory QAO. Laboratory issues will be reported to the PM within 4 hours.
Field Corrective Action (CA)	FTL	TBD		The need for CA for field and analytical issues will be determined by the FTL and/or senior consultants. The senior consultants will ensure SAP requirements are met by field staff. The FTL will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA.
Analytical CAs/ release of analytical data	Project Chemist	Megan Morrison	703-376-5053	The need for CA by the analytical laboratory will be determined by the Project Chemist. The Project Chemist will ensure QAPP requirements are met by the laboratory. No analytical data can be released until data usability is completed and approved by the Project Chemist.
Reporting laboratory data quality issues	Laboratory QAO or PM	Mark Warren/ Kristen Blanchard	508-481-6200	All Quality Assurance/Quality Control (QA/QC) issues with project field samples will be reported within 1 day to the Project Chemist (Megan Morrison) by the laboratory. Should analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data such that the project completeness goal cannot be obtained, the project chemist will notify the project team including the Navy RPM and Navy QAO.
Reporting data quality issues	Data Validator	Megan Morrison	703-376-5053	The data validator reviews and qualifies analytical data as necessary. The data along with a validation narrative are completed within 14 calendar days.

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Todd Bober	RPM	NAVFAC MIDLANT	Coordinates the work of Navy resources to accomplish goals and policies at NAS Brunswick
Venky Venkatesh	PM	AGVIQ-CH2M HILL	Manages project; directs and oversees project staff. PM is responsible for implementation of Program quality management.
Theresa Rojas	PQM/Navy Small Business Response Action Contract QAM	AGVIQ-CH2M HILL	PQM disseminates Program quality management procedures to PMs. PM is responsible for implementation of Program quality management at project level. Provides project delivery support and program level approval of UFP-SAP; responsible for performing or reviewing audit results and CAs.
Mike Niebauer	Hydrogeologist/ Maine C.G.	AGVIQ-CH2M HILL	Determines monitoring well and piezometer locations, depths, and construction details based on interpretation of geology and hydrogeologic regime. Evaluates geologic and hydrogeologic data collected.
Dan Lavoie	Ecological Risk Assessor	AGVIQ-CH2M HILL	Contributes to the development of sampling design. Evaluates and documents ecological chemicals of concern (COCs) data.
Hiroshi Awata	Human Health Risk Assessor	AGVIQ-CH2M HILL	Contributes to the development of sampling design. Evaluates and documents human health chemicals of concern (COCs) data
Megan Morrison	Project Chemist	AGVIQ-CH2M HILL	Assists in SAP preparation, manages sample tracking, coordinates laboratory subcontractors, and performs data validation
Monica Martin	Project Engineer	AGVIQ-CH2M HILL	UFP-SAP coordination
FTL		AGVIQ-CH2M HILL	Coordinates all field activities and sampling; tracks, stores, and retrieves all laboratory and field supplies
Mark Orman	H&S Officer	AGVIQ-CH2M HILL	Prepares HSP; manages H&S for all field activities
SSC		AGVIQ-CH2M HILL	Oversees H&S for all field activities
Kristen Blanchard	Laboratory PM	Accutest	Manages samples tracking and maintains communication with Project Chemist and EIS
Mark Warren	Laboratory QAO	Accutest	Responsible for audits, CA, checks of QA performance within the laboratory

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SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/ Certificates
Groundwater-Surface Water Interface Investigation	Hazardous Waste Operations and Emergency Response 40-hour training or 8-hour annual refresher, as appropriate	Registered training organization	Agency- and contractor-specific	FTL (TBD), field team members (TBD), SSC (TBD); Navy and regulatory agency representatives	Field team members SSCs from AGVIQ-CH2M HILL; onsite visitors from Navy and regulatory agencies	Contractor, Navy, or regulatory agency human resources department
Groundwater-Surface Water Interface Investigation	Site Safety Coordinator (SSC) – Hazardous Waste	Registered training organization	Agency-specific	SSC	SSC from AGVIQ-CH2M HILL	Contractor human resources department

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

Project Name: Groundwater-Surface Water Interface Investigation at Mere Brook and Merriconeag Stream **Projected Date(s) of Sampling:** Fall 2010 **PM:** Venky Venkatesh – AGVIQ-CH2M HILL	**Site Name:** Mere Brook and Merriconeag Stream **Site Location:** NAS Brunswick, Brunswick, Maine
Date of Session: July 29, 2010 **Scoping Session Purpose:** Discuss sampling design.	

Name	Project Role	Affiliation	Phone #	E-mail Address
Todd Bober	RPM	NAVFAC MIDLANT	215-897-4911	todd.bober@navy.mil
David Barclift	Technical Support Branch	NAVFAC BRAC PMO NE	215-897-4913	david.barclift@navy.mil
Venky Venkatesh	PM	AGVIQ-CH2M HILL	216-235-8613	venky.venkatesh@ch2m.com
Mike Niebauer	Hydrogeologist/ Maine C.G.	AGVIQ-CH2M HILL	414-847-0254	mike.niebauer@ch2m.com

Objective:

The objective was to discuss the sampling design for the groundwater-surface water interface investigation at Mere Brook and Merriconeag Stream.

Overview:

Prior to the scoping session, the Navy provided comments on a technical memorandum AGVIQ-CH2M HILL submitted to the Navy proposing no additional sampling with the exception of additions to the long-term monitoring (LTM) program for additional sampling at Mere Brook and Merriconeag Stream to resolve uncertainties with the existing data in these areas. The scoping session consisted of a discussion regarding the type of sampling to be performed, which was defined to be groundwater, pore water, surface water, and sediment sampling at Mere Brook and Merriconeag Stream.

Path Forward:

AGVIQ-CH2M HILL will develop, in detail, the sampling design discussed in general during the scoping session including; defining proposed sampling locations, media to be sampled, rationale for the sampling locations, and sample collection methods.

Action Items:

AGVIQ-CH2M HILL: Submit a technical memorandum describing the sampling design, including; proposed sampling locations, media to be sampled, and methods, as well as the rationale for the sampling design.

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

Project Name: Groundwater-Surface Water Interface Investigation at Mere Brook and Merriconeag Stream **Projected Date(s) of Sampling:** Fall 2010 **PM:** Venky Venkatesh – AGVIQ-CH2M HILL	**Site Name:** Mere Brook and Merriconeag Stream **Site Location:** NAS Brunswick, Brunswick, Maine

Date of Session: August 11, 2010

Scoping Session Purpose: Discuss sampling techniques.

Name	Project Role	Affiliation	Phone #	E-mail Address
David Barclift	Technical Support Branch	NAVFAC BRAC PMO NE	215-897-4913	david.barclift@navy.mil
Venky Venkatesh	PM	AGVIQ-CH2M HILL	216-235-8613	venky.venkatesh@ch2m.com
Jennifer Wright	Technical Support	NAVFAC Atlantic	757-322-8428	jennifer.h.wright@navy.mil
Mike Niebauer	Hydrogeologist/ Maine C.G.	AGVIQ-CH2M HILL	414-847-0254	mike.niebauer@ch2m.com
Dan Lavoie	Ecological Risk Assessor	AGVIQ-CH2M HILL	202-290-1455	daniel.lavoie@ch2m.com
Monica Martin	Project Engineer	AGVIQ-CH2M HILL	314-335-3026	monica.martin@ch2m.com

Objective:

The objective was to discuss the passive sampling method(s) to be used to collect pore water samples.

Overview:

The Navy indicated that they were anticipating that a series of passive diffusion bags (PDBs) would be proposed as the method for collecting all pore water samples (at multiple depth intervals) rather than collecting pore water samples at deeper intervals using the well-point method. The participants discussed the limitations associated with the PDBs, including the need to have more than one PDB at a given depth interval to collect samples for analysis of volatile organic compounds and 1,4-dioxane and not being able to collect monitored natural attenuation parameters with this sampling method. AGVIQ-CH2M HILL also clarified that the well-point method is a passive sampling method. For these reasons, the participants decided that all pore water samples would be collected using the well-point method.

Path Forward:

The well-point method will be the sampling method for all pore water samples collected during this investigation.

Action Items:

AGVIQ-CH2M HILL: Submit a revised technical memorandum to the Navy that specified the well-point method will be used to collect pore water samples at all depth water intervals.

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

Project Name: Groundwater-Surface Water Interface Investigation at Mere Brook and Merriconeag Stream **Projected Date(s) of Sampling:** Fall 2010 **PM:** Venky Venkatesh – AGVIQ-CH2M HILL	**Site Name:** Mere Brook and Merriconeag Stream **Site Location:** NAS Brunswick, Brunswick, Maine

Date of Session: September 10, 2010

Scoping Session Purpose: Discuss sampling design and techniques.

Name	Project Role	Affiliation	Phone #	E-mail Address
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Carolyn Lepage	Stakeholder	Lepage Environmental, Advisors for BACSE	207-777-1049	calpage@roadrunner.com
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Monica Martin	Project Engineer	AGVIQ-CH2M HILL	314-335-3026	monica.martin@ch2m.com

Objective:

The objective was to discuss the sampling design and methods for the groundwater-surface water interface investigation at Mere Brook and Merriconeag Stream.

Overview:

MEDEP, EPA, and Lepage Environmental, Advisors for BACSE provided input on the sampling design and methods based on review of the technical memorandum submitted by the Navy that summarized the proposed groundwater-surface water interface sampling at Mere Brook and Merriconeag Stream.

EPA and MEDEP inquired as to whether the use of a manometer was to determine the sampling locations or if it was an informational tool. AGVIQ-CH2M HILL explained that it was proposed in the technical memorandum as an informational tool but agreed there was value to using it to identify sampling locations.

Lepage Environmental, Advisors for BACSE asked whether the pore water methods (well-point and MEDEP method) would be compared at each location and if the well-point method has been used in this environment before. AGVIQ-CH2M HILL clarified that the comparison of methods would be done at two sampling locations, at multiple depth intervals. The plan is to target the confluence area for this comparison. The well-point method has been used at two sites with similar environments, one of which the results are available. The results showed there were no contamination issues with the data.

MEDEP discussed the need for a contingency plan for sampling if a rain event occurs before or during the planned sampling event. Attendees agreed with the approach of moving forward with installing all of the temporary points and waiting to sample until the site conditions no longer reflect a wet weather event.

MEDEP suggested that sampling locations be moved or added to capture the area north of Merriconeag, near PW-EP-02. AGVIQ-CH2M HILL explained that sampling was considered in this area but was not proposed in this area since the location has shown to be an isolated area of contamination and continues to be sampled in the long term monitoring. MEDEP indicated that the sampling program should target detections rather than non-detects and said MEDEP would take a closer look at this area to determine whether the agency will recommend sampling in this area.

Lepage Environmental, Advisors for BACSE indicated that there is a geologic component missing from the streambed and banks. It was agreed that lithology would also be obtained for qualitative purposes from the shallow sediment locations.

EPA and MEDEP pointed out that SW-12 as shown on the figure in the technical memorandum may likely be in the stream channel rather than in the confluence area. AGVIQ-CH2M HILL clarified that the intent is to collect samples from locations that meet the defined objectives and will be adjusted based on site conditions.

MEDEP asked whether the Encore sampling method would be used for sediment collected for VOC analysis. AGVIQ-CH2M HILL indicated that sampling larger intact samples would be more advantageous allowing an intact sample to be extracted by the lab from the center of the sample. The method proposed has been considered successful in the past.

Lepage Environmental, Advisors for BACSE asked whether the sampling was driven by the Tiger Team Report. The Navy explained that the Tiger Team Report was considered and that at least two Tiger Team members were consulted, but that the sampling is being done in response to input from the Restoration Advisory Board and stakeholders that additional sampling is needed.

The attendees discussed the analyses proposed for sediment samples that will be collected and agreed that total organic carbon and grain size will also be collected for analysis. AGVIQ-CH2M HILL clarified that moisture content will be measured as part of the VOC analysis already planned.

MEDEP and EPA suggested that MNA parameters be analyzed for samples collected from proposed monitoring well location MW-340 (to be revised to MW-360) and that either MW-313 or MW-354 be sampled for VOC, 1,4-dioxane, and MNA parameters. The changes were agreed upon by meeting participants. The objective of installing and sampling proposed monitoring

well MW-341 (name will be revised to MW-361) was unclear to MEDEP and EPA. AGVIQ-CH2M HILL explained that MW-341 was proposed based on the recommendations in the 2008 Summary Report by ECC and indicated the location would either removed from the sampling program or moved to a different location.

It was agreed upon that proposed pore water sampling location GSI-14 would be moved to the north so it is closer to PW-EP-03.

Path Forward:

The following items will be incorporated into the UFP-SAP based on the discussions and agreements made during the scoping session:

- A manometer will be used in the four areas to be sampled to identify upwelling locations and proposed sample locations will be adjusted from those that are proposed to bias the sampling to these site conditions. Shallow groundwater points will be installed first in each area.
- Lithologic data will be collected from the shallow sediment near where pore water will be collected for qualitative purposes.
- Clarification will be included in the UFP-SAP to indicate that surface water sampling locations (particularly near the confluence area) will be adjusted in the field based on site conditions so that the samples are collected from the confluence rather than from in the stream channel.
- A contingency plan will be included for sampling if a rain event has just occurred or is occurring when fieldwork is scheduled.
- Sediment samples will be analyzed for total organic carbon and grain size as well as volatile organic compounds (VOCs) and 1,4-dioxane. Moisture content will be measured as part of the VOC analysis.
- Either existing monitoring well MW-313 or MW-354 will be sampled for analysis of VOCs, 1,4-dioxane and monitored natural attenuation (MNA) parameters.
- Proposed monitoring well MW-340 (MW ID will be revised to MW-360) will be sampled and analyzed for MNA parameters as well as VOCs and 1,4-dioxane.
- Proposed monitoring well MW-341 (name will be revised to MW-361) will be removed from the sampling program or relocated.
- Proposed pore water sampling location GSI-14 will be adjusted so that it is near PW-EP-03.
- Clarification will be included in the UFP-SAP when describing the pore water sampling apparatus
- References will be reviewed and revised as necessary

Action Items:

AGVIQ-CH2M HILL: Submit the revised draft UFP-SAP to the Navy that incorporates the changes discussed during the scoping session. Subsequent to Navy review and comment, submit the final draft UFP-SAP incorporating Navy comments to MEDEP and EPA for review.

MEDEP: Provide general length of response time of flushing condition after a rain event based on existing information so that the Navy can implement the contingency plan effectively if a rain event occurs when sampling is planned.

SAP Worksheet #10—Problem Definition

Site Description and History

NAS Brunswick is located south of the Androscoggin River between Brunswick and Bath, Maine. NAS Brunswick is an active base owned and operated by the Federal government through the Department of the Navy. In 1987, NAS Brunswick was placed on the National Priorities List and is currently participating in the Navy's Installation Restoration Program. In 2005, NAS Brunswick was included in the Department of Defense (DoD) Base Re-Alignment and Closure (BRAC) list of facilities to be closed. NAS Brunswick will be closed in May 2011 under the BRAC Program and transferred to the state of Maine for industrial, commercial and recreational purposes.

Mere Brook, Merriconeag Stream, and the associated floodplain area are located on the eastern portion of the Eastern Plume, adjacent to the eastern base boundary (Figure 1). The Eastern Plume consists of groundwater contamination resulting from Sites 4, 11, and 13. The Eastern Plume, which is primarily contaminated with volatile organic compounds (VOCs) and 1,4-dioxane, has migrated south and east toward the Mere Brook and Merriconeag Stream along the eastern border of NAS Brunswick. There is evidence that contaminated groundwater is discharging into these bodies of water. The primary objectives of this investigation are to determine the magnitude of contamination discharging to these water bodies and evaluate the potential degradation of the contaminants as the groundwater discharges. This investigation will also assist with the characterization of the geologic and hydrologic conditions at the site and update the conceptual site model (CSM).

Previous Investigations and Ongoing Long-Term Monitoring

Previous investigations show that groundwater contamination from the Eastern Plume has migrated from north to south and west to east into the Mere Brook and Merriconeag Stream floodplain area along the eastern border of NAS Brunswick. However, contaminant concentrations within the Eastern Plume (the source of contamination in the Mere Brook and Merriconeag Stream floodplain area) are declining based on review of trends in groundwater concentrations.

A remedy to mitigate groundwater contamination was selected in the Record of Decision (ROD) in 1998 which includes groundwater extraction and treatment. This system was installed in June of 1995 and is currently still in operating. The groundwater extraction system operates to maintain hydraulic control of the aquifer and the treatment system removes VOCs from groundwater. The Navy is currently performing LTM as part of the remedy to mitigate groundwater contamination.

Previous investigations and ongoing LTM that relate to the investigation detailed in this UFP-SAP are summarized below.

2005 Mere Brook and Merriconeag Stream Pore Water Investigation

Environmental monitoring indicated that the Eastern Plume was migrating into the area of MW-313. In August and September 2005, the Navy, MEDEP, and EPA worked together to perform pore water sampling along a segment of Mere Brook (MEDEP, 2005). The objective of the pore water sampling was to determine whether the Eastern Plume had migrated into

Mere Brook and its associated floodplain in the vicinity of MW-313, Merriconeag Steam, and the combined floodplain.

Pore water samples were collected along the western stream bank of Mere Brook in the vicinity of MW-313. A field gas chromatograph (GC) was used to analyze each of the samples for a target list of VOCs, including; trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE). Laboratory analysis for VOCs and 1,4-dioxane was performed on some of the samples based on field GC results.

VOCs and 1,4-dioxane were detected in pore water samples collected from Mere Brook, Merriconeag Stream, and in associated floodplain areas. Therefore, additional investigation was conducted in 2007 (as described below).

2007 Mere Brook and Merriconeag Stream Investigation

An investigation was initiated in 2007 based on the results of the pore water sampling program within the Mere Brook and Merriconeag Stream floodplain area conducted in 2005 (MEDEP, 2005). Previous environmental monitoring indicated that contaminated groundwater from the Eastern Plume was migrating east toward Mere Brook and Merriconeag Stream.

The objectives of the 2007 investigation included the following:

- Determine the extent of the Eastern Plume VOC migration to surface water within the vicinity of Mere Brook and Merriconeag Stream confluence and associated floodplains; and
- Refine understanding of localized subsurface geology and flow regime within the vicinity of Mere Brook and Merriconeag Stream confluence and associated floodplains.

Results of the pore water sampling program confirmed that constituents of the Eastern Plume were migrating into the Mere Brook and Merriconeag Stream area. Sample results indicated the highest concentrations of contaminants were located within the area of the Mere Brook and Merriconeag Stream confluence and the associated floodplain to the north. These concentrations are in exceedance of MEDEP Maximum Exposure Guidelines (MEGs) and/or Federal Maximum Contaminant Levels (MCLs) for groundwater.

The field investigation was conducted between February and September 2007. The field program consisted of advancement of soil borings, discrete interval groundwater sampling, installation of 48 piezometers and 18 monitoring wells, groundwater sampling, a groundwater elevation survey, and surveying of the newly installed piezometers and monitoring wells.

Supplemental Remedial Investigation, August 2008 through January 2010

A Supplemental remedial investigation (RI) was conducted from August 2008 through January 2010 to characterize the extent of 1,4-dioxane and chlorinated VOCs in the overburden of the Eastern Plume and in the underlying bedrock in the vicinity of a bedrock knob at monitoring well MW-308. The Navy undertook the Supplemental RI to obtain information ultimately to support evaluation of remedial alternatives to address 1,4-dioxane contamination in the Eastern Plume, which was not addressed previously. Activities included collection of lithology data, electrical conductivity lithology profiling and associated discrete-interval sampling, bedrock borehole geophysics and bedrock monitoring well installation, overburden monitoring well

construction, pore water sampling, water level gauging, monitoring well sampling, and hydraulic conductivity testing.

The results indicated that groundwater flow in the Upper Sand and Transition Unit is generally in a southeasterly direction toward Merriconeag Stream and Mere Brook in the area north of Mere Brook. South of Mere Brook, groundwater flow is in an easterly direction toward Mere Brook. The confluence is a significant groundwater discharge area. The Lower Sand is confined or semi-confined by the overlying silt and clay layers of the Transition Unit. Groundwater in the Lower Sand migrates in a southerly direction and then shifts to the southeast as it approach the confluence from the north. Data suggests source removals and natural attenuation have effectively depleted nearly all the residual fuels and solvents in the source areas at Sites 4, 11, and 13 so these areas no longer ongoing sources for the Eastern Plume. However, residual contamination within the fine-grained statigraphy of the Transition Unit remains in the Eastern Plume. 1,4-Dioxane exceedances mainly occurred to the north in the vicinity of extraction well EW-05B, and also near and south of the Mere Brook-Merriconeag Stream confluence, with concentrations increasing toward Mere Brook. The bedrock investigation in the vicinity of MW-308 confirmed the presence of chlorinated VOCs in bedrock at concentrations with concentrations decreasing with depth.

Long-Term Monitoring

The Navy is currently performing LTM, maintenance, and corrective measures at the Eastern Plume as part of the long-term remedial actions required by the *ROD for No Further Action at Sites 4, 11, and 13 and Remedial Action for the Eastern Plume* (ABB Environmental Services, Inc. [ABB-ES], 1998) and Explanation of Significant Differences (ESD) for the Eastern Plume (Navy, 2010).

The current Long-Term Monitoring Plan (LTMP) was developed to support the Navy's overall strategy for remediation at NAS Brunswick, Eastern Plume. The objective of the LTMP is to obtain data necessary to assess the long-term effectiveness of the remedial actions conducted at the Eastern Plume. The remedial action objectives include:

- Minimizing further migration of the Eastern Plume
- Minimizing any further negative impact to surface water resulting from discharge of contaminated groundwater
- Reducing the potential risk associated with ingestion of contaminated groundwater to acceptable levels
- Restoring the aquifer

Monitoring and sampling data collected during LTM events are being used to:

- Assess the ambient groundwater and surface water quality conditions by collecting samples to monitor trends and assess effectiveness of remedial actions
- Evaluate the effectiveness of the groundwater extraction system by assessing trends in the concentrations of VOCs in groundwater within the boundaries of the Eastern Plume and to provide recommendations to improve system effectiveness

- Analyze the effective capture zone of the groundwater extraction system at the Eastern Plume to determine the degree of hydraulic control achieved through remedial pumping

The groundwater system will continue to be monitored in accordance with the most recent LTMP (ECC, 2008b).

Conceptual Site Model

Figure 2 presents a generalized conceptual site model of the Site. Various elements of the CSM are discussed below. The CSM will be refined as necessary after additional data proposed for collection in this UFP-SAP are collected and evaluated.

Potential Contaminant Transport Pathways

Geological, hydrogeological, and analytical data indicate that contaminants of the Eastern Plume are migrating from north to south and from west to east into the Mere Brook and Merriconeag Stream floodplain area via the lower sand unit. As the lower sand unit approaches the floodplain area, it rises in elevation following the top of clay. The lower sand unit thins and gradually pinches out. Groundwater from the lower sand unit is forced upward, diffusing through the sand and silty sand layers of the transition zone into the upper sand unit, eventually discharging into the floodplain area and ultimately into Mere Brook and/or Merriconeag Stream. On the eastern side of Mere Brook and Merriconeag Stream, historical data indicate the continued increase in elevation of the confining clay layer and bedrock from a natural barrier that inhibits contaminant migration to the east.

Potential Receptors and Exposure Pathways

The potentially complete exposure pathways were identified for human and ecological receptors based on information from previous investigations, considering current and reasonably foreseeable future land uses.

Mere Brook and Merriconeag Stream are significant, well-established flowing water bodies. As such, they represent viable aquatic habitats that are expected to maintain a variety of ecological receptor populations, such as benthic macroinvertebrates (e.g., insects and worms), fish and other aquatic biota (e.g., plankton, aquatic plants). Therefore, there is a potential for these populations to be exposed to Eastern Plume constituents migrating to these water bodies. Because people may use these surface water bodies for recreational fishing purposes, potential recreational fishers can be exposed to site-related constituents in surface water and sediment in these water bodies through dermal contact, incidental ingestion, and inhalation of volatiles. However, the degree of exposures is likely insignificant because of the limited skin surface area coming into contact with the exposure media, and short duration and infrequent nature of the exposure. In addition, these potential receptors may be indirectly exposed to site-related constituents through the consumption of fish contaminated by plume constituents. Furthermore, since there is potential for future "mixed use" of this area, it is possible for potential residential receptors to be exposed to site-related constituents in groundwater and/or surface water through ingestion and dermal contact, and inhalation during household water uses when they are used as a source of potable water in the future. Also, these potential future residents in buildings above groundwater contaminated with VOCs could be exposed through migration of VOCs from groundwater to indoor air, followed by inhalation exposure.

Data Quality Objectives

Site-specific data quality objectives (DQOs) were developed to address the data gaps and uncertainties identified in the CSM and to meet the investigation objectives, using the EPA seven-step process (EPA, 2006a). Table 10-1 summarizes the DQOs for this investigation.

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TABLE 10-1
Data Quality Objectives

Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
Problem: 1. Lack of investigation in four areas suspected of discharging groundwater to surface water to determine whether levels of contamination in groundwater are migrating into the Merriconeag Stream and Mere Brook. 2. Limited evaluation of potential exposures and risks for human health and ecological receptor populations 3. Limited evaluation of potential natural attenuation (degradation) of groundwater contaminants in groundwater/surface water interface (GSI) discharge zones 4. Incomplete characterization of geologic and hydrogeologic conditions at the site. ***Conceptual Site Model.*** Previous investigations suggest Eastern Plume contamination is discharging at the groundwater-surface water interface of Mere Brook and Merriconeag Stream, which are viable aquatic habitats expected to maintain a variety of ecological receptor populations (e.g., benthic macroinvertebrates, fish and other aquatic biota). There is potential for receptor exposures to Eastern Plume constituents migrating to these water bodies. There is also potential for human use of these water bodies for recreational fishing; therefore, exposure through contaminated fish consumption, as well as dermal contact, incidental ingestion, and inhalation of constituents in surface water and sediment may occur. Furthermore, a potential for future "mixed use" of the area, yields potential human exposure to groundwater and/or surface water constituents when they are used as a source of potable water in the future and/or indoor air exposure scenarios. Evidence of breakdown products of plume constituents suggests natural attenuation (degradation) of the contamination is occurring. ***General intended use of collected data.*** The data in this study will be used to determine if the levels of contamination in groundwater are migrating into the Merriconeag Stream and Mere Brook, and if so, whether or not natural attenuation is occurring and if current conditions suggest potential unacceptable risks to human and	***Principal study questions (numbered to align with stated problems in Step 1):*** 1. A. What are the concentrations of Eastern Plume constituents across the migration pathway (groundwater → pore water/sediment → surface water)? B. Are concentrations of Eastern Plume constituents detected in groundwater (deep, shallow) and pore water samples greater than action levels? C. Does the data support that groundwater is discharging to surface water? 2. Are concentrations of detected Eastern Plume constituents across the migration pathway representative of potential exposure risks for current or future: A. human health receptor populations?; and/or B. ecological receptor populations? 3. Is natural degradation of Eastern Plume constituents occurring across the migration pathway? 4. Are the geologic and hydrogeologic conditions consistent with the existing CSM?	***Information needed to answer the study questions (parenthetical numbers indicate to which Step 2 study question these inputs relate):*** • Historic data – used to develop current understanding of groundwater contamination and identify problem (Step 1), formulate study questions and propose additional investigation. • Eastern Plume contaminant data (VOCs and 1,4-Dioxane) from new samples (listed in order of site-stream migration pathway): o Deep groundwater (1A-B, 2A) – Lower sand; lower portion of the aquifer. o Shallow groundwater (1A-B, 2A) - Upper Sand; area between the lower sand and the surface water. o Pore water (1A-B, 2A-B) – up to three intervals (shallow, intermediate and deep); includes measures of: - *Vertical hydraulic pressure* - characterize potential upwelling/ downwelling conditions; and - *Water quality parameters* - pH, specific conductance, temperature, oxidation-reduction potential, turbidity, total dissolved solids, and dissolved oxygen. o Surface sediments (1A-B, 2B) – in sample zones; and o Surface water (1A-B, 2A-B) – co-located with sediment; includes standard water quality parameters (see *pore water*). • Monitored natural attenuation (MNA) parameters (*shallow groundwater and shallow pore water only*) (3) - measures of dissolved iron and manganese, nitrate, sulfate, methane, ethane, ethane, and total organic carbon. ***Action levels[1]:*** • Water (groundwater, surface water, pore water) – Maine Center for Disease Control Maximum Exposure Guidelines (MEGs), Federal Maximum Contaminant Levels (MCLs), EPA Regional Screening Levels (RSLs) (May 2010) for tap water, Groundwater Screening Levels for Protection of Indoor Air (EPA, 2002), National Recommended Water Quality Criteria (for consumption of water and organisms), Ecological Target Quantitation Limits, and Eastern Plume Groundwater Remediation Goals. Details on how water-based PALs will be applied are discussed on Worksheet #11. Specific PALs are listed on Worksheet #15.	***Target Populations:*** • Potential current and future receptor populations (as detailed in Worksheet 11): o Humans – potential exposure to constituents in groundwater and/or surface water when they are used as a source of potable water in the future (ingestion, dermal contact, and inhalation), consumption of contaminated fish, dermal contact, incidental ingestion, and inhalation of constituents in surface water and sediment, and/or inhalation of indoor air affected by VOCs in groundwater. o Ecological receptors (aquatic biota) - potential direct exposure to constituents at the GSI (pore water, sediment) or the water column (surface water). ***Spatial:*** Project area defined as follows: • Lateral – From site to adjacent surface water bodies (Mere Brook and Merriconeag Stream) in four representative areas where Eastern Plume constituents are suspected of migrating across and potentially discharging based on previous investigation and hydrogeological conditions: 1. Northern extent of discharge zone in Merriconeag Stream; 2. Confluence area of the Mere Brook/ Merriconeag Stream; 3. Eastern seep area of Mere Brook; and 4. Southern extent of discharge zone in Merriconeag Stream • Vertical – o Surface water samples will be collected from within 6 inches of sediment surface; o Sediment samples will be collected from 0 to 6 inches of surface sediment; o Pore water samples will be collected in up to three intervals in subsurface sediment: shallow	As related to principal study questions: 1. If chlorinated VOCs and/or 1,4-dioxane are detected in new samples collected from site-related media at the groundwater-surface water interface in Mere Brook and Merriconeag Stream, then it will be concluded that such constituents are related to Eastern Plume discharges and the hydrological CSM will be refined as necessary. 2. If concentrations of detected constituents from relevant exposure media (e.g., ground water, pore water, sediment, surface water) exceed respective benchmarks (e.g., action levels on Worksheet #15), then it will be concluded that there is a potential for unacceptable risks for receptor populations corresponding to the exposure media/benchmark exposure combinations and a decision will be required regarding if further investigation or evaluation is needed to determined actual risks.	Chemical analytical data used to indicate the presence of plume constituents at the groundwater-surface water interface cannot be used in isolation to characterize the overall severity of discharges. Hydrological information such as hydraulic pressure gradients, frequency/ magnitude of detection, location and depths of detection across the vertical profile (e.g., pore water intervals, groundwater), and MNA parameters must be considered collectively to interpret study results and answer the study questions. Exceedance of project action limits cannot be used in isolation to determine site-wide risks for identified receptor populations. All exposure media and corresponding criteria or benchmark must also be considered with the above-mentioned factors to appropriately identify and qualify potential site-related risks.	***Select the sampling design.*** See Worksheet 17 for the sampling design and rationale based on these DQOs.

[1] "Action levels" in this context refer to constituent concentrations which serve as basis for laboratory quantitation. These levels might also represent thresholds for identifying potential human health or ecological risks as discussed in further worksheets. They are not considered "clean-up" levels for Merriconeag Stream and Mere Brook.

TABLE 10-1
Data Quality Objectives

Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
ecological receptor populations.			(2 to 8 inches) and intermediate (8 to 14 inches) intervals at all locations, and in the deep interval (14 to 26 inches) at select locations; o Deep groundwater samples will be collected from wells installed in the Lower sand (40 to 50 feet below ground surface);			
		• Sediment - EPA RSLs (May 2010) for residential soil and Ecological Target Quantitation Limits are listed on Worksheet #15. ***Sampling and analysis methods.*** Sampling procedures will be performed in accordance with the SOPs cited on Worksheet 21 and presented in Attachment B.	o Shallow groundwater samples will be collected from temporary wells (7 to 12 feet below ground surface) and a permanent well (5 to 15 feete below ground surface) from the Upper sand in areas between the site and the pore water locations in Mere Brook and Merriconeag Stream. ***Temporal:*** Previous sample data and new (proposed) sample data will provide information needed to evaluate changes over time.	3. If the relative concentrations of detected Eastern Plume constituents in deep groundwater vs. shallow groundwater/pore water plus natural attenuation parameter measures suggest degradation is occurring, then it will be concluded that natural attenuation of contamination is occurring.		

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

- **Who will use the data?**

The Department of the Navy, the AGVIQ-CH2M HILL project team, including chemists and risk assessors (human health and ecological), and the public will use the data.

- **What are the Project Action Limits (PALs)?**

Project Action Limits (PALs) were set for Eastern Plume constituents of concern and are listed on Worksheets #15-1 (groundwater, surface water, pore water) and 15-2 (sediment). These values are summarized in the following paragraphs.

Federal and State Water Quality Standards

The following State and Federal water quality standards are relevant for aqueous based Eastern Plume constituents of concern (chlorinated VOCs and 1,4-dioxane):

- Maine Center for Disease Control and Prevention (CDC) Maximum Exposure Guidelines (MEGs) for drinking water (Maine CDC, 2010)
- Federal Maximum Contaminant Levels (MCLs; EPA, 2010)

The results from groundwater (shallow and deep) will be compared against appropriate MEGs and MCLs.

Eastern Plume Remediation Goals

The remediation goals defined in the ROD (ABB-ES, 1998) and *Explanation of Significant Differences, Eastern Plume, Naval Air Station Brunswick, Maine* (Navy, 2010) are relevant for aqueous based Eastern Plume constituents of concern (1,1-DCE, 1,1-dichloroethane, cis-1,2-DCE, trans-1,2-dichloroethene, 1,1,1-TCA, TCE, PCE, vinyl chloride, and 1,4-dioxane). The results from groundwater (shallow and deep) will be compared against remediation goals.

Ecological Risk

The Ecological Target Quantitation Limits (ETQLs) presented on Worksheets #15-1 and 15-2 are direct exposure screening values for fresh water surface water and sediment. These are ecotoxicologically-based benchmarks that are presented as targets for which the analytical laboratory has been asked to achieve during analysis, but are also thresholds indicative of effects to aquatic biota. In general, if a constituent is below its respective screening value, it is assumed that it poses little potential risk to ecological receptors and warrants no further investigation. An exceedance of a screening value does not necessarily imply unacceptable risk but rather suggests that further evaluation is necessary to determine if unacceptable risk is actually present. The greater the exceedance of a screening value the more likely adverse effects would be measured. The surface water PALs are appropriate for screening pore water constituent data as well, due to the potential hydrological connection of the groundwater to surface water at the groundwater-surface water interface. That is, it is conservative to screen

pore water with surface water PALs to be protective of aquatic biota in the streams in the event contaminated groundwater is discharged.

The primary source of the ETQLs is the Biological Technical Assistance Group (BTAG), Region 3 Freshwater and Sediment Screening Benchmarks (EPA, 2006). If BTAG Region 3 values were not available, EPA Region 4 values presented in the Supplemental Guidance to RAGS: Region 4 Bulletins (EPA, 2001) were selected. Finally, the screening value selected for TCE was the secondary chronic value (SCV) obtained from the EPA Compendium of Tier 2 Values for Nonionic Organics (EPA, 2008).

Human Health Risk

The groundwater data collected within the Eastern Plume will be compared to EPA RSLs for Tapwater (EPA, 2010) based on a target excess lifetime cancer risk (ELCR) of $1x10^{-6}$ and a non-cancer hazard quotient (HQ) of 0.1. In addition, although no buildings are currently present in the vicinity of the Eastern Plume, the area is designated as "mixed-use" with the potential for housing in the future. However, a deed restriction will be implemented to eliminate groundwater as a potable drinking water source. Since there is a potential for future housing, the shallow groundwater data in upland areas will be compared to screening levels for protection of indoor air (IA GWSLs) to address the hypothetical future residential indoor air exposure scenario. The IA GWSLs were obtained from EPA's draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance) (EPA, 2002). For those chemicals whose IA GWSLs were defaulted to MCL in the EPA's guidance document, the risk-based IA GWSLs provided by EPA Region 1 were used (Attachment E).

Since Mere Brook and Merriconeag Stream are both well-established flowing surface water bodies with viable aquatic habitat, fish populations are expected to be present. However, there is limited potential for anglers to fish at potential plume discharge areas adjacent to the site because the narrow and shallow characteristics of the streams adjacent to the site would limit the amount of sport fish in these areas. Because fishing might occur in deeper, wider reaches of streams downstream of potential discharges, the site-specific surface water data will be compared to EPA's National Recommended Water Quality Criteria (NRWQC) (EPA, 2009) to conservatively assess the potential impact on the downstream locations where such a fishing exposure scenario may be more realistic. The surface water in the stream is not currently used as a potable water source and it is expected that this will not change in the future. However, NRWQC for consumption of water and organism will be used as conservative screening levels. Pore water data characterize the chemical concentrations near the groundwater-surface water interface; therefore, the data will be used for the nature and extent purposes only and will not be screened against the human health screening levels. Based on the current site conditions, the realistic exposure scenarios around the proposed surface water sampling locations are exposures to chemicals in surface water through incidental ingestion and/or dermal contact under recreational/trespasser scenarios. However, due to the lack of screening levels specific to these exposure scenarios, surface water data will also be conservatively compared to EPA RSLs for Tapwater (based on an ELCR of $1x10^{-6}$ and adjusted HQ of 0.1 as described above; EPA, 2010).

The exposure to site-related chemicals in sediment during recreational fishing is expected to be insignificant because of the limited skin surface area coming into contact with sediment, and

short duration and infrequent nature of the activity. However, sediment data will be conservatively compared to EPA RSLs for residential soil (based on an ELCR of $1x10^{-6}$ and adjusted HQ of 0.1 as described above; EPA, 2010).

- **What are the Project Indicator Limits (PILs)?**

Project Indicator Limits (PILs) were set for monitored natural attenuation (MNA) parameters and are listed on Worksheet #15-3. The PILs for MNA parameters will be reviewed using the EPA protocol for evaluating natural attenuation of chlorinated solvents in groundwater (EPA, 1998). The purpose of the evaluation will be to determine if the conditions in the aquifer are sufficient to promote biodegradation of VOCs, particularly chlorinated solvents PCE, 1,1-TCA, and TCE and their associated daughter products.

Additionally, there are no screening criteria for the parameters in Worksheets #15-4 and 15-5. Data will be used to help describe habitat conditions and assist in understanding the spatial distribution and magnitude of contamination in the study area.

- **What will the data be used for?**
- Chemists will use the data to evaluate overall data quality with respect to subcontracted laboratory performance.
- The AGVIQ-CH2M HILL project team will compare detected constituent concentrations from aqueous samples collected across the Eastern Plume migration pathway (groundwater, pore water, surface water) to the remediation goals defined in the ROD (ABB-ES, 1998) and ESD (Navy, 2010) to determine if groundwater concentrations are above remediation goals established for the Eastern Plume.
- AGVIQ-CH2M HILL human health and ecological risk assessors will use the data from relevant sample media to estimate potential exposure levels and calculate whether there are potential unacceptable risks for receptor populations.
- The NAS Brunswick Partnering Team will use the data and the project team's results to communicate levels of contamination, or lack thereof, to the public and what, if any, measures would be appropriate and effective to mitigate site risks.
- **What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?**

Worksheet #17 contains detailed information on the types of data needed for this project, including proposed sample locations and depth intervals. Worksheet #15 details the laboratory analytical protocol.

- **How "good" do the data need to be in order to support the environmental decision?**

QC data requirements are detailed in Worksheet #20.

The offsite analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments of potential risks to human and ecological receptors posed by the contaminants identified. For risk assessment and high-level decisions based on analytical data, laboratory methods will meet CERCLA, EPA Region 1, and Navy guidance. The laboratory will follow the Measurement Performance Criteria (MPC) in Worksheet #12 for field

QC samples and Worksheet #28 for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) version 4.1 as applicable and laboratory in-house limits where the QSM does not apply.

Ten percent of the data will be validated by the project chemist using Level III validation procedures described in Worksheet #36. A data usability study will be conducted following data validation. This process is outlined in Worksheet #37. The remaining 90 percent of the data will be validated by the project chemist at Level I. This includes verification that samples were analyzed for the methods requested and review of the data for outliers and anomalies.

In addition to listing the particular analytes and their PALs, Worksheet # 15 also presents a comparison of selected PALs to analytical quantitation and detection limits. As indicated in Worksheet # 15, the selected risk-based PALs (e.g., Tapwater RSLs) are identified to be lower than limits of detection (LODs) for many analytes. However, this is not expected to adversely affect the ability to make decisions regarding that particular analyte at the site for the following reasons:

- Although LODs are higher than PALs, detection limits (DLs) are closer to or lower than PALs for some analytes. In theory, the laboratory instrument could detect an analyte down to its DL at concentrations that would then be reported as estimated.
- Detections of other constituents within a similar chemical group (e.g., chlorinated VOCs) would aid in determining if residual contamination is present at the site (e.g., chlorinated VOCs commonly occur together).

The uncertainties associated with the chemical data will be considered as part of the risk assessment process. Such uncertainties primarily will be associated with instances of undetected chemicals exhibiting detection limits greater than PALs and/or detected chemicals lacking PALs.

- **How much data should be collected (number of samples for each analytical group and matrix)?**

Detailed information on how much data will be collected is provided on Worksheet #17. Sample locations are provided on Figure 3.

The overall completeness goal for this project is 90 percent. Completeness will be calculated by the project chemist during the data usability assessment.

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

Detailed information on where, when, and how the data will be collected is provided in Worksheet #14.

- **Who will collect and generate the data? How will the data be reported?**

AGVIQ-CH2M HILL field personnel will collect all data subject to this SAP. All laboratory analytical data will be generated by Accutest.

Data collected as part of this investigation will be presented to the NAS Brunswick Partnering Team and formally documented in a subsequent report.

- **How will the data be archived?**

Data will be archived according to procedures dictated via the Navy Small Business Response Action Contract (SB RAC) program; all data will be uploaded into a centralized database used for Navy projects. At the end of the project, archived data will be returned to the Navy.

- **List the project conditions in the form of if/then qualitative and quantitative statements.**

As related to principal study questions presented in Worksheet #10:

1. If chlorinated VOCs and/or 1,4-dioxane are detected in new samples collected from site-related media at the groundwater-surface water interface in Mere Brook and Merriconeag Stream, then it will be concluded that such constituents are related to Eastern Plume discharges and the hydrological CSM will be refined as necessary.

2. If concentrations of detected constituents from relevant exposure media (e.g., groundwater, pore water, sediment, or surface water) exceed respective benchmarks (see project action limits defined on Worksheet #15), then it will be concluded that there is a potential for unacceptable risks for receptor populations corresponding to the exposure media/ benchmark exposure combinations. The uncertainties associated with the chemical data will be considered as part of the risk assessment process. Such uncertainties primarily will be associated with instances of undetected chemicals exhibiting detection limits greater than PALs and/or detected chemicals lacking PALs.

3. If the relative concentrations of detected Eastern Plume constituents in deep groundwater vs. shallow groundwater/pore water plus natural attenuation parameter measures suggest degradation is occurring, then it will be concluded that natural attenuation of contamination is occurring.

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

Matrix:	Aqueous				
Analytical Group:	Select VOCs				
Concentration Level:	Low				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Field Duplicates	Select VOCs	One per 10 field samples	Precision	Relative Percent Difference (RPD) < 25%	S&A
Equipment Rinsate Blank		One per week of sampling	Contamination/bias	All target compounds <1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory containing VOCs			S&A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy / Representativeness	4 ±2°C	S

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

Matrix:	Aqueous				
Analytical Group:	Vinyl chloride (VC) and Tetrachloroethene (PCE)				
Concentration Level:	Select Ion Monitoring (SIM)				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Field Duplicates	VC and PCE	One per 10 field samples	Precision	Relative Percent Difference (RPD) < 25%	S&A
Equipment Rinsate Blank		One per week of sampling	Contamination/bias	All target compounds <1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory containing VOCs			S&A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy / Representativeness	4 ±2°C	S

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

Matrix:	Aqueous				
Analytical Group:	1,4-Dioxane				
Concentration Level:	Low				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Equipment Rinsate Blank	1,4-Dioxane	One per week of sampling	Contamination/bias	All target compounds <1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory containing VOCs			S&A
Field Duplicates		One per 10 field samples	Precision	RPD <25%	S&A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	4 ±2°C	S

SAP Worksheet #12-4— Measurement Performance Criteria Table- Field QC Samples

Matrix:	Sediment				
Analytical Group:	Select VOCs				
Concentration Level:	Low				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Field Duplicates	Select VOCs	One per 10 field samples	Precision	RPD <35%	S&A
Equipment Rinsate Blank		One per week of sampling	Contamination/bias	All target compounds <1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory containing VOCs			S&A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy / Representativeness	4 ±2°C	S

SAP Worksheet #12-5— Measurement Performance Criteria Table- Field QC Samples

Matrix:	Sediment				
Analytical Group:	1,4-Dioxane				
Concentration Level:	Low				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Equipment Rinsate Blank	1,4-Dioxane	One per week of sampling	Contamination/bias	All target compounds <1/2 LOQ	S&A
Trip Blank		One per cooler to the laboratory containing VOCs			S&A
Field Duplicates		One per 10 field samples	Precision	RPD <35%	S&A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	4 ±2°C	S

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Pore Water Sampling Data from Mere Brook and Merriconeag Stream Area, data collected August and September 2005	MEDEP Bureau of Remediation and Waste Management. 2005. *Pore Water Sampling Data from Mere Brook and Merriconeag Stream Area, Naval Air Station Brunswick*.	MEDEP, EPA, and the Navy co-operated in a combined effort to perform pore water sampling along a limited segment of Mere Brook.	Data used to determine the proposed sample locations for the SAP. Data will be used in conjunction with data proposed to be collected in this SAP to assess potential risk to human and ecological receptors.	None known. If more recent analytical data are available from the same general area, historical data with elevated detection limits will not be used in the quantitative risk assessment.
Mere Brook and Merriconeag Stream Floodplain and Upland Area Investigation, data collected between February and September 2007.	ECC. 2008. *Final Summary Report for the Mere Brook and Merriconeag Stream Floodplain and Upland Area Investigation, Eastern Plume, Naval Air Station Brunswick, Maine.*	ECC with agreement from the Navy, MEDEP, and EPA investigated geologic and hydrogeologic conditions, installed temporary piezometers and permanent monitoring wells, and sampled groundwater in the Mere Brook and Merriconeag Stream area in 2007.	Data used to determine the proposed sample locations for the SAP. Data will be used in conjunction with data proposed to be collected in this SAP to assess potential risk to human and ecological receptors.	None known. If more recent analytical data are available from the same general area, historical data with elevated detection limits will not be used in the quantitative risk assessment.
Eastern Plume Long-Term Monitoring data, data collected 1996 through April 2010.	ECC. *Eastern Plume Monitoring Events.*	ECC with agreement from the Navy, MEDEP, and EPA has performed long-term monitoring at the site since 1996.	Data used to determine the proposed sample locations for the SAP. Data may be used in conjunction with data proposed to be collected in this SAP to assess potential risk to human and ecological receptors.	None known. Historical data (e.g., data older than 2-3 years old) will not be used in quantitative risk assessments. Rather, these data will be used qualitatively to assess general trend of site concentrations.
Supplemental RI data for the Eastern Plume, data collected from August 2008 through January 2010.	Tetra Tech NUS, January 2010. *Supplemental Remedial Investigation Report for 1,4-Dioxane in the Eastern Plume and Bedrock*	Tetra Tech NUS with agreement from the Navy, MEDEP, and EPA further investigated the Eastern Plume for VOC and 1,4-dioxane contamination as well as to further refine the conceptual site model.	Data used to confirm the proposed sample locations for the SAP. Data may be used in conjunction with data proposed to be collected in this SAP to assess potential risk to human and ecological receptors.	None known.

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SAP Worksheet #14—Summary of Project Tasks

Applicable SOPs for project tasks outlined in this section are listed on Worksheet #21 and provided in Attachment B.

Mobilization

- Following approval of the SAP, AGVIQ-CH2M HILL will begin mobilization activities. Before mobilization, all field team members will review this SAP and the project-specific Health and Safety Plan (HSP, Attachment A). A field team kickoff meeting will be held to ensure that personnel are familiar with the scope of field activities and safety issues. Mobilization activities include coordination with base personnel and subcontractors, and preparation of field equipment. The three phases of control will be implemented and documented for this Definable Feature of Work (DFOW).
- Mobilization includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the AGVIQ-CH2M HILL field team mobilizes for field activities.
- If a rain event occurs before or during pore water or shallow groundwater sampling, the sampling schedule will be adjusted to ensure that samples are not collected during wet weather conditions.

Before beginning any phase of work, AGVIQ-CH2M HILL and its subcontractors will have field meetings to discuss the work items, worker responsibilities, and familiarize workers with the HSP. Before beginning any intrusive activities, all appropriate approvals will be obtained and the site will be cleared for utilities. AGVIQ-CH2M HILL will coordinate subsurface utility clearances with Dig Safe, Inc. and a third-party utility locate service. No intrusive activities will begin until the utility clearance has been completed.

Vertical Gradient Measurements

- The three phases of control will be implemented and documented for this DFOW.
- A manometer will also be used to measure the hydraulic pressure difference across the proposed pore water sample intervals to attempt to locate conditions characteristic of upwelling (groundwater-to-surface water) at or near the proposed pore water sampling locations. Pore water sampling locations may be adjusted based on site conditions as a result of vertical gradient measurements.
- The field team will attempt a reasonable amount of hydraulic pressure measures across sampling zones (Figure 3) before pore and surface water samples are collected. Because the objective will be to identify upwelling areas from which these samples will be collected, the pre-measured pressure readings will potentially be used to identify final in-stream sampling locations. However, it will not clear until the time of the field investigation if upwelling conditions are even present. Therefore it is not possible to determine how many pressure readings will be made in advance of sampling and/or if pore water samples will also be located at these pressure readings locations.

- The procedures under Section 6.17.7.0 ("*Using a Manometer Board to Measure Hydraulic Heads in Piezometers*") of the Washington State Department of Ecology's Environmental Assessment Program SOP will be used.

Pore Water Sampling

- The three phases of control will be implemented and documented for this DFOW.
- Thirty-eight pore water samples will be collected from 16 well-point locations (Figure 3).
- All but two of the pore water samples for this additional investigation will be collected using an approach known as the "well-point" method. This method allows for a more targeted screening interval in the immediate subsurface environment than the method used to collect pore water during previous investigations. At two pore water locations additional, collocated samples will also be collected using the MEDEP method to evaluate potential differences between the well-point and MEDEP collection methods. The additional samples will be collected from the intermediate and/or deep intervals and will be analyzed for VOCs and 1,4-dioxane. The locations of the additional samples will be determined in the field based on sampling conditions. However, it is anticipated they will be collected from two of the proposed locations in the Confluence Area (Figure 3).
- The well-point method incorporates an outer and inner piezometer apparatus that will include screen and riser segments of polyvinyl chloride (PVC) piping. The screen on the outer piezometer will be incorporated into 15-inch segments of 2-inch diameter PVC pipe, and will consist of a 6- or 12-inch machine slotted screen (0.010 inch slot size) depending on the sampling interval. Both shallow (2 to 8 inches) and intermediate (8 to 14 inches) pore water samples will require 6-inch outer screens, while a 12-inch outer screen will be used for deep (14 to 26 inches) pore water samples. A pointed well cap will be attached to the bottom of the outer screened segment, and the top end of this segment will be threaded to accept 2-inch diameter PVC riser segments. The screen area of the outer piezometer will be driven into the subsurface sediment such that the top of the screened interval is aligned with the top of the planned sampling interval (e.g., 2 inches for shallow, 8 inches for intermediate and 14 inches for deep).
- Once the outer piezometers are installed, they will be purged of one to two complete volumes of water and left to stand for at least 2 hours to equilibrate and recharge before sampling. After the equilibration period, an inner piezometer (also a screen and riser apparatus) will be inserted within the outer piezometer. The screen on the inner piezometer will be incorporated into a using 15-inch segment of 1-inch diameter PVC pipe and will consist of a 12-inch machine slotted screen area (0.010 inch slot size). Each inner screen will be capped at the bottom. However, each inner screen will also be covered by a pre-pack filter that consists of a metal mesh covering filled with coarse well-drillers sand. This filter reduces intake of colloidal particles and facilitates collection of a more representative pore water sample. The top end of the inner screen segment will be threaded to accept 1-inch-diameter PVC riser segments. The inner screen and riser will be inserted into the outer well point, and additional 1-inch-diameter risers will be attached to achieve enough overall length so the top inner riser segment will extend to within a couple of inches below the top of the outer piezometer.

- Once the inner screens are inserted, pore water samples will be collected from within the inner well point screen using peristaltic pumps.
- Water quality parameters, including pH, specific conductance, temperature, oxidation-reduction potential, turbidity, total dissolved solids, and dissolved oxygen, will be measured in both pore water and surface water directly adjacent to the well point using a handheld water quality meter. Because these water quality parameters are expected to differ in the pore water and the surface water environments, they will be compared onsite during sampling activities. This comparison also will be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping. The parameters will be measured and recorded before, during, and immediately after sample collection for the purposes of this verification.
- Sample location coordinates will be collected using a global positioning system (GPS).
- All relevant site-specific observations, onsite conditions, and sampling activities will be logged in the field notebook and summarized in the Contractor Production Report (CPR) and Contractor Quality Control Report (CQCR).
- All samples will be collected in laboratory-prepared sampling containers, packed on ice, and shipped overnight to an offsite laboratory every evening (see Worksheet #27).

Groundwater Sampling

- The three phases of control will be implemented and documented for this DFOW.
- Deep groundwater samples will be collected from three permanent monitoring well locations (Figure 3).
- One deep groundwater monitoring well will be installed using similar techniques as those installed for the LTMP for the Eastern Plume (ECC, 2008b).
- The monitoring well will be installed according to MEDEP groundwater Monitoring Well/Piezometer Installation Details and the installation will be overseen by a Maine Certified Geologist (C.G.). Soils will be logged continuously during drilling to document the lithology from shallow and deep groundwater borings.
- Shallow groundwater samples will be collected from 16 temporary piezometer locations and one permanent monitoring well location (Figure 3).
- The temporary piezometers from which shallow groundwater samples will be collected, will be installed using direct-push technology drilling techniques. A 1-inch PVC temporary well will be installed into the borehole created by the direct-push point.
- All groundwater samples will be collected from monitoring wells and temporary piezometers will be collected using low-flow sampling methods as specified in the LTMP (ECC, 2008b) in accordance with EPA low-flow (minimal drawdown) groundwater sampling procedures.
- The new permanent monitoring well will be surveyed by a Maine licensed professional surveyor. Horizontal coordinates will be recorded in the North American Datum of 1983,

State Plane Maine West and will be recorded to within 0.1 feet. Vertical coordinates will be collected in North American Vertical Datum of 1988 to within 0.01 feet. Elevations will be recorded at the ground surface, top of riser, and the top of casing.

- Coordinates for temporary well points will be collected using a GPS.
- All relevant site-specific observations, onsite conditions, and sampling activities will be logged in the field notebook and summarized in the CPR and CQCR.
- All samples will be collected in laboratory-prepared sampling containers, packed on ice, and shipped overnight to an offsite laboratory every evening (see Worksheet #27).

Surface Water Sampling

- The three phases of control will be implemented and documented for this DFOW.
- Surface water samples will be collected from seven locations (Figure 3). Sample locations will be adjusted based on site conditions to meet the objectives of the sampling design.
- Surface water samples will be collected using the same tubing and peristaltic pump technique as pore water sampling. However, the tubing will be attached to a pole such that the opening of the tubing is approximately 2 inches from the bottom of the pole. The pole with tubing attached will be lowered into the surface water such that the bottom of the pole rests gently on the sediment surface so the surface water sample will be collected from approximately 2 inches from the sediment surface. To prevent intake of disturbed sediment/silt, turbidity will be allowed to clear prior to sampling and the sample water coming from the tubing will be inspected for particulate.
- Water quality parameters, including pH, specific conductance, temperature, oxidation-reduction potential, turbidity, total dissolved solids, and dissolved oxygen, will be measured will be measured at each surface water sample location.
- Sample location coordinates will be collected using a global positioning system.
- All relevant site-specific observations, onsite conditions, and sampling activities will be logged in the field notebook and summarized in the CPR and CQCR.
- All samples will be collected in laboratory-prepared sampling containers, packed on ice, and shipped overnight to an offsite laboratory every evening (see Worksheet #27).

Sediment Sampling

- The three phases of control will be implemented and documented for this DFOW.
- Sediment samples will be collected from five locations (Figure 3) using coring techniques.
- Due to the volatile nature of the constituents of concern, sediment samples will be collected and bottled in as close to in situ conditions as possible. Therefore, sediment samples will be collected from the 0- to 6-inch interval using Lexane core tubes that facilitate the least practical amount of sediment disturbance. The Lexane core tube will be lowered gently into the sediment/surface water interface. After contact with the sediment surface, the core tube will be pushed gently into the soft sediment to reduce compaction. A core driver will be

placed over the core tube and a post-hole or sledge hammer will be used to gently advance the tube into the clay substrate to refusal, or to the maximum depth necessary. The tube will be filled to the top with surface water and an end cap will be placed over the top end of the tube. The core tube will then be pulled slowly from the sediment and another end cap will be placed at the bottom. The top cap will then be removed and the overlying water will be slowly decanted, taking care not to disturb the sediment surface. An un-homogenized sediment sample will be placed directly from the core tube into the sample jar from within the 0- to 6-inch interval for VOCs and 1,4-dioxane. The jar will be filled to the top and sealed with no head space (i.e., air pocket). Additional sediment from 0 to 6 inches will be collected via additional coring, homogenized and transferred for the remaining parameters (grain size, TOC and percent moisture) .

- The remainder of the core within approximately the upper 1 to 2 feet of sediment will be visually observed in order to collect qualitative sediment stratigraphy and profile information. This information will potentially be used to help evaluate chemical constituent observations for surface sediment and pore water samples.
- Sample location coordinates will be collected using a GPS.
- All relevant site-specific observations, onsite conditions, and sampling activities will be logged in the field notebook.
- All samples will be collected in laboratory-prepared sampling containers, packed on ice, and shipped overnight to an offsite laboratory every evening (see Worksheet #27).

Equipment Decontamination

All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs (Attachment B). The sampling tools will be scrubbed with tap water and Liquinox solution, rinsed with deionized water, rinsed with methanol, and rinsed a second time with deionized water before use at each sample location. Decontamination fluids will be collected, contained, and disposed of in accordance with state and federal regulations for handling investigation-derived waste (IDW).

Generated Waste

The three phases of control will be implemented and documented for this DFOW. Waste (including soil cuttings, monitoring well development water, purge water, and decontamination water) will be generated during the field investigation. An addendum to the existing Waste Management Plan for work performed at Brunswick is included as Attachment D. The addendum also defines the waste characterization sampling and analysis for this investigation.

Quality Control

- The three phases of control will be implemented and documented for each DFOW.
- Implement SOPs for field (Attachment B) and laboratory (Attachment C) activities being performed.
- QC samples to be collected are outlined on Worksheet #20.

Analytical Tasks

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. (Worksheets #24 and #25).
- The laboratory will process and prepare samples for analysis.
- The laboratory will analyze pore water, groundwater, surface water, and sediment for the analyses as shown on Worksheet #18.

Procedures for Recording Data, Including Guidelines for Recording and Correcting Data

- Project Assessment/Audit (Worksheets #31 and #32)
- Data Review
  - Data Validation (Worksheets #35 and #36)
  - Data Usability Assessment (Worksheet #37)

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

Matrix: Water (Groundwater, Surface Water, Pore Water)
Analytical Group: Select VOCs (including 1,4-Dioxane)

		Project Action Limits[1]								Laboratory-specific			MS/MSD and LCS Recovery Limits		
Analyte	**CAS Number**	**MEG (ug/L)**	**MCL (ug/L)**	**RSL (ELCR=10^{-6}; HQ=0.1) (ug/L)**	**IAVI SL[3] (ug/L)**	**NRWQC (consumption of organisms) (ug/L)**	**Ecological Target Quantitation Limits (ug/L)**	**Groundwater Remediation Goal (ug/L)**	**Project Quantitation Limit (PQL) Goal[2] (ug/L)**	**LOQ (ug/L)**	**LOD (ug/L)**	**DL (ug/L)**	**Lower Limit (%)**	**Upper Limit (%)**	**RPD (%)**
1,1,1-Trichloroethane	71-55-6	10,000	200	910	3,100	NC	11.0	200	5.5	1.0	0.5	0.35	65	130	30
1,1,2,2-Tetrachloroethane	79-34-5	2	NC	0.067	3	0.17	610.0	NC	0.0335	1.0	1.0	0.89	65	130	30
1,1,2-Trichloroethane	79-00-5	6	5	0.24	4.1	0.59	1200.0	NC	0.12	1.0	1.0	0.72	75	125	30
1,1-Dichloroethane	75-34-3	60	NC	2.4	2,200	NC	47.0	5(70**)	1.2	1.0	1.0	0.63	70	135	30
1,1-Dichloroethene	75-35-4	40	7	34	190	330	25.0	7	0.3	1.0	1.0	0.70	70	130	30
1,2-Dichloroethane	107-06-2	4	5	0.15	2.3	0.38	100.0	NC	0.075	1.0	1.0	0.74	70	130	30
1,2-Dichloroethene (total)	540-59-0	NC	NC	33	NC	NC	590.0	NC	16.5	1.0	1.0	0.66	70	125	30
1,2-Dichloropropane	78-87-5	10	5	0.39	35	0.5	525.0	NC	0.195	2.0	1.0	0.83	75	125	30
2-Butanone	78-93-3	4000	NC	710	440,000	NC	14000.0	NC	355	5.0	5.0	2.1	30	150	30
2-Hexanone	591-78-6	NC	NC	4.7	NC	NC	99.0	NC	2.35	5.0	5.0	2.5	55	130	30
4-Methyl-2-pentanone	108-10-1	500	NC	200	14,000	NC	170.0	NC	85	5.0	5.0	1.3	60	135	30
Acetone	67-64-1	6000	NC	2200	220,000	NC	1500.0	NC	750	5.0	5.0	4.6	40	140	30
Benzene	71-43-2	4	5	0.41	1.4	2.2	370.0	NC	0.205	0.5	0.5	0.35	80	120	30
Bromodichloromethane	75-27-4	6	NC	0.12	2.1	0.55	NC	NC	0.06	1.0	1.0	0.62	75	120	30
Bromoform	75-25-2	40	NC	8.5	0.0083	4.3	320.0	NC	4.25	1.0	1.0	0.73	70	130	30
Bromomethane	74-83-9	10	NC	0.87	20	47	110.0	NC	0.435	2.0	2.0	0.95	30	145	30
Carbon disulfide	75-15-0	600	NC	100	560	NC	0.92	NC	0.46	5.0	5.0	0.35	35	160	30
Carbon tetrachloride	56-23-5	5	5	0.44	0.34	0.23	13.3	NC	0.22	1.0	1.0	0.42	65	140	30
Chlorobenzene	108-90-7	100	NC	9.1	390	130	1.3	NC	0.65	1.0	1.0	0.61	80	120	30
Chloroethane	75-00-3	7	NC	2100	28,000	NC	NC	NC	2	2.0	2.0	0.76	60	135	30
Chloroform	67-66-3	70	80	0.19	0.71	5.7	1.8	NC	0.095	1.0	1.0	0.72	65	135	30
Chloromethane	74-87-3	20	NC	19	6.7	NC	5500.0	NC	1.5	2.0	2.0	0.81	40	125	30
cis-1,2-Dichloroethene	156-59-2	70	70	7.3	210	NC	590.0	70	18.5	1.0	1.0	0.66	70	125	30
cis-1,3-Dichloropropene	10061-01-5	4	NC	0.43	0.84	0.34	0.0244	NC	0.0122	0.5	0.5	0.23	70	130	30
Dibromochloromethane	124-48-1	4	NC	0.15	3.2	0.4	NC	NC	0.075	1.0	1.0	0.86	60	135	30
Ethylbenzene	100-41-4	30	700	1.5	3.0	530	90.0	NC	0.75	1.0	1.0	0.61	75	125	30
Methylene chloride	75-09-2	50	5	4.8	58	4.6	98.1	NC	2.4	2.0	2.0	0.75	55	140	30
Styrene	100-42-5	100	100	160	8,900	NC	72.0	NC	36	5.0	5.0	0.68	65	135	30
*Tetrachloroethene	127-18-4	0.6	5	0.11	0.55	0.69	111.0	3	0.055	0.05	0.05	TBD[4]	70	130	30

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

Matrix: Water (Groundwater, Surface Water, Pore Water)

Analytical Group: Select VOCs (including 1,4-Dioxane)

		Project Action Limits[1]								Laboratory-specific			MS/MSD and LCS Recovery Limits		
Analyte	**CAS Number**	**MEG (ug/L)**	**MCL (ug/L)**	**RSL (ELCR=10^{-6}; HQ=0.1) (ug/L)**	**IAVI SL[3] (ug/L)**	**NRWQC (consumption of organisms) (ug/L)**	**Ecological Target Quantitation Limits (ug/L)**	**Groundwater Remediation Goal (ug/L)**	**Project Quantitation Limit (PQL) Goal[2] (ug/L)**	**LOQ (ug/L)**	**LOD (ug/L)**	**DL (ug/L)**	**Lower Limit (%)**	**Upper Limit (%)**	**RPD (%)**
Toluene	108-88-3	600	1000	230	1,500	1,300	2.0	NC	1	1.0	1.0	0.74	75	120	30
trans-1,2-Dichloroethene	156-60-5	100	100	11	180	140	970.0	70	5.5	1.0	1.0	0.74	60	140	30
trans-1,3-Dichloropropene	10061-02-6	4	NC	0.43	0.84	0.34	0.0244	NC	0.0122	0.5	0.5	0.23	55	140	30
Trichloroethene	79-01-6	30	5	2	2.9	2.5	21.0	5	1	1.0	1.0	0.49	70	125	30
*Vinyl chloride	75-01-4	0.2	2	0.016	0.15	0.025	930.0	0.15	0.008	0.05	0.05	TBD[4]	70	130	30
Xylene (total)	1330-20-7	1000	10000	20	22,000	NC	13.0	NC	6.5	1.0	1.0	0.56	80	120	30
*1,4-Dioxane	123-91-1	30	NC	0.67	NC	NC	NC	3.5	0.335	1.0	1.0	0.39	60	140	30

[1] Details on how water-based PALs will be applied are discussed in Worksheet #11. Specific PALs are listed on Worksheet #15.
[2] PQL Goals are 2 times lower than the minimum PAL.
[3] GW SL for protection of indoor air was obtained from draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance (EPA, 2002). For those constituents whos vapor intrusion screening levels were defaulted to the MCL, the risk-based screening levels were calculated (Attachment E) based on an excess lifetime cancer risk of 10^{-5} and a hazard quotient of 1.
[4] TBD. The DLs for VC and PCE will be established by the laboratory prior to sample analysis.
MEGs are Maine CDC Maximum Exposure Guidelines for drinking water.

MCLs are the Federal Maximum Contaminant Levels.

RSL - EPA Regional Screening Levels for Tapwater (05/2010)

National Recommended Water Quality Criteria for ingestion of organisms only (EPA, 2009).
Ecological Screening Values are compiled from:
EPA. 2006. Biological Technical Assistance Group (BTAG), Region 3 Freshwater Screening Benchmarks
EPA. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment.
Shading represents laboratory LODs that are greater than the PAL.
*SIM analysis. VC and PCE will be analyzed using SIM for groundwater and surface water only.
** Revised MEG recommended by the State of Maine on June 19, 1995.
1-4-Dioxane RSL was calculated using the most recent toxicity values presented in IRIS (8/11/2010).
cis-1,2-Dichloroethene RSL was calculated using the most recent toxicity values presented in IRIS (9/30/2010).
Groundwater remediation goals are reported as defined in the ROD (ABB-ES, 1998) and Explanation of Significant Differences (Navy, 2010).

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

Matrix: Sediment

Analytical Group: Select VOCs (including 1,4-Dioxane)

Analyte	CAS Number	Ecological Target Quantitation Limits[1] (ug/Kg)	RSL (ELCR=10^{-6}; HQ=0.1) (ug/kg)	PQL Goal[2] (ug/Kg)	Laboratory-specific			MS/MSD and LCS Recovery Limits		
					LOQ (ug/Kg)	LOD (ug/Kg)	DL (ug/Kg)	Lower Limit (%)	Upper Limit (%)	RPD (%)
1,1,1-Trichloroethane	71-55-6	30.2	640,000	15.1	2.0	0.5	0.13	70	135	30
1,1,2,2-Tetrachloroethane	79-34-5	1360	560	680	2.0	0.5	0.18	55	130	30
1,1,2-Trichloroethane	79-00-5	1240	1,100	620	2.0	0.5	0.13	60	125	30
1,1-Dichloroethane	75-34-3	NC	3,300	0.5	2.0	0.5	0.17	75	125	30
1,1-Dichloroethene	75-35-4	31	24,000	15.5	2.0	0.5	0.12	65	135	30
1,2-Dichloroethene (total)	540-59-0	NC	70,000	0.5	5.0	0.5	0.19	65	125	30
1,2-Dichloroethane	107-06-2	NC	430	0.25	2.0	0.25	0.12	70	135	30
1,2-Dichloropropane	78-87-5	NC	890	0.5	2.0	0.5	0.17	70	120	30
2-Butanone	78-93-3	NC	2,800,000	5.0	5.0	5.0	1.5	30	160	30
2-Hexanone	591-78-6	NC	21,000	1.0	5.0	1.0	0.86	45	145	30
4-Methyl-2-pentanone	108-10-1	NC	530,000	5.0	5.0	5.0	1.0	45	145	30
Acetone	67-64-1	NC	6,100,000	5.0	5.0	5.0	5.0	20	160	30
Benzene	71-43-2	NC	1,100	0.5	0.5	0.5	0.11	75	125	30
Bromodichloromethane	75-27-4	NC	270	0.5	2.0	0.5	0.19	70	130	30
Bromoform	75-25-2	654	61,000	327	2.0	1.0	1.0	55	135	30
Bromomethane	74-83-9	NC	730	1	2.0	1.0	0.35	30	160	30
Carbon disulfide	75-15-0	0.851	82,000	0.4255	5.0	0.5	0.19	45	160	30
Carbon tetrachloride	56-23-5	64.2	610	32.1	2.0	0.5	0.19	65	135	30
Chlorobenzene	108-90-7	8.42	29,000	4.21	2.0	0.5	0.22	75	125	30
Chloroethane	75-00-3	NC	1,500,000	1.0	5.0	1.0	0.32	40	155	30
Chloroform	67-66-3	NC	290	0.5	2.0	0.5	0.16	70	125	30
Chloromethane	74-87-3	NC	12,000	0.5	5.0	0.5	0.13	50	130	30
cis-1,2-Dichloroethene	156-59-2	NC	16,000	0.5	2.0	0.5	0.2	65	125	30
cis-1,3-Dichloropropene	10061-01-5	NC	1,700	2.0	2.0	2.0	0.5	70	125	30
Dibromochloromethane	124-48-1	NC	680	1.0	2.0	1.0	1.0	65	130	30
Ethylbenzene	100-41-4	1100	5,400	550	2.0	0.25	0.11	75	125	30
Methylene chloride	75-09-2	NC	11,000	0.5	2.0	0.5	0.17	55	140	30
Styrene	100-42-5	559	630,000	279.5	5.0	0.5	0.16	75	125	30

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

Matrix: Sediment

Analytical Group: Select VOCs (including 1,4-Dioxane)

Analyte	CAS Number	Ecological Target Quantitation Limits[1] (ug/Kg)	RSL (ELCR=10^{-6}; HQ=0.1) (ug/kg)	PQL Goal[2] (ug/Kg)	Laboratory-specific			MS/MSD and LCS Recovery Limits		
					LOQ (ug/Kg)	LOD (ug/Kg)	DL (ug/Kg)	Lower Limit (%)	Upper Limit (%)	RPD (%)
Tetrachloroethene	127-18-4	468	550	234	2.0	0.5	0.17	65	140	30
Toluene	108-88-3	NC	500,000	0.5	5.0	0.5	0.18	70	125	30
trans-1,2-Dichloroethene	156-60-5	1050	15,000	525	5.0	0.5	0.19	65	135	30
trans-1,3-Dichloropropene	10061-02-6	NC	1,700	2	2.0	2.0	1.0	65	125	30
Trichloroethene	79-01-6	96.9	2,800	48.45	2.0	0.5	0.21	75	125	30
Vinyl chloride	75-01-4	NC	60	1	2.0	1.0	0.27	60	125	30
Xylene (total)	1330-20-7	25.2	63,000	12.6	2.0	1.0	0.13	80	125	30
1,4-Dioxane	123-91-1	NC	4,900	1	1.0	1.0	0.3	60	140	30

[1] Refer to Worksheets #10 and #11 for a detailed discussion on development of PALs.
[2] PQL Goals are 2 times lower than the PAL. If no PAL is present, the PQL Goal is equivalent to the LOD.
Ecological Screening Values are compiled from:
EPA. 2006. Biological Technical Assistance Group (BTAG), Region 3 Freshwater Screening Benchmarks
RSL – EPA Regional Screening Levels for Residential Soil (05/2010).
1,4-Dioxane RSL was calculated using the most recent toxicity values presented in IRIS (08/11/2010).
cis-1,2-Dichloroethene RSL was calculated using the most recent toxicity values presented in IRIS (09/30/2010).

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

Matrix: Aqueous
Analytical Group:
Various

Analyte	CAS Number	Project Indicator Levels (PILs)[1, 2] (ug/L)	Effect	Laboratory-specific			MS/MSD and LCS Recovery Limits		
				LOQ (ug/L)	LOD (ug/L)	DL (ug/L)	Lower Limit (%)	Upper Limit (%)	LCS/LCSD and/or MS/MSD RPD (%)
Total Organic Carbon	TOC[3]	>20,000	Carbon and energy source available; drives dechlorination	1000	700	300	75	125	20
Dissolved Iron	7439-89-6	>1,000	Reductive pathway is possible	100.0	75.0	50	80	120	20
Dissolved Manganese	7439-96-5	present	Electron acceptor under anaerobic conditions	15	10	5.0	80	120	20
Methane	74-82-8	>5,000/<5,000	Vinyl Chloride (VC) oxidizes/VC accumulates	10	5.0	0.5	80	120	25
Ethane	74-84-0	>10	Evidence of VC daughter product	10	5.0	0.5	80	120	25
Ethene	74-85-1	>100	Evidence of VC daughter product	10	6.0	0.7	80	120	25
Nitrate	14797-55-8	<1,000	At higher concentrations may compete with reductive pathway	100	40	20	75	125	20
Sulfate	14808-79-8	<20,000	At higher concentrations may compete with reductive pathway	5000.0	1300	700	75	125	20

[1] Refer to Worksheets #10 and #11 for a detailed discussion on development of PILs.
[2] PQL Goals are equivalent to the PIL. If no PIL is available, the PQL Goal is equivalent to the LOD.
[3] Contractor-generated CAS number
Compounds in Worksheet #15-3 will not be compared to risk-based screening criteria. Instead, they will be compared to the above PILs. These compounds will be analyzed for in order to provide more information about the state of the aquifer. See Worksheet #11 for more information.

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

Matrix: Sediment
Analytical Group: Wet Chemistry

		Laboratory-Specific			MS/MSD and (LCS) Recovery Limits		
Analyte	**CAS Number**	**LOQ (mg/Kg)**	**LOD (mg/Kg)**	**DL (mg/Kg)**	**Lower Limit (%)**	**Upper Limit (%)**	**RPD (%)**
TOC	TOC	100	100	100	80	120	20

TOC results are used to determine the bioavailability of organic chemicals.

SAP Worksheet #15-5—Reference Limits and Evaluation Table

Matrix: Sediment
Analytical Group: Wet Chemistry (Grain size-sieve only)

Analyte	CAS Number
Sieve 3 Inch (75.0 mm)	SIEVE 75000
Sieve 1.5 Inch (37.5 mm)	SIEVE 37500
Sieve 3/4 Inch (19.0 mm)	SIEVE 19000
Sieve 3/8 Inch (9.5 mm)	SIEVE9500
Sieve No. 004 (4.75 mm)	SIEVE4.75
Sieve No. 08 (2.36 mm)	SIEVE2360
Sieve No. 010 (2.00 mm)	SIEVE2000
Sieve No. 016 (1.18 mm)	SIEVE1180
Sieve No. 030 (0.600 mm)	SIEVE600
Sieve No. 050 (0.300 mm)	SIEVE300
Sieve No. 100 (150 mm)	SIEVE150
Sieve No. 200 (0.075 mm)	SIEVE75

Grain size helps determine the nature of the substrate and how suitable it is as habitat for particular species; the distribution of particle sizes will also influence the bioavailability of some chemicals.

Note: Alternate series of sieves is also allowed in the method.

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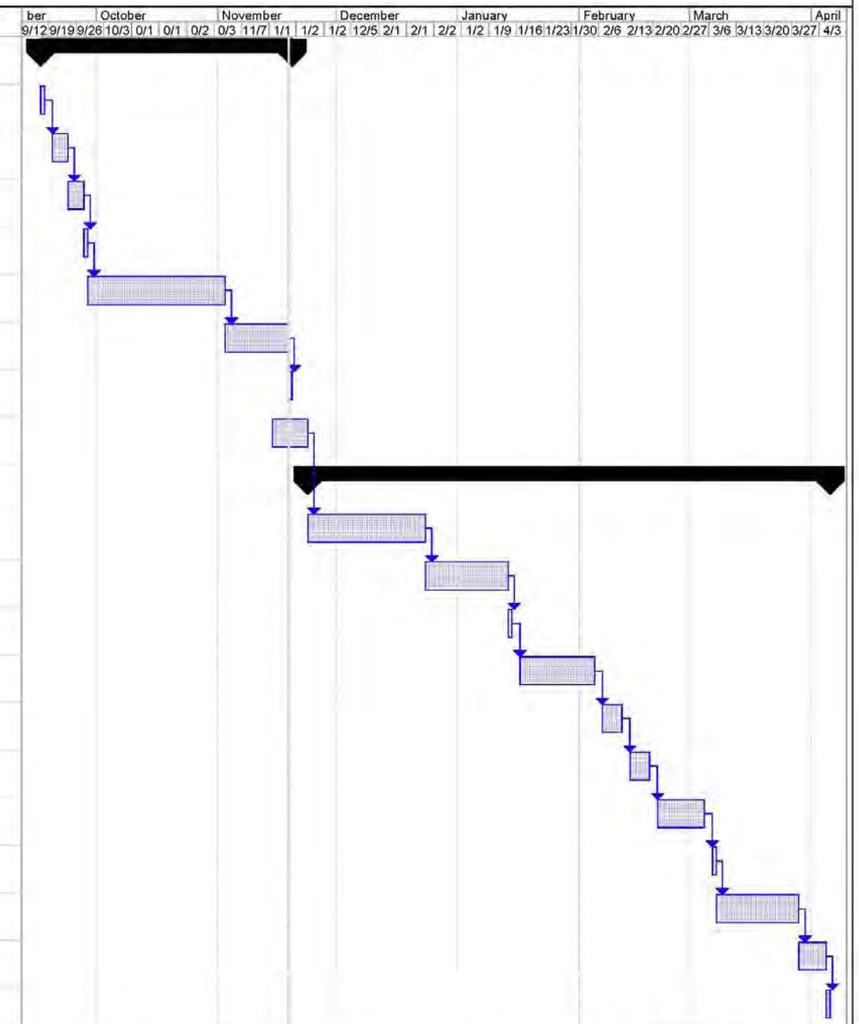
SAP #16—Schedule

UFP SAP SCHEDULE
MERRICONEAG STREAM
BRUNSWICK, MAINE

ID	Task Name	Duration	Start	Finish	Predecessors
1	**UFP-SAP**	**46 days**	**Fri 9/17/10**	**Fri 11/19/10**	
2	Submit Draft UFP-SAP to Navy	1 day	Fri 9/17/10	Fri 9/17/10	
3	Navy Review of UFP-SAP	4 days	Mon 9/20/10	Thu 9/23/10	2
4	Respond to Navy Comments and Prepare Draft Final UFP-SAP	2 days	Fri 9/24/10	Mon 9/27/10	3
5	Submit Draft Final UFP-SAP to MEDEP and USEPA	1 day	Tue 9/28/10	Tue 9/28/10	4
6	MEDEP and USEPA Review of Final Draft UFP-SAP	25 days	Wed 9/29/10	Tue 11/2/10	5
7	Respond to MEDEP and USEPA Comments and Prepare Final UFP-SAP	12 days	Wed 11/3/10	Thu 11/18/10	6
8	Submit Final UFP-SAP	1 day	Fri 11/19/10	Fri 11/19/10	7
9	**Field Investigations**	7 days	Mon 11/15/10	Tue 11/23/10	
10	**Reporting**	**95 days**	**Tue 11/23/10**	**Tue 4/5/11**	
11	Laboratory Analysis and Data Validation	30 edays	Tue 11/23/10	Thu 12/23/10	9
12	Prepare Draft Report	15 days	Fri 12/24/10	Thu 1/13/11	11
13	Submit Draft Report to Navy	1 day	Fri 1/14/11	Fri 1/14/11	12
14	Navy Review of Draft Report	15 days	Mon 1/17/11	Fri 2/4/11	13
15	Respond to Navy Comments and Prepare Final Draft Report	5 days	Mon 2/7/11	Fri 2/11/11	14
16	Navy Review of Final Draft Report	5 days	Mon 2/14/11	Fri 2/18/11	15
17	Respond to Navy Comments and Prepare Draft Final Report	10 days	Mon 2/21/11	Fri 3/4/11	16
18	Submit Draft Final Report to MEDEP and USEPA	1 day	Mon 3/7/11	Mon 3/7/11	17
19	MEDEP and USEPA Review of Draft Final Report	15 days	Tue 3/8/11	Mon 3/28/11	18
20	Respond to MEDEP and USEPA Comments and Prepare Final Report	5 days	Tue 3/29/11	Mon 4/4/11	19
21	Submit Final Report	1 day	Tue 4/5/11	Tue 4/5/11	20



Project: SAP_16_Final_Schedule.mpp
Date: Fri 11/19/10

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

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SAP Worksheet #17—Sampling Design and Rationale

Four areas show potential for contaminated groundwater discharge into surface water (i.e., the confluence of the Merriconeag stream and the Mere Brook; east of the confluence near SEEP-11; north of the confluence near SW-13; and south of the confluence near SW-12); refer to Figure 3 for these areas. Pore water samples and shallow groundwater samples will be collected from each area, and a shallow groundwater sample will be collected directly upgradient of the confluence area. In addition sediment and surface water samples will be collected from at least one location from each of the four areas, and two upgradient surface water samples will be collected from the study areas. Sediment will be collected from 0 to 6 inches below sediment surface and surface water will be collected from as close to the groundwater/surface water interface (GSI) as possible (i.e., within 6 inches of sediment surface). Sediment samples will be analyzed for VOCs, 1,4-dioxane, grain size and total organic carbon (TOC). Surface water pore water and groundwater samples will be analyzed for VOCs and 1,4-dioxane. Shallow pore water and shallow groundwater samples will also analyzed for MNA parameters (dissolved iron and manganese, nitrate, sulfate, methane, ethane, ethane, and TOC). Field water quality parameters will also be collected from water sample locations (see Worksheet #14).

Measurements of the vertical hydraulic gradient will be collected from each of the discharge areas using a manometer to determine the exact sampling locations so they are in areas of upwelling (groundwater-to-surface water) and to help interpret the pore water and surface water chemical analytical data.

Pore water samples will be collected within the stream from up to three intervals (shallow, intermediate and deep) across the top approximately 26 inches of shallow subsurface sediment. The number of samples and depth intervals will depend on location relative to the site and objectives, but all samples at all pore water locations will be collected from target intervals of approximately 2 to 8 inches (shallow) and 8 to 14 inches (intermediate). An additional pore water sample will also be collected at confluence sample locations at an interval of approximately 14 to 26 inches (deep); however, actual depth intervals will be determined based on site conditions. Two pore water locations will be collocated using the MEDEP method to determine if there is a difference in results from the well-point pore water collection method.

Shallow groundwater samples will be collected from temporary monitoring wells installed near paired pore water locations to the extent possible as access to these areas is expected to be difficult with a drill rig. The temporary wells will be installed within the upper sand layer at a targeted depth interval of approximately 10 to 12 feet below ground surface (bgs). Actual installation depths may be adjusted based on subsurface conditions. Existing piezometers PZ-MB-B4A, PZ-MB-B3C, and PZ-MB-C3C) will be evaluated in the field to be used instead of installing one or more of the proposed temporary monitoring wells if they are in good working condition. Co-located pore water sampling locations will be adjusted as needed if existing piezometers are used to ensure they are near the shallow groundwater samples collected.

Areas where deep groundwater (approximately 30 to 50 feet bgs) comes into potential contact with the stream and is upgradient of the confluence area will be investigated for discharging contaminated groundwater based on data collected from existing or newly installed monitoring wells.

Sample locations will be adjusted in the field as needed based on site conditions to fulfill the objectives of the investigation. The spacing between pore water and shallow aquifer samples is based on historic size of discharge zones as noted from the confluence area.

Northern Extent of Discharge Zone

Four sample locations (GSI-01 through GSI-04; Figure 3) will be collected along the Merriconeag stream stretching from near the confluence area (GSI-04) to the bend in the river near surface water location SW-13 (GSI-01). At SW-13, TCE was detected at 2.9 micrograms per liter (µg/L) in 2009. The area will be investigated for discharging groundwater contaminated with VOCs potentially migrating from the deep groundwater primarily through collection of pore water (both a shallow and intermediate) and shallow groundwater (adjacent to pore water sample locations) samples. Surface water in the area upgradient of the northern extent of discharge will be investigated to account for the potential of background VOCs and 1,4-dioxane levels flowing into the study area (SW-17). Surface water and sediment samples will also be collected at one location (GSI-03). Additionally, a deep groundwater sample will be collected from a newly installed monitoring well as proposed below. All samples (pore water, shallow and deep groundwater, surface water, and sediment) will be analyzed for VOCs and 1,4-dioxane. In addition, shallow pore water, and groundwater samples will also be analyzed for MNA parameters and the sediment sample will also be analyzed for TOC and grain size. The proposed sampling locations are as follows (Figure 3):

- GSI -01 – Upstream of SW-13, east of where deep groundwater contamination is estimated to be located.
- GSI-02 – Located near the pore water location PW-SP-09 where VOC contamination has been detected previously. This location is located just downstream of the bend in the Merriconeag Stream.
- GSI-03 – Near the same location as the historic surface water sample SW-13 which is located at a turn in the Merriconeag stream. This is a likely place where deep aquifer contamination may be discharging into the stream.
- GSI-04 – Located up stream of the confluence near the LTM location PW-EP-02. This LTM location has consistently been detected for 1,4 -Dioxane.
- MW-360 – Deep aquifer monitoring well to be installed upgradient of historical surface water sample location SW-13. The boring will be continuously sampled from 40 to 60 feet bgs to determine the optimal screen placement before setting the well. It is anticipated that the depth of this well will be approximately 40 to 50 feet belowground surface. The purpose of deep aquifer monitoring well is to delineate the eastern extent of deep groundwater in this area and determine if there is a source of discharge into the stream at this location.
- SW-17 – Located approximately 300 to 400 feet upgradient of GSI-01 to account for the potential of background VOCs and 1,4-dioxane levels flowing into the study area.

Confluence Area

Six sample locations (GSI-05 through GSI-10; Figure 3) will be collected from the area near the confluence where contamination has been identified in pore water sampling from 2005 and piezometer sampling in 2007. Sampling in this area will primarily consist of pore water

(shallow, intermediate, and deep intervals) and shallow groundwater (adjacent to pore water sample locations) samples. Surface water and sediment samples will also be collected at two locations (GSI-07, and GSI-08). Additionally, a shallow and deep groundwater sample will be collected from an existing monitoring well series (MW-MB-06) directly upgradient of the confluence area to provide a comparison of data prior to and after operation of the new extraction wells. All samples (pore water, shallow and deep groundwater, surface water, and sediment) will be analyzed for VOCs and 1,4-dioxane. In addition, shallow pore water and groundwater samples will also be analyzed for MNA parameters and sediment samples will also be analyzed for TOC and grain size. The proposed sampling locations are as follows (Figure 3):

- GSI-05 – Location where PWTR2-03 was located in 2005. Elevated concentrations of VOCs and 1,4-dioxane were detected in this sample during the 2005 pore water sampling event.
- GSI-06 – Location where PWTR1-04 was located in 2005 and SW-14 is collected for the LTM program. Elevated concentrations of VOCs and 1,4-dioxane were detected in PWTR1-04 during the 2005 pore water sampling event.
- GSI-07 – Near the location where PWTR1-02 was located in 2005. Elevated concentrations of VOCs and 1,4-dioxane were detected during the 2005 pore water sampling event.
- GSI-08 – Near the location where PWTR1-01 was located in 2005. Elevated concentrations of VOCs and 1,4-dioxane were detected during the 2005 pore water sampling event.
- GSI-09 – South of the confluence to obtain analytical data from an area identified as having groundwater discharge into the Mere Brook.
- GSI-10 – South of the GSI-09 to obtain analytical data from an area identified as having groundwater discharge into the Mere Brook.
- MW-MB-06 –The A screen and the C screen in this well series will be sampled to provide a shallow and deep samples directly upgradient of the confluence area to provide a comparison of data prior to and after operation of the new extraction wells.

Eastern Seep Area

Three sample locations (GSI-11 through GSI-13; Figure 3) will be collected from the Eastern Seep Area near to where a previous seep sample (SEEP-11) located along Mere brook west of the confluence showed elevated concentrations of VOCs in April of 2009. Sampling in this area will primarily consist of pore water (shallow and intermediate intervals) and shallow groundwater (adjacent to pore water sample locations). Surface water and sediment samples will also be collected at one location (GSI-12). Surface water in the area upgradient of the eastern seep will also be investigated to account for the potential of background VOCs and 1,4-dioxane levels flowing into the study area (SW-18). All samples (pore water, shallow groundwater, surface water, and sediment) will be analyzed for VOCs and 1,4-dioxane. In addition, shallow pore water and shallow groundwater samples will also be analyzed for MNA parameters and the sediment sample will also be analyzed for TOC and grain size. The proposed sampling locations are as follows (Figure 3):

- GSI-11 – Upstream of SEEP-11 and near the location of SW-10, an up gradient sampling location for the seep.

- GSI-12 – At the brook near SEEP-11 and will be used to detect any discharge at the stream or in surface water from the seep.
- GSI-13 – Downstream of SEEP-11 along Mere Brook.
- SW-18 - Located approximately 300 to 400 feet upgradient of GSI-11 to account for the potential of background VOCs and 1,4-dioxane levels flowing into the study area.

Southern Extent of Discharge Zone

Three sample locations (GSI-14 through GSI-16; Figure 3) will be collected to further investigate the southern extent of the discharge area near the area where the deep aquifer is contaminated with to 1,4-dioxane. Sampling in this area will primarily consist of pore water (shallow and intermediate intervals) and shallow groundwater (adjacent to pore water sample locations). Surface water and sediment samples will also be collected at one location (GSI-14). All samples (pore water, shallow groundwater, surface water, and sediment) will be analyzed for VOCs and 1,4-dioxane. In addition, shallow pore water and groundwater samples will also be analyzed for MNA parameters and the sediment sample will also be analyzed for TOC and grain size. The proposed sampling locations are as follows (Figure 3):

- GSI-14 – Downstream of PW-EP-03 which has historically seen 1,4-dioxane detections above the 30 parts per billion (ppb) MEG.
- GSI-15 – Downstream of GSI-14 along the stream.
- GSI-16 – Downstream of GSI-15 along the stream.
- MW-313 - Existing deep aquifer monitoring well will be sampled for analysis of VOCs, 1,4-dioxane, and MNA parameters to determine whether degradation is occurring from deep groundwater to shallow groundwater and pore water in this area.

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

Sampling Location	Sample ID	Sample Type	Depth Interval (bgs)	Analyses
Northern Extent of Discharge Zone				
GSI-01	BN-PW-GSI-01-02	Pore Water[1]	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-01-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-01-10	Shallow Groundwater[2]	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-02	BN-PW-GSI-02-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-02-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-02-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-03	BN-PW-GSI-03-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-03-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-03-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
	BN-SW-GSI-03-00	Surface Water[3]	0-6"	VOCs and 1,4-Dioxane
	BN-SD-GSI-03-00	Sediment[4]	0-6"	VOCs and 1,4-Dioxane, TOC, grain size, and moisture content
GSI-04	BN-PW-GSI-04-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-04-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-04-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
MW-EP-360	BN-GW-MW-EP-360	Deep Groundwater[5]	40'-50'	VOCs, 1,4-Dioxane, and MNA parameters
SW-17	BN-SW-17-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
Confluence Area[7]				
GSI-05	BN-PW-GSI-05-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-05-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PW-GSI-05-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-05-10	Shallow Groundwater[6]	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-06	BN-PW-GSI-06-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-06-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PW-GSI-06-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-06-10	Shallow Groundwater[6]	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-07	BN-PW-GSI-07-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-07-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PW-GSI-07-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-07-10	Shallow Groundwater[6]	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
	BN-SW-GSI-07-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
	BN-SD-GSI-07-00	Sediment	0-6"	VOCs and 1,4-Dioxane, TOC, grain size, and moisture content
GSI-08	BN-PW-GSI-08-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-08-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane

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

Sampling Location	Sample ID	Sample Type	Depth Interval (bgs)	Analyses
	BN-PW-GSI-08-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-08-10	Shallow Groundwater[6]	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
	BN-SW-GSI-08-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
	BN-SD-GSI-08-00	Sediment	0-6"	VOCs and 1,4-Dioxane, TOC, grain size, and moisture content
GSI-09	BN-PW-GSI-09-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-09-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PW-GSI-09-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-09-10	Shallow Groundwater	7-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-10	BN-PW-GSI-10-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-10-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PW-GSI-10-14	Pore Water	14"-26"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-10-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
MW-MB-06A	BN-MW-MB-06-A	Shallow Groundwater	5'-15'	VOCs, 1,4-Dioxane, and MNA parameters
MW-MB-06C	BN-MW-MB-06-C	Deep Groundwater	40'-50'	VOCs, 1,4-Dioxane, and MNA parameters
Eastern Seep Area				
GSI-11	BN-PW-GSI-11-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-11-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-11-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-12	BN-PW-GSI-12-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-12-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-12-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
	BN-SW-GSI-12-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
	BN-SD-GSI-12-00	Sediment	0-6"	VOCs and 1,4-Dioxane, TOC, grain size, and moisture content
GSI-13	BN-PW-GSI-13-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-13-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-13-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
SW-18	BN-SW-18-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
Southern Extent of Discharge Zone				
GSI-14	BN-PW-GSI-14-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-14-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-14-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
	BN-SW-GSI-14-00	Surface Water	0-6"	VOCs and 1,4-Dioxane
	BN-SD-GSI-14-00	Sediment	0-6"	VOCs and 1,4-Dioxane, TOC, grain size, and moisture content

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

Sampling Location	Sample ID	Sample Type	Depth Interval (bgs)	Analyses
GSI-15	BN-PW-GSI-15-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-15-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-15-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
GSI-16	BN-PW-GSI-16-02	Pore Water	2"-8"	VOCs, 1,4-Dioxane, and MNA parameters
	BN-PW-GSI-16-08	Pore Water	8"-14"	VOCs and 1,4-Dioxane
	BN-PZ-GSI-16-10	Shallow Groundwater	7'-12'	VOCs, 1,4-Dioxane, and MNA parameters
MW-313	BN-GW-MW313	Deep Groundwater	27'-37'	VOCs, 1,4-Dioxane, and MNA parameters

Notes:
bgs - below ground surface

VOCs - Volatile organic compounds

TOC – Total organic carbon

MNA parameters including the following analyses: dissolved iron and manganese, nitrate, sulfate, methane, ethane, ethane, and total organic carbon.

QA/QC sampling will be performed at locations determined in the field based on site conditions. The frequency of QA/QC sampling is defined in Worksheet #20.

1 – Pore water sampling will be performed following SOP-08. Hydraulic gradient measurements will be taken at these locations following SOP-10.
2 – Shallow groundwater sampling will be performed following SOP-07. Water levels and total depths will be measured from these sample locations following SOP-07.
3 – Surface water sampling will be performed following SOP-11.
4 – Sediment sampling will be performed following SOP-12.
5 – Soil logging of monitoring well boreholes will be conducted following SOP-03. Monitoring wells at deep groundwater sampling locations will be installed and developed following SOP-04 and SOP-05. Deep groundwater sampling will be performed following SOP- 06. Water levels and total depths will be measured from these sample locations following SOP-07.
6 –Existing piezometers (PZ-MB-B4A, PZ-MB-B3C, and PZ-MB-C3C) will be evaluated in the field to be used instead of installing one or more of the proposed temporary monitoring wells if they are in good working condition. Co-located pore water sampling locations will be adjusted as needed if existing piezometers are used to ensure they are near the shallow groundwater samples collected.
7 - At two pore water locations (yet-to-be determined), additional co-located samples will also be collected from the intermediate and/or deep intervals using the MEDEP method to evaluate potential differences between the well-point and MEDEP collection methods; these samples will most likely be collected from the Confluence Area (Figure 3 and will be analyzed for VOCs and 1,4-dioxane.

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SAP Worksheet #19— Analytical SOP Requirements Table

Matrix		Analytical and Preparation Method/ SOP Reference[1]	Containers (Number, Size, and Type)	Sample Volume	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/ Analysis)[2]
Groundwater, Surface Water, Pore Water	Select VOCs	SW-846 8260B/ MMS105-11	X3 40-ml vials	120 ml	HCL, 4 ±2°C	14 days
	1,4-Dioxane	SW-846 8260B SIM, EPA Reg 1 SOP/ MMS308-02	X3 40-ml vials	120 ml	4 ±2°C	14 days
Groundwater, Surface Water	VC and PCE	SW-846 8260B SIM/ MMS105-11	X3 40-ml vials	120 ml	HCL, 4 ±2°C	14 days
Pore Water, Groundwater	Methane, Ethane, Ethene	RSK-175/ MGC297-03	X3 40-ml vials	120 ml	HCL, 4 ±2°C	14 days
	Dissolved Iron and Manganese	SW-846 6010B/ MMA077-18	X1 250-ml poly	250 ml	4 ±2°C	180 days
	Nitrate	EPA 353.2/ MGN160-06	X1 500-ml poly	500 ml	4 ± 2° C	48 Hours
	Sulfate	ASTM D 516-90-2/ MGN154-06	X1 500-ml poly	500 ml	4 ±2°C	28 days
	TOC	SW-846 9060A/ MGN064-08	X3 40-ml vials	120 ml	Phosphoric Acid, 4 ±2°C	28 days
Sediment	Grain Size	ASTM D422-63/ EGN258	X2 16-oz plastic	1 KG	N/A	N/A
	TOC	Lloyd Kahn/ MGN261	X1 2-oz glass jar	1 g	4 ±2°C	14 days
	Select VOCs	SW-846 8260B/ MMS105-11	X1 2-oz glass jar	20 g	4 ±2°C	14 days
	1,4-Dioxane	SW-846 8260B SIM, EPA Reg 1 SOP/ MMS308-02		10 g		14 days (48 hours to freeze)

[1] See Worksheet 23
[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. (Not Validated Time of Sample Receipt [VTSR])

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of Trip Blanks	Total No. of Samples to Lab
Surface Water	Select VOCs	7	1	1/1	0	1	1	12
	VC and PCE	7	1	1/1	0	1	1	12
	1,4-Dioxane	7	1	1/1	0	1	1	12
Sediment	Select VOCs	5	1	1/1	0	1	1	10
	1,4-Dioxane	5	1	1/1	0	1	1	10
	Grain Size	5	0	0	0	0	0	5
	TOC	5	0	1/1	0	0	0	7
Groundwater	Select VOCs	20	2	2/2	0	1	4	31
	VC and PCE	20	2	2/2	0	1	4	31
	1,4-Dioxane	20	2	2/2	0	1	4	31
	Dissolved Iron and Manganese	20	0	2/2	0	0	0	24
	Nitrate	20	0	2/2	0	0	0	24
	Sulfate	20	0	2/2	0	0	0	24
	Methane, Ethane, Ethene	20	0	2/2	0	0	0	24
	TOC	20	0	2/2	0	0	0	24
Pore Water	Select VOCs	40	4	2/2	0	1	5	54
	1,4-Dioxane	40	4	2/2	0	1	5	54
	Dissolved Iron and Manganese	16	0	1/1	0	0	0	18
	Nitrate	16	0	1/1	0	0	0	18
	Sulfate	16	0	1/1	0	0	0	18
	Methane, Ethane, Ethene	16	0	1/1	0	0	0	18
	TOC	16	0	1/1	0	0	0	18

QA/QC samples will be collected based on the following guidelines:
1 Field duplicate will be collected for every 10 field samples defined as definitive data.
1 MS/MSD pair will be collected for every 20 samples, including QA/QC and field samples.
1 equipment blank will be collected per week.
1 trip blank will be collected per cooler containing volatiles.

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SAP Worksheet #21—Project Sampling SOP References Table

This worksheet summarizes the field methods to be used to perform sampling. The field SOPs are provided in Attachment B.

Procedure Number	Procedure Title	Issue Date
SOP-01	Note Taking and Field Logbook	08/2010
SOP-02	Utility Clearance for Intrusive Operations	08/2010
SOP-03	Soil Boring Logging	08/2010
SOP-04	Monitoring Well Installation	11/2010
SOP-05	Monitoring Well Development	08/2010
SOP-06	Water Level and Total Depth Measurements	08/2010
SOP-07	Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures	04/1996
SOP-08	Groundwater-Surface Water Investigation: Well-Point Method Pore Water Sampling Procedures	08/2010
SOP-09	Protocol for Groundwater/Surface Water Interface Sampling Using a Pore Water Sampler	04/2009
SOP-10	Measurement of Groundwater-Surface Water Hydraulic Gradient	08/2010
SOP-11	Surface Water Sampling	11/2010
SOP-12	Sediment Sample Collection	11/2010
SOP-13	Personnel and Equipment Decontamination Procedures	08/2010
SOP-14	Packing and Shipping Procedures for Low Concentration Samples	08/2010
SOP-15	Sample Handling and Chain-of-Custody Procedures	08/2010
SOP-16	EPA Region 1 Calibration of Field Instruments	06/03/1998

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

This worksheet identifies field equipment and instruments that require calibration, maintenance, testing, or inspection and provide the SOP reference number for each type of equipment. In addition, document the frequency of activity, acceptance criteria, and corrective action requirements on the worksheet.

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria Cor	rective Action	Responsible Person SOP	Reference[1]
Water Level Indicator or Oil/Water interface probe	Calibrate annually to determine the accuracy of the measurement.	Perform maintenance per manufacturer's instructions.	Measures depth-to-liquid and total well depth	Per manufacturer's instructions	Daily before use	+/- 0.01 foot	If meter fails to calibrate, do not use this meter.	Field Team Leader or designee	SOP-05 SOP-06 SOP-07 SOP-08 SOP-09
Water Quality Meter – YSI 600XLM or similar	Calibrate daily prior to collecting water quality data according to manufacturer calibration specifications developed for the instrument being calibrated.	Performed per manufacturer's instructions.	Measures dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, pH, and temperature.	Per manufacturer's instructions	Daily before use	Check operations manual for acceptable range of calibrated probes.	If meter fails to calibrate, do not use this meter.	Field Team Leader or designee	SOP-05 SOP-07 SOP-11 SOP-16
HACH turbidity Meter	Calibrate daily per manufacturer's instructions.	Performed per manufacturer's instructions.	Measures turbidity (NTUs).	Per manufacturer's instructions	Daily before use	Check operations manual for acceptable range of calibration.	If meter fails to calibrate, do not use this meter.	Field Team Leader or designee	SOP-05 SOP-07 SOP-11 SOP-16
Ultrameter II	Calibrate daily per manufacturer's instructions.	Performed per manufacturer's instructions.	Measures ORP, specific conductance, pH, total dissolved solids and temperature.	Per manufacturer's instructions	Daily before use	Check operations manual for acceptable range of calibration.	If meter fails to calibrate, do not use this meter.	Field Team Leader or designee	SOP-08 SOP-09 SOP-16

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Photoionization detector (PID)	Calibrate for organic vapors using compressed gas cylinders, per manufacturer's instructions.	Charge batteries. Allow the batteries to totally discharge before recharging to prevent battery memory from occurring. Perform maintenance per manufacturer's instructions.	Screens for potential volatile compound concentrations.	Per manufacturer's instructions	Daily before use.	Calibrates to +/- respective values for the probe for the specific lamp model. (refer to operations manual).	If meter fails to calibrate correctly, do not use this meter.	Field Team Leader or designee	SOP-03 SOP-04 SOP-08 SOP-09 SOP-12
GPS Unit with external beacon	NA	Charge batteries.	Measures the horizontal geographic position of locations.	Per manufacturer's instructions	Daily before use.	A sufficient signal is available to obtain an accurate measurement of horizontal position.	If a sufficient signal is not available, measurements should not be taken. If significant time has passed and a sufficient signal is not available, contact the equipment supplier or manufacturer.	Field Team Leader	SOP-02 SOP-04 SOP-08 SOP-09 SOP-10 SOP-11 SOP-12

[1]Refer to the Project Sampling SOP References table (Worksheet #21).

SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
MGN261	Total Organic Carbon in Soil Samples Using SW846 Method 9060 (Modified), and US EPA Region 2 Lloyd Kahn Method, 7/17/09	Screening	Sediment/ TOC	TOC Analyzer	Accutest	N
EGN258	Grain Size and Sieve Testing, 4/28/09	Screening	Sediment/ Grain Size	N/A	Accutest	N
MMS105-11	Determination of Volatile Organics Using GC/MS System, Rev 11, 10/23/09	Definitive	Water, Sediment/ VOCs, SIM VOCs	GC/MS	Accutest	N
MMS308-02	Determination of 1,4-Dioxane Using GC/MS System and Selective Ion Monitoring, Rev. 2, 3/5/07	Definitive	Water, Sediment/ 1,4-Dioxane	GC/MS	Accutest	N
MGC297-03	Laboratory Analysis of Dissolved Gases in Aqueous Samples, Rev. 3, 7/18/06	Screening	Water/ Methane, Ethane, Ethene	GC	Accutest	N
MMA077-18	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry SW846 6010B, Rev. 18, 12/17/08	Screening	Metals	ICP	Accutest	N
MGN160-06	Nitrate/Nitrite and Nitrate Only by Cadmium Reduction Analysis (LACHAT Autoanalyzer), Rev. 6, 5/4/07	Screening	Nitrate	LACHAT	Accutest	N
MGN154-06	Sulfate, Turbidimetric Analysis, Rev. 6, 5/4/07	Screening	Sulfate	Turbidometer	Accutest	N
MGN064-08	Total Organic Carbon in Aqueous Samples, Rev. 8, 11/10/09	Screening	TOC	TOC Analyzer	Accutest	N
MSM080-10	Chain of Custody and Log-in Procedures, Rev. 10, 10/29/08	NA	NA	NA	Accutest	N

GC – gas chromatograph
GC/MA – gas chromatography/mass spectroscopy
ICP – inductively coupled plasma
NA – not applicable
VOC – volatile organic compounds

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS Select VOCs	Tuning	Prior to ICAL and at the beginning of each 12-hour period	Must meet the ion abundance criteria required by the method	Manual tuning; replacement of the ion source or filament. Rerun affected samples.	Analyst/Supervisor	MMS105-11, MMS308-02
	ICAL	Prior to sample analysis (minimum 5-point)	Average RF for VOC SPCCs ≥0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥0.1 for chloromethane, bromoform, and 1,1-dichloroethane; RSD for CCCs for VOCs ≤30%; RSD for each analyte ≤15% or linear least squares regression >0.995 or non-linear regression (minimum 6-point) coefficient of determination >0.990.	Correct problem then repeat ICAL		
	ICV	After each ICAL	All analytes within ±20% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Daily prior to sample analysis each 12-hour analysis period	RF for VOC SPCCs ≥0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥0.1 for chloromethane, bromoform, and 1,1-dichloroethane; % difference/drift for all analytes ≤20%	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	Retention time window position establishment for each analyte and surrogate	Once per ICAL and at the beginning of the analytical shift	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.	N/A		
	Evaluation of RRTs	With each sample	RRT of each target analyte within +/-0.06 RRT units	Correct problem, rerun ICAL		
GC/FID Methane, Ethane, Ethene	ICAL - 6 point Calibration	Instrument receipt, major instrument change, when CCV does not meet criteria	Average %RSD must be </=30	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/Supervisor	MGC297-03
	ICV	Once after each initial calibration.	%D for all analytes within 30%	Identify source of problem, correct, repeat calibration, rerun samples.		
	CV	If initial calibration analyzed, daily and after 20 samples, and at end of sequence.	%D for all analytes within 30%	Evaluate the samples: If the %RPD >30% and sample results are < PQL, narrate. If %RPD >30% and is likely a result of matrix interference, narrate. Otherwise, reanalyze all samples after last acceptable CV.		
Sulfate	ICAL - 5 standards plus a blank	Prior to sample analysis	Correlation coefficient >/= 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	MGN154-06
	Second-Source ICV/LCS	Once per every prep batch of 20 or fewer samples	80-120% of True Value	If the LCS fails high, report samples that are <PQL. Recalibrate and/or reanalyze other samples.		
	CCV	Every 4 samples and at the end of the run	80-120% of True Value	If the CCV fails high, report samples that are <PQL. Recalibrate and/or reanalyze samples back to last acceptable CCV recovery.		
Lachat Nitrate	ICAL - 5 standards plus a blank	Prior to sample analysis.	Correlation coefficient >/= 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	MGN160-06
	Second-Source ICV/LCS	Once per every prep batch of 20 or fewer samples	90-110% of True Value	If the LCS fails high, report samples that are <PQL. Recalibrate and/or reanalyze other samples.		
	CCV	Every 10 samples and at the end of the run	90-110% of True Value	If the CCV fails high, report samples that are <PQL. Recalibrate and/or reanalyze samples back to last acceptable CCV recovery.		
TOC Analyzer TOC (Aqueous)	ICAL - 5 standards plus a blank	Initially, when the daily CCV does not pass, but, no longer than every 3 months.	Correlation coefficient >/= 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	MGN064-08
	Second-Source ICV/LCS	Once per every prep batch of 20 or fewer samples	80-120% of true value.	If the LCS fails high, report samples that are <PQL. Recalibrate and/or reanalyze other samples.		
	CCV	Every 10 samples and at the end of the run	90-110% of true value.	If the CCV fails high, report samples that are <PQL. Recalibrate and/or reanalyze samples back to last acceptable CCV recovery.		

SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
TOC Analyzer TOC (Solid)	ICAL	Quarterly	R ≥ 0.995	Correct problem and repeat ICAL.	Analyst/Supervisor	MGN261
	ICV/CCV	Beginning and end of analysis and every 10 samples (ICV only at beginning)	All target analytes within ± 10% of the true value.	Prepare and reanalyze. If it fails again, repeat ICAL.		
ICP-AES Dissolved Iron and Manganese	ICAL	Beginning of each day or if QC exceeds criteria	Minimum one high standard and a calibration blank. If 3 standards plus calibration blank, linear regression correlation coefficient ≥0.995.	Correct problem, repeat ICAL	Analyst/Supervisor	MMA077-18
	ICV	Second source, once after each ICAL, prior to beginning a sample run	Analytes must agree within 10% of the expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	CCV	Every 10 samples and at the end of the analytical sequence	Analytes must agree within 10% of the expected value	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.		
	High-level check standard	Every 6 months	Within 10% of true value	Correct problem, reanalyze		
	Low-level calibration check standard	Daily after ICAL	Analytes must agree within 20% of the true value	Correct problem, reanalyze		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.		
	ICS	After beginning of the analytical run	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD ICS-AB: Within 20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.		

AES – atomic emission spectroscopy
CCC – continuing calibration check
CCV – continuing calibration verification
CV – calibration verification
GC – gas chromatography
ICAL – initial calibration
ICP – inductively coupled plasma
ICS – interference check solutions
LCS – laboratory control sample
LOD – limit of detection
MS – mass spectroscopy
NA – not applicable
PQL – program quality limit
QC – quality control
RRT – relative retention time
SOP – stand operating procedure
TOC – total organic carbon

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
TOC Analyzer (Solid)	Catalyst replacement, fill rinse bottles, absorber replacement (check drier, rinse, sample, and tin Chl tube, pump cassette, and optical cells)		Tubing, sample boat, syringe	As needed/ Daily	Acceptable calibration or CCV	Fix, clean, or replace	Analyst, Department Manager	MGN261
GC/MS	Check pressure and gas supply daily. Bake out trap and column, manual tune if BFB not in criteria, change septa as needed, cut column as needed, change trap as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Volatiles standards	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	Prior to initial calibration and/or as necessary.	Acceptable Tune	Correct the problem and repeat tune check		MMS105-11, MMS308-02
GC/FID	Check pressure and gas supply daily. Change septa and/or liner as needed, replace or cut column as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Methane, Ethane, Ethene standards	Injector liner, column, column flow, detector signal		Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV		MGC297-03
ICP-AES	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, replace peristaltic pump tubing as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Dissolved Iron and Manganese standard	Torch, nebulizer chamber, pump, pump tubing					MMA077-18
Turbidometer	Calibrate as needed	Sulfate standard	NA					MGN154-06
TOC Analyzer (Aqueous)	Check level of dilution water, drain vessel water, humidifier water, autosampler rinse water and phosphoric acid vessel and fill as needed. Replace oxygen cylinder.	Total organic carbon standard	Tubing, sample boat, syringe, humidifier, rinse lectrode, phosphoric acid vessel, oxygen pressure					MGN064-08
Lachat	Change the pump tubing monthly, replace capillary tubing, clean valves and flow cells.	Nitrate standard	Pump tubing, capillary tubing, reagent bottles, manifolds	Daily				MGN160-06

AES – atomic emission spectroscopy
GC – gas chromatography
ICP – inductively coupled plasma
MS – mass spectroscopy
NA – not applicable
SOP – stand operating procedure

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FTL/ AGVIQ-CH2M HILL
Sample Packaging (Personnel/Organization): FTL/ AGVIQ-CH2M HILL
Coordination of Shipment (Personnel/Organization): FTL/ AGVIQ-CH2M HILL
Type of Shipment/Carrier: Overnight Carrier/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt and Custody: Accutest employees
Analysis: Accutest employees
Sample Preparation: Accutest employees
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 1 year
SAMPLE DISPOSAL
Personnel/Organization: Accutest employees
Number of Days from Analysis: 90 days from receipt

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SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Samples will be collected by field team members under the supervision of the field team leader. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples 4±2˚C until they are received by the laboratory. The chain-of-custody will be placed into the cooler in a Ziploc® bag. Coolers will be taped up and shipped to the laboratories via FedEx overnight, with the air bill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to AGVIQ-CH2M HILL. See Worksheet #21 for SOPs containing sample custody guidance. The AGVIQ-CH2M HILL field team will ship all environmental samples to Accutest.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): Laboratory custody procedures can be found in the following SOPs, which are referenced in Worksheet #23 and can be found in Appendix C of this SAP: Accutest SOP MSM080-10
Sample Identification Procedures: Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, and sampler's initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain-of-custody. The laboratory will send sample login forms to the project chemist to check that sample IDs and parameters are correct.
Chain-of-custody Procedures: Chains–of-custody will include, at minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID. Date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain-of-custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems (LIMS) database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix	Groundwater, Surface Water, Pore Water, Sediment
Analytical Group	Select VOCs
Analytical Method/ SOP Reference	SW846 8260B/ MMS105-11

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/Contamination	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)
Laboratory Control Sample (LCS)		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If LCS fail high and samples are < LOD, narrate		Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.		Precision/Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1
Internal Standard	All field and QC samples, standards	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Accuracy/ Bias	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.
Surrogate	All field and QC samples	Percent recoveries: 1,2-Dichloroethane-d4 70-120; Dibromofluoromethane 85-115 Toluene-d8 85-120%; 4-Bromofluorobenzene 75-120%	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogates fail high and samples are < LOD, narrate. Contact Client if samples cannot be reanalyzed within hold time.		Accuracy/Bias	Percent recoveries: 1,2-Dichloroethane-d4 70-120; Dibromofluoromethane 85-115 Toluene-d8 85-120%; 4-Bromofluorobenzene 75-120%

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix	Groundwater, Surface Water,
Analytical Group	VC and PCE
Analytical Method/ SOP Reference	SW846 8260B SIM/ MMS105-11

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/Contamination	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)
Laboratory Control Sample (LCS)		See Worksheet #15-1	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If LCS fail high and samples are < LOD, narrate		Accuracy/ Bias	See Worksheet #15-1
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)		See Worksheet #15-1	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.		Precision/Accuracy/ Bias	See Worksheet #15-1
Internal Standard	All field and QC samples, standards	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Accuracy/ Bias	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.
Surrogate	All field and QC samples	Percent recoveries: Dibromofluoromethane 83-127% Toluene-d8 89-112%	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogates fail high and samples are < LOD, narrate. Contact Client if samples cannot be reanalyzed within hold time.		Accuracy/Bias	Percent recoveries: Dibromofluoromethane 83-127% Toluene-d8 89-112%

SAP Worksheet #28-3—Laboratory QC Samples Table

Matrix	Groundwater, Surface Water, Pore Water
Analytical Group	1,4-Dioxane
Analytical Method/ SOP Reference	SW846 8260B SIM/ MMS308-02

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/Contamination	No target compounds > ½ LOQ
LCS		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If LCS fail high and samples are < LOD, narrate		Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1
MS/MSD		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.		Precision/Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-1
Internal Standard	All field and QC samples, standards	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Accuracy/ Bias	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.
Surrogate	All field and QC samples	Percent recoveries: 1,2-Dichloroethane-d4 70-120; Dibromofluoromethane 85-115 Toluene-d8 85-120%; 4-Bromofluorobenzene 75-120%	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogates fail high and samples are < LOD, narrate. Contact Client if samples cannot be reanalyzed within hold time.		Accuracy/Bias	Percent recoveries: 1,2-Dichloroethane-d4 70-120; Dibromofluoromethane 85-115 Toluene-d8 85-120%; 4-Bromofluorobenzene 75-120%

SAP Worksheet #28-4—Laboratory QC Samples Table

Matrix	Pore Water, Groundwater
Analytical Group	Methane, Ethane, Ethene
Analytical Method/SOP Reference	RSK-175/ MGC297-03

QC Sample:	**Frequency/ Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	1 per batch of 20 or fewer samples.	No target compounds > ½ LOQ	Investigate source of contamination, Evaluate the samples and the associated QC: i.e. If the blank results are above the QL, report sample results which are <QL or >10X the blank concentration for that analyte. Otherwise, re-prepare a blank and the remaining SAMPLES	Analyst, Laboratory Department Manager	Accuracy/Bias, Contamination	No target compounds > ½ LOQ
MS/ MSD		See Worksheet #15-3	Evaluate the samples and associated QC. CA will not be taken for samples when recoveries are outside limits and LCS criteria are met. 2) If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC.		Accuracy/Bias, Precision	See Worksheet #15-3
LCS		See Worksheet #15-3	If an MS/MSD was performed and acceptable narrate. If the LCS recovery is high but the sample results are <QL, narrate. Otherwise, re-prepare the affected samples.		Accuracy/Bias	See Worksheet #15-3

SAP Worksheet #28-5—Laboratory QC Samples Table

Matrix	Pore Water, Groundwater
Analytical Group	Dissolved Iron and Manganese
Analytical Method/ SOP Reference	SW846 6010B/ MMA077-18

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per digestion batch of 20 or fewer samples of similar matrix.	No target metals> ½ LOQ	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/contamination	No target metals> ½ LOQ
LCS		See Worksheet #15-3	Redigest and reanalyze all associated samples for affected analyte.		Accuracy/Bias/ Contamination	See Worksheet #15-3
MS/MSD		See Worksheet #15-3	Flag results for affected analytes for all associated samples with ”N”.		Accuracy/Bias	See Worksheet #15-3
Post-digestion Spike	When MS recovery fails or analyte concentration in all samples < 50x LOD	Recovery should be within 75-125%	Run associated samples by method of standard addition or flag results.		Accuracy/Bias	Recovery should be within 75-125%
ICP Serial Dilution	One per preparation batch of twenty or fewer samples of similar matrix.	If original sample result is at least 50x LOQ, 5-fold dilution must agree within ±10% of the original result.	Flag results for affected analytes for all associated samples with “E”.		Accuracy/Bias	If original sample result is at least 50x LOQ, 5-fold dilution must agree within ± 10% of the original result.

SAP Worksheet #28-6—Laboratory QC Samples Table

Matrix	Pore Water, Groundwater
Analytical Group	Nitrate
Analytical Method/SOP Reference	EPA 352.1/ MGN160-06

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per prep batch of 20 samples or less.	No analyte detected > 1/2 LOQ	Investigate source of contamination. Report all sample results <PQL. Report sample results >10X the blank result and flag results with a “B”. Reanalyze all other samples associated with the failing blank.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	No analyte detected > 1/2 LOQ
Laboratory Duplicate		RPD <20; applies to samples >3X the PQL. RPD should be <100% for samples <3X the PQL.	Investigate problem and reanalyze sample in duplicate. If RPD still out, report original result with notation or narration		Precision	RPD <20; applies to samples >3X the PQL. RPD should be <100% for samples <3X the PQL.
MS/MSD		See Worksheet #15-3	Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. If both the LCS and MS are unacceptable re-prepare and reanalyze the samples and QC. Notate sample result in raw data if matrix interference suspected.		Accuracy/Bias	See Worksheet #15-3
LCS		See Worksheet #15-3	If the LCS fails high, report samples that are <PQL.. Recalibrate and/or reanalyze other samples.		Accuracy/Bias	See Worksheet #15-3

SAP Worksheet #28-7—Laboratory QC Samples Table

Matrix	Pore Water, Groundwater
Analytical Group	Sulfate
Analytical Method/SOP Reference	EPA 375.4/ MGN154-06

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One reagent blank analyzed as part of the calibration curve	No analyte detected > 1/2 LOQ	Investigate source of contamination. Report all sample results <PQL. Report sample results >10X the blank result and flag results with a “B”. Re-prepare and analyze method blank and all other samples processed with the contaminated blank	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	No analyte detected > 1/2 LOQ
Laboratory Duplicate	One sample duplicate per 20 samples	RPD <20 for results >3X PQL; RPD< 100 for results < 3X PQL	If lab QC in criteria and matrix interference suspected, flag data. Else, reanalyze.		Precision	RPD <20 for results >3X PQL; RPD< 100 for results < 3X PQL
MS		See Worksheet #15-3	If lab QC in criteria and matrix interference suspected, flag data. Else, reanalyze		Accuracy/Bias	See Worksheet #15-3
LCS		See Worksheet #15-3	Verify formulation, reanalyze and/or recalibrate		Accuracy/Bias	See Worksheet #15-3

SAP Worksheet #28-8—Laboratory QC Samples Table

Matrix	Pore Water, Groundwater
Analytical Group	TOC
Analytical Method/SOP Reference	SW-846 9060/ MGN064-08

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per prep batch	No analyte detected > 1/2 LOQ	Investigate source of contamination. Evaluate the samples and associated QC: i.e. If the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, re-prepare a blank and the remaining samples.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	No analyte detected > 1/2 LOQ
Laboratory Duplicate		RPD < 20%	(1) If lab QC in criteria and matrix interference suspected, flag data. Else, reanalyze		Precision	RPD < 20%
MS		See Worksheet #15-3	(1) If LCS in criteria and matrix interference suspected, flag data. Else, reanalyze		Accuracy/Bias	See Worksheet #15-3
LCS		See Worksheet #15-3	Investigate source of problem. If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, re-prepare a blank and the remaining samples.		Accuracy/Bias	See Worksheet #15-3

SAP Worksheet #28-9—Laboratory QC Samples Table

Matrix	Sediment
Analytical Group	Select VOCs
Analytical Method/ SOP Reference	SW846 8260B/ MMS105-11

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/Contamination	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)
LCS		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If LCS fail high and samples are < LOD, narrate		Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2
MS/MSD		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.		Precision/Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2
Internal Standard	All field and QC samples, standards	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Accuracy/ Bias	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.
Surrogate	All field and QC samples	Percent recoveries: Toluene-d8 85-115%; 4-Bromofluorobenzene 85-120%	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogates fail high and samples are < LOD, narrate. Contact Client if samples cannot be reanalyzed within hold time.		Accuracy/Bias	Percent recoveries: Toluene-d8 85-115%; 4-Bromofluorobenzene 85-120%

SAP Worksheet #28-10—Laboratory QC Samples Table

Matrix	Sediment
Analytical Group	1,4-Dioxane
Analytical Method/ SOP Reference	SW846 8260B SIM/ MMS308-02

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch of twenty or fewer samples of similar matrix.	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Bias/Contamination	No target compounds > ½ LOQ (> LOQ for common laboratory contaminants)
LCS		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If LCS fail high and samples are < LOD, narrate		Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2
MS/MSD		%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2	Corrective actions will not be taken for samples when recoveries are outside limits if likely due to matrix, otherwise contact client.		Precision/Accuracy/ Bias	%Rs must be within DoD QSM ver. 4.1 QC limits, see Worksheet #15-2
Internal Standard	All field and QC samples, standards	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.		Accuracy/ Bias	Retention times for internal standards must be +/- 30 seconds and the responses within -50% to +100% of the ICAL midpoint standard.
Surrogate	All field and QC samples	Percent recoveries: Toluene-d8 85-115%; 4-Bromofluorobenzene 85-120%	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogates fail high and samples are < LOD, narrate. Contact Client if samples cannot be reanalyzed within hold time.		Accuracy/Bias	Percent recoveries: Toluene-d8 85-115%; 4-Bromofluorobenzene 85-120%

SAP Worksheet #28-11—Laboratory QC Samples Table

Matrix:	Sediment
Analytical Group:	TOC
Analytical Method / SOP Reference:	Lloyd Kahn/ MGN261

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One is performed for each batch of up to 20 samples.	Target analytes must be < LOQ	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-extraction/re-analysis not feasible.	Analyst, Laboratory Supervisor	Contamination/ Bias	Target analytes must be < ½ LOQ
Lab duplicate		RPD ≤ 20%			Precision/ Accuracy	RPD < 20%
LCS		80-120%			Accuracy/Bias	80-120%

SAP Worksheet #28-12—Laboratory QC Samples Table

Matrix:	Sediment
Analytical Group:	Grain Size
Analytical Method / SOP Reference:	ASTM D422-63/EGN258

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Lab Duplicate	One per 20 samples	RPD $\leq$20%	If duplicate is outside control limits, no reanalysis is necessary. QC results must be footnoted to note possible sample non-homogeneity.	Analyst, Laboratory Supervisor	Precision/Accuracy	RPD $\leq$20%

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables (EDDs) • Identification of QC Samples • Release of Analytical Data • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes • Sample Receipt, CoC, and Tracking Records • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Data Validation Reports	• Field data deliverables such as logbooks entries, CoCs, air bills, EDDs, etc will be kept on AGVIQ-CH2M HILL's local network server. • Field parameter data will be loaded with the analytical data into Navy Installation Restoration Information System (NIRIS) • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. • Electronic data from the laboratory will be loaded into NIRIS • Following project completion, hardcopy deliverables such as logbooks, CoCs, raw data, data validation reports, etc will be archived indefinitely.

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SAP Worksheet #30—Analytical Services Table

All samples shall be shipped to Accutest in Marlborough, Massachusetts, for analysis. The data package will include hardcopy data (Level III deliverable- no raw data), a compact disk (CD) containing portable document format (PDF) versions of the data package, and two EDDs. The full data package will be due within 21 calendar days of sample receipt. The first data deliverable will include PDF versions of the final Form 1 results only and will be due within 14 calendar days.

Matrix	Analytical Group	Sample Locations/ Identification Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
Surface Water	Select VOCs	See Worksheet #18	SW-846 8260B	14 calendar days for Form1 results/ 21-calendar days for Level III hardcopy and EDDs	Accutest Kristen Blanchard Accutest Laboratories Of New England 495 Technology Center West, Building One Marlborough, MA 01752 508-481-6200	TBD[1]
	VC and PCE		SW-846 8260B SIM			
	1,4-Dioxane		SW-846 8260B SIM			
Sediment	Select VOCs		SW-846 8260B			
	1,4-Dioxane		SW-846 8260B SIM			
	TOC		Lloyd Kahn			
	Grain Size		ASTM D422			
Groundwater	Select VOCs		SW-846 8260B			
	VC and PCE		SW-846 8260B SIM			
	1,4-Dioxane		SW-846 8260B SIM			
	Dissolved Iron and Manganese		SW-846 6010B			
	Nitrate		EPA 352.1			
	Sulfate		EPA 375.4			
	Methane, Ethane, Ethene		RSK-175			
	TOC		SW-846 9060			
Pore Water	Select VOCs		SW-846 8260B			
	1,4-Dioxane		SW-846 8260B SIM			
	Dissolved Iron and Manganese		SW-846 6010B			
	Nitrate		EPA 352.1			

Matrix	Analytical Group	Sample Locations/ Identification Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
	Sulfate		EPA 375.4			
	Methane, Ethane, Ethene		RSK-175			
	TOC		SW-846 9060			

[1] If circumstances arise that render Accutest unable to provide analytical services, a backup laboratory will be chosen at that time.

SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Response to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Onsite Laboratory Technical Systems Audit	Laboratory must have a current accreditation from the DoD Environmental Laboratory Accreditation Program (ELAP) which will identify the period of performance and scope of analytical methods[1]. The laboratory must be re-evaluated prior to expiration of period of performance	External	DoD Laboratory Accrediting Body (TBD)	DoD Laboratory Accrediting Body (TBD)	Mark Warren/ Accutest QAO	Mark Warren/ Accutest QAO	Theresa Rojas, SB-RAC QA Manager
Field Performance Audit	Once per definable feature of work	Internal	AGVIQ-CH2M HILL	FTL	FTL and SSC	FTL and SSC	Venky Venkatesh, AGVIQ-CH2M HILL PM

Note: Stop Work Order: Any field member can immediately stop work if an unsafe condition, which is immediately threatening to human health, is observed. Ultimately, the FTL or PM can stop work for a period of time. NAVFAC Atlantic can stop work at any time.

[1] See Attachment C for a copy of Accutest New England's DoD ELAP Certificate of Accreditation and Scope of Accreditation

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field Performance Audit	Checklist and written audit report	Venky Venkatesh, PM AGVIQ-CH2M HILL	Within 1 week of audit	Memorandum	FTL AGVIQ-CH2M HILL (TBD)	Within 1 week of receipt of CA Form
Offsite Laboratory Technical Systems Audit	Written Audit Report	Mark Warren/ Accutest QAO	Within 2 months of audit	Memorandum	NFESC Auditor, TBD	Within 2 months of receipt of initial notification.

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SAP Worksheet #32-1—Corrective Action Form

Person initiating corrective action _____ Date _____

Description of problem and when identified: _____
_____
_____
_____

Cause of problem, if known or suspected: _____
_____
_____
_____

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

CA implemented by: _____ Date: _____
CA initially approved by: _____ Date: _____
Follow-up date: _____
Final CA approved by: _____ Date: _____

Information copies to:
Theresa Rojas/ Navy SB RAC QAM

SAP Worksheet #32-2— Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members:

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

_____

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

_____

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

_____

Sample Collection

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

_____

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

_____

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

_____

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

_____

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

_____

Yes _ No _ 6) Are quality assurance checks performed as specified in the work plan?
Comments _____

_____

Yes _ No _ 7) Are photographs taken and documented?
Comments _____

_____

Document Control

Yes _ No _ 1) Have any accountable documents been lost?
Comments _____

_____

Yes _ No _ 2) Have any accountable documents been voided?
Comments _____

_____

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

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

_____

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

_____

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

_____

Yes _ No _ 7) Is chain-of-custody documented and maintained?
Comments _____

_____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Performance CA Memorandum	After Field Audit	1 week after audit, if necessary	AGVIQ-CH2M HILL FTL	Will be posted in project file.
QA Management Report/Technical Memorandum	Once results are received from data validator	Approximately 8 weeks following sample collection	AGVIQ-CH2M HILL Project Team	Will be posted in project file.

The following will be addressed in the QA/QC section of QA Management Report/Technical Memorandum:

- Summary of project QA/QC programs and trainings
- Conformance of project activities to SAP requirements and procedures
- Status of project and schedule delays
- Deviations from approved SAP and approved amendments to SAP
- Description and findings of audits
- Results of data review activities in terms of amount of usable data generated (results of the Chemist's QC check on data prior to loading into AGVIQ-CH2M HILL's database)
- Required CAs and effectiveness of CA implementation
- Data usability assessments in terms of accuracy, precision, representativeness, completeness, comparability and sensitivity.
- Limitations on use of measurement data generated.

The report will also include data quality concerns:

- Narrative and timelines of project activities; summary of project quality objective development
- Reconciliation of project data with project quality objectives
- Summary of major problems encountered and their resolution
- Data summary, including tables, charts, graphs, with appropriate sample identification or station location numbers, concentration units, percent solids (not applicable), and data quality flags
- Conclusions and recommendations

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SAP Worksheet #34—Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	Venky Venkatesh – AGVIQ-CH2M HILL
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.	Internal	FTL – AGVIQ-CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, and sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	Venky Venkatesh – AGVIQ-CH2M HILL
Laboratory Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the chain-of-custody (CoC) records. All sample labels will be checked against the CoC, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and workstation required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	Accutest employees
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	Megan Morrison – AGVIQ-CH2M HILL
Laboratory Data Package	Once received from the laboratory, the data package will be reviewed for completeness and consistency before the data are loaded.	External	Megan Morrison – AGVIQ-CH2M HILL

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SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation
IIb	Onsite Screening	Ensure that all field data meet UFP-SAP requirements for completeness and accuracy based on the field calibration records.	FTL – AGVIQ-CH2M HILL
IIa	SOPs	Ensure that all sampling and analytical SOPs were followed.	FTL – AGVIQ-CH2M HILL Accutest QAO
IIa	Method QC Results	Ensure that all required QC samples were run and meet method and/or project required limits.	Megan Morrison – AGVIQ-CH2M HILL
IIb	UFP-SAP QC Sample Results	Ensure that all required UFP-SAP QC samples were run and meet required limits.	Megan Morrison – AGVIQ-CH2M HILL
IIb	QLs	Ensure all sample results met the project QL goals specified in the UFP-SAP	Megan Morrison – AGVIQ-CH2M HILL

[1] IIa=compliance with methods, procedures, and contracts.

IIb=comparison with measurement performance criteria (MPC) in the SAP.

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SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater, Surface Water, Sediment, Pore Water	Select VOCs, 1,4-Dioxane, Dissolved Iron and Manganese, Nitrate, Sulfate, Methane, Ethane, Ethene, TOC	10% of all samples will be validated using analytical methods and laboratory SOPs as presented in this SAP to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers that may be used are those presented in *National Functional Guidelines for Superfund Organic Methods* (EPA, 2008) and *National Functional Guidelines for Inorganic Data Review* (EPA, 2004). National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Megan Morrison, AGVIQ-CH2M HILL
IIa		Select VOCs, 1,4-Dioxane, Dissolved Iron and Manganese, Nitrate, Sulfate, Methane, Ethane, Ethene, Grain Size, TOC	The remaining data will be reviewed against the analytical methods for outstanding QA/QC issues and anomalies by the laboratory. Issues will be summarized in the case narrative. AGVIQ-CH2M HILL Chemist and PM will review the analytical results and case narrative before the data is loaded to ensure no major problems exist.	Accutest employees Venky Venkatesh, Megan Morrison AGVIQ-CH2M HILL
IIb		Select VOCs, 1,4-Dioxane, Dissolved Iron and Manganese, Nitrate, Sulfate, Methane, Ethane, Ethene, Grain Size, TOC	Results will be compared to PALs/PILs as specified in Worksheet #15. QA/QC results will be compared to measurement performance criteria in Worksheets #24 and #28.	Venky Venkatesh, Megan Morrison AGVIQ-CH2M HILL

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SAP Worksheet #37—Usability Assessment

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

- Non-detected site contaminants will be evaluated to ensure that project QL goals in Worksheet #15 were achieved. If project QLs were achieved and the verification and validation steps yielded acceptable data, the data is considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, J+, or J-. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions.
  - J- Analyte present. Reported value may or may not be accurate or precise.
  - UJ- Analyte not detected. QL may be inaccurate or imprecise.
  - J+- Analyte present. Interferences present that may cause the reported result to be biased high. Actual value is expected to be lower.
  - J- - Analyte present. Reported value may be biased low. Actual value is expected to be higher.
  - R- Rejected result. Result not reliable.
- Additional qualifiers that may be given by the validator are:
  - N- Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
  - NJ- Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
  - U- Not Detected.
- For statistical comparisons, non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable (EDD). Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

SAP Worksheet #37—Usability Assessment (continued)

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

- To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be reconciled with MPC following validation and review of data quality indicators (DQIs).
- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater detail because they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between lab and field precision, the cause will be further evaluated to assess impact on decision making.

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

The following will be prepared by AGVIQ-CH2M HILL and presented to and submitted to the NAS Brunswick Partnering Team (MEDEP, EPA, Navy, and AGVIQ-CH2M HILL) for review and decisions on the path forward for the site:

- Data tables will be produced to reflect detected and non-detected site contaminants of concern (COCs) as well as other parameters analyzed. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation considering all of the above will be provided as part of presentations and follow-up reporting presented to the NAS Brunswick Partnering Team. The presentations and reporting will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

The AGVIQ-CH2M HILL Project Team, including the PM and Project Chemist, will review the data and compile a presentation for the NAS Brunswick Partnering Team. The Partnering Team as a whole will assess the usability of the data.

References

ABB Environmental Services, Inc. (ABB-ES). 1998. Record of Decision for No Further Action at Sites 4, 11, and 13 and Remedial action for the Eastern Plume. February.

ECC. 2008a. Final Summary Report for the Mere Brook and Merriconeag Stream Floodplain and Upland Area Investigation, Eastern Plume. Naval Air Station Brunswick, Maine. July.

ECC. 2008b. Final Long-Term Monitoring Plan Eastern Plum, Naval Air Station, Brunswick, Maine. February.

Maine Center for Disease Control and Prevention (CDC). 2010. Maximum Exposure Guidelines (MEGs) for drinking water. October 21.

Maine Department of Environmental Protection (MDEP). 2005. Bureau of Remediation & Waste Management - Pore Water Sampling Data from Mere Brook & Merriconeag Stream Area. December.

Maine Department of Environmental Protection Bureau of Remediation & Waste Management. 2005. Pore Water Sampling Data from Mere Brook & Merriconeag Stream Area. December.

Maine Department of Environmental Protection and Center for Disease Control. 2009. Guidance for Human Health Risk Assessment For Hazardous Substances in Maine. July 2009 Draft.

U.S. Environmental Protection Agency (EPA). 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents. EPA/6000/R-98/128. September.

U.S. Environmental Protection Agency (EPA). 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001: http://www.epa.gov/region4/waste/ots/ecolbul.htm.

U.S. Environmental Protection Agency (EPA). 2002. Draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance).

U.S. Environmental Protection Agency (EPA). 2006a. *Guidance on Systematic Planning Using the Data Quality Objectives Process*.

U.S. Environmental Protection Agency (EPA). 2006b. Biological Technical Assistance Group (BTAG), Region 3 Freshwater Screening Benchmarks. Available at: http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm.

U.S. Environmental Protection Agency (EPA). 2008. Procedures for the Derivation of Equilibrium Partitioning Sediment benchmarks (ESBs) for the Protection of Benthic Organisms. Compendium of Tier 2 Values for Nonionic Organics. U.S. Environmental Protection Agency, Office of Research and Development: Washington DC. EPA/600/R-02/016. PB2008-107282. March 2008. Available at: http://www.epa.gov/NHEERL/publications/files/ESB_Compendium_v14_final.pdf.

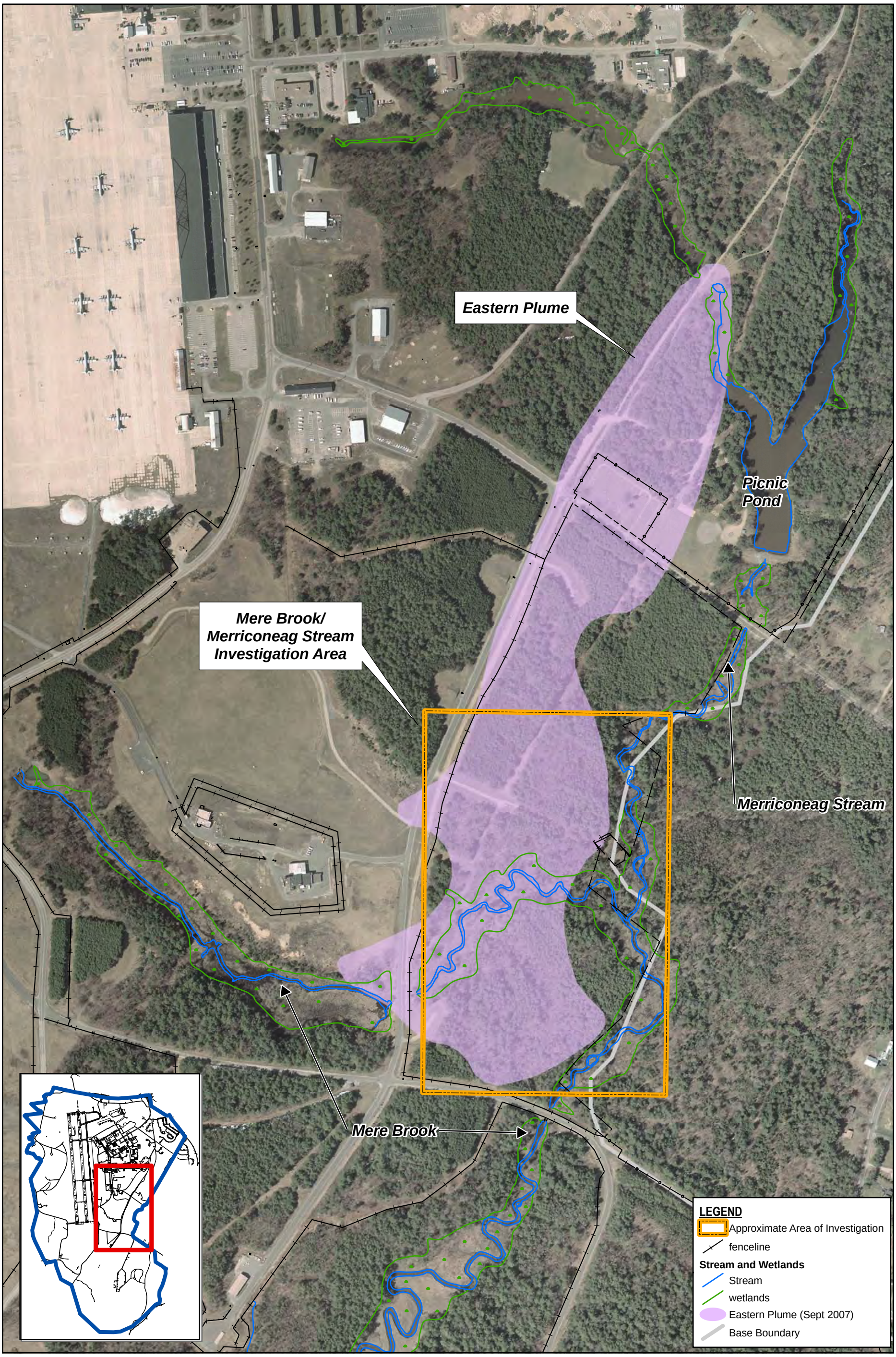
U.S. Environmental Protection Agency (EPA). 2009. National Recommended Water Quality Criteria. Office of Water Office of Science and Technology. [Online] Available at: http://www.epa.gov/ost/criteria/wqctable/.

U.S. Environmental Protection Agency (EPA). 2010. Regional Screening Levels for Chemical Contaminants at Superfund Sites. [Online] Available at: http://epa-prgs.ornl.gov/chemicals/index.shtml .

U.S. Navy. 2010. *Explanation of Significant Differences, Eastern Plume, Naval Air Station Brunswick, Maine.* September.

Washington State Department of Ecology. 2010. *Standard Operating Procedure for installing, measuring, and decommissioning hand-driven in-water piezometers.* August.

Figures



AGVIQ ENVIRONMENTAL SERVICES CH2M HILL JOINT VENTURE

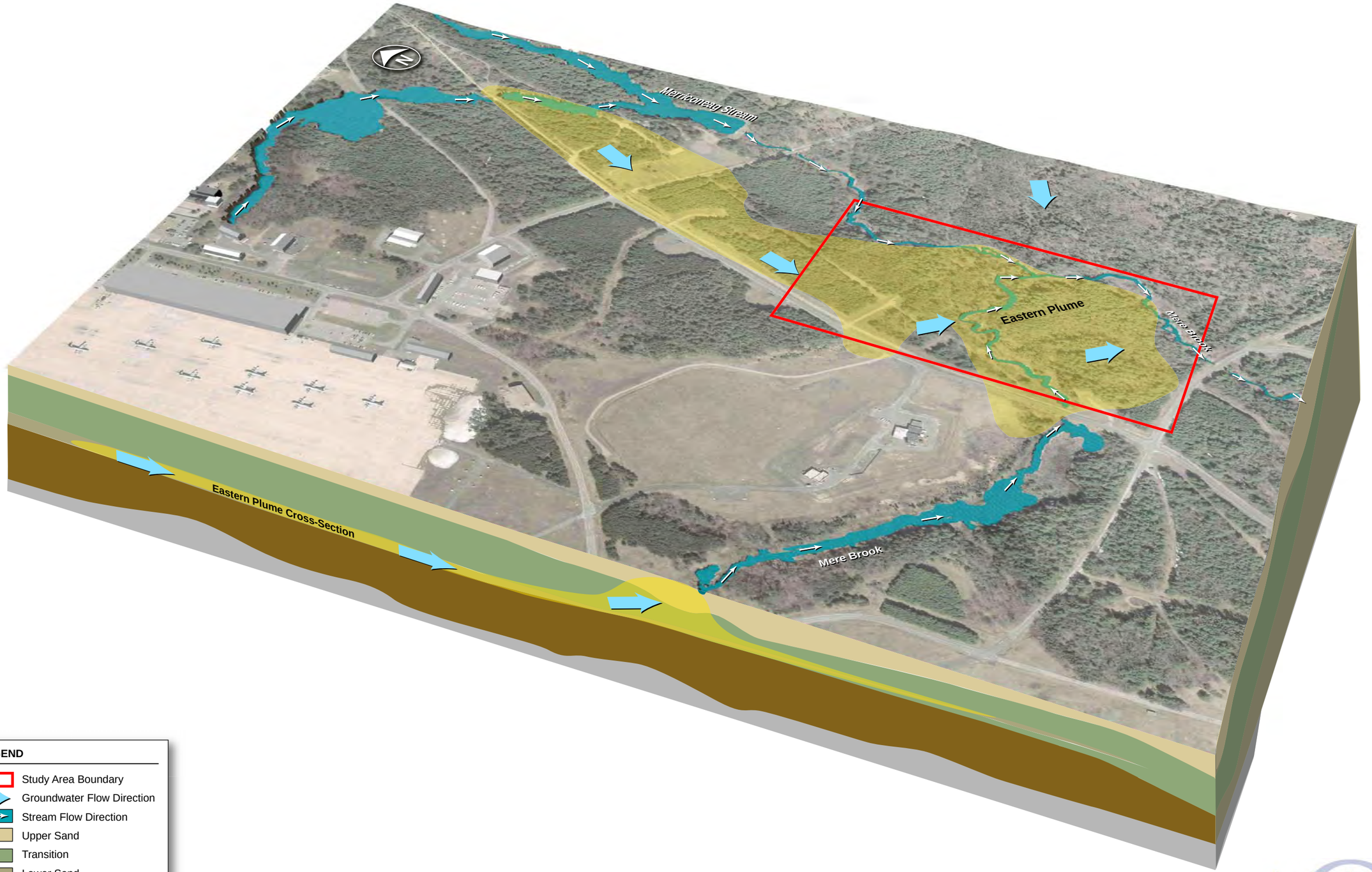
0 150 300 600 900 1,200 Feet

N

Figure 1

Mere Brook/Merriconeag Stream Investigation Area
Groundwater - Surface Water Interface Investigation
Naval Air Station Brunswick
Brunswick, Maine

C:\Documents and Settings\MNIEBAUE\My Documents\mike projects\NAVY-Brunswick\GIS\Merriconeag

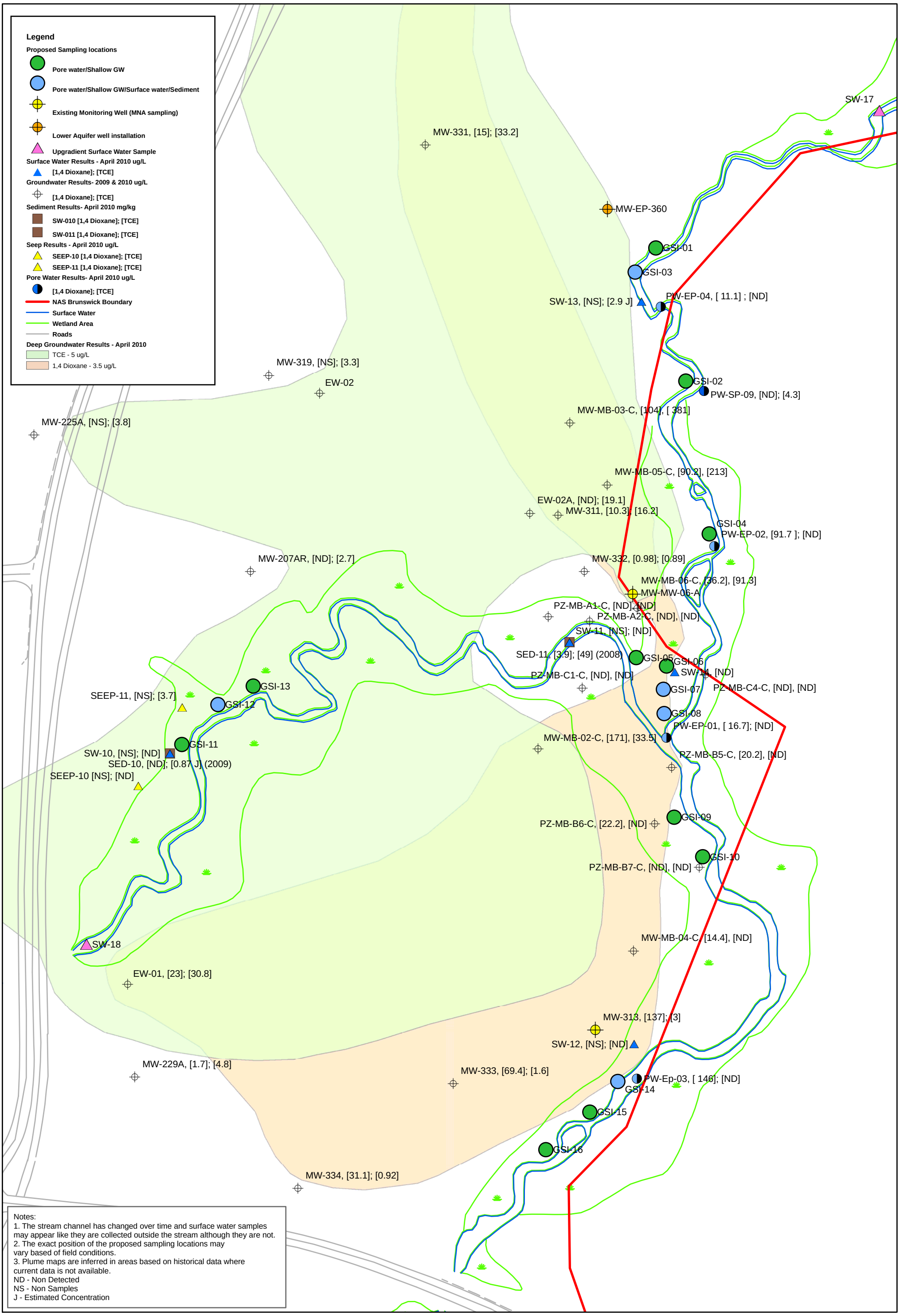


LEGEND

- Study Area Boundary
- Groundwater Flow Direction
- Stream Flow Direction
- Upper Sand
- Transition
- Lower Sand
- Presumpscot Clay
- Bedrock
- Eastern Plume

FIGURE 2
Conceptual Site Model
Groundwater-Surface Water Interface Investigation
Naval Air Station Brunswick
Brunswick, Maine

AGVIQ ENVIRONMENTAL SERVICES
CH2M HILL JOINT VENTURE



AGVIQ ENVIRONMENTAL SERVICES
CH2M HILL JOINT VENTURE

0 50 100 200 300 400 Feet

N

Figure 3

Proposed Sampling Locations
Groundwater-Surface Water Interface Investigation
Naval Air Station Brunswick
Brunswick, Maine

\\andromeda\proj\AGVIQ\37468Brunswick\GIS MPN 11-5-10

ATTACHMENT A

Health and Safety Plan

Health and Safety Plan

Merriconeag Stream Sampling
Naval Air Station Brunswick
Brunswick, Maine

Revision No. 0

Contract No. N62470-08-D-1006
Task Order No. WE09

Submitted to:

U.S. Naval Facilities
Engineering Command
Mid-Atlantic

Prepared by:

1000 Abernathy Road
Suite 1600
Atlanta, GA 30328

Revision 0

August, 2010

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2 Employee Signoff Form
3 Subcontractor H&S Tracking Form
4 Project H&S Forms/Permits
5 Material Safety Data Sheets
6 Chemical-Specific Training Form and Project-Specific Chemical Product Hazard Communication Form
7 Activity Hazard Analyses (AHAs)
8 Pre-Task Safety Plan (PTSP)
9 Loss Prevention Observation (LPO) Form
10 Incident Report Form
Loss/Near Loss Incident Report Form
11 Emergency Contact List
12 Hurricane Preparedness Plan (Reserved)

Acronyms and Abbreviations

AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Joint Venture
AHA	Activity Hazard Analysis
AL	Action Level
ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASTM	American Society for testing and Materials
BBLPS	Behavior Based Loss Prevention System
bgs	below ground surface
C&D	construction and demolition
CFR	Code of Federal Regulation
CIH	Certified Industrial Hygienist
COCs	Constituents of Concern
COPC	Chemical of Potential Concern
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CSE	Confined Space Entry
CTO	Contract Task Order
dB	decibels
DEET	N, N-diethyl-meta-polyamide
DFWP	Drug Free Workplace Program
DOT	Department of Transportation
EOD	explosive ordnance disposal
ESC	erosion and sediment control
EZ	exclusion zone
FA	first aid
FC	foot candle
FS	Feasibility Study
GFCI	ground fault circuit interrupter
GPR	ground-penetrating radar
H&S	Health and Safety
HBV	Hepatitis B Virus
HIV	Human Immunodeficiency Virus
HAZWOPER	Hazard Waste Operations
HEPA	high-efficiency particulate air
HR	heart rate
HS&E	Health, Safety, and Environment
HSPA	Health and Safety Program Administrator
HSP	Health and Safety Plan
IDW	Investigation Derived Waste
IRF	Incident Report Form

KA	Contracts Administrator
LPO	Loss Prevention Observation
m	meter(s)
MEC	munitions of explosive concern
$\mu g/m^3$	micrograms per cubic meter
mg/kg	milligrams per kilogram
MPPEH	material presenting a potentially explosive hazard
MSDS	Material Safety Data Sheet
NAVFAC	Naval Facilities Engineering Command
NIOSH	National Institute for Occupational Health
NLI	Near Loss Investigation
NSC	National Safety Council
NTR	Navy Technical Representative
OEL	Occupational Exposure Limits
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
POC	Point of Contact
PPE	Personal Protective Equipment
ppb	parts per billion
ppm	parts per million
PTSP	Pre-Task Safety Plan
RA	Remedial Action
SWMU	Solid Waste Management Units
RCRA	Resource Conservation and Recovery Act
RF	radio frequency
RMSF	Southern Tick-Associated Rash Illness
ROICC	Resident Officer in Charge of Construction
SOP	Standard of Practice
SSC	Site Safety Coordinator (synonymous with SSHO)
SSHO	Site Safety and Health Officer
SSHS	Site Safety and Health Specialist (synonymous with SSHO)
STARI	Southern Tick-Associated Rash Illness
SVOC	Semi-Volatile Organic Compounds
SWO	Stop Work Order
SZ	Support Zone
TSCA	Toxic Substances Control Act
UL	Underwriters Laboratory
UV	ultraviolet
UXO	unexploded ordnance
VOCs	Volatile Organic Compounds
WIS	waste information sheet

1.0 Introduction

AGVIQ-CH2M HILL Constructors, Inc. Joint Venture (AGVIQ-CH2M HILL) has prepared this Health and Safety Plan (HSP) in response to the Naval Facilities Engineering Command, Mid-Atlantic (NAVFAC MIDLANT), Statement of Work (SOW) for Task Order (TO) No. WE09.

It is the intent of this HSP and the Accident Prevention Plan (APP) in **Attachment 1** of this HSP, to address requirements set forth by 29CFR1910, 29CFR1926 and EM 385 1-1, Appendix A, but especially the requirements of 29CFR1910.120. For clarification, this HSP and APP shall be collectively referenced as the HSP throughout, but implemented together as a single document, in their entirety.

Signatory authorization of the HSP and APP preparer and designated AGVIQ-CH2M HILL personnel who approve and concur that this HSP and its components are acceptable for full project implementation is included in section 11.0 "Approvals" of this HSP, as well as section 1.0 of **Attachment 1**, "Signatures".

Contact information for these designated personnel is provided in Section 2.2.1, Section 11.0 and **Attachment 1**, Section 1.0 of this HSP.

A hardcopy of this HSP and APP, inclusive of the project Remedial Action Work Plan (RAWP) and its other components shall be available on-site for reference by site personnel.

All site personnel, including AGVIQ-CH2M HILL and subcontractors, who may be covered by this Health and Safety Plan (HSP), must review or be provided a detailed briefing on the contents of this document and sign the Employee Signoff Form (**Attachment 2**).

1.1 Site Background

The Eastern Plume Site is located at the Naval Air Station (NAS) Brunswick has migrated south and east toward the Mere Brook and Merriconeag Stream along the eastern border of NAS Brunswick. There is evidence that the groundwater is discharging into these bodies of water. Determining the magnitude of contamination discharging and evaluating the possible degradation of the contaminants as the groundwater discharges are the general objectives of this investigation. This investigation will assist in characterization of the geologic and hydrologic conditions at the site and update the conceptual site model. The purpose of this technical memorandum is to propose sampling and analysis that will address this objective. Subsequently, a Uniform Federal Policy – Sampling and Analysis Plan (UFP-SAP) will be developed for the proposed sampling and analysis summarized herein.

1.2 General Task Order Scope of Work

The following objectives will be accomplished following execution of the work outlined in the Remedial Action Work Plan:

- **Groundwater-Surface Water Interface Sampling at Mere Brook and Merriconeag Stream**
  - Monitoring well installation
  - Groundwater sampling

- Pore water sampling
- Surface water sampling
- Sediment sampling

1.3 Health and Safety Plan Assumption Set

The assumption set for the development of this HSP is that AGVIQ-CH2M HILL site personnel and AGVIQ-CH2M HILL controlled subcontractors, who may be covered by this HSP, will not be exposed to identified COCs, or chemical products that may be used in operational processes, in excess of established Occupational Exposure Limits (OELs) while executing their assigned tasks. This assumption is based on the following:

- Site personnel shall execute good personal hygiene practices to facilitate a negative exposure to identified site COCs via incidental dermal or ingestion exposure vectors.
- Where use of personal protective equipment (PPE) equipment is specified, it will be used in accordance with Section 5.0 of this HSP.
- Where the use of air monitoring equipment is specified, it shall be in accordance with Section 6.0 of this HSP. Action levels and action level responses defined by this HSP shall be adhered to. Air monitoring data collected during the execution of the task order work phases shall be documented and included for the project file.
- Work is being performed in an open air, well ventilated environment. This in combination with the low risk potential for exposure to site COCs within the surface areas that these COC's may be encountered during intrusive operations, it is anticipated that personnel will not be exposed to identified site COCs in excess of established OELs while performing their assigned duties.
- Unexploded ordnance (UXO), munitions of explosive concern (MEC), or materials presenting a potentially explosive hazard (MPPEH) will not be encountered, handled, or otherwise managed under this contract and UXO avoidance support is not required per the conditions of the contract.

In the event that the above assumption set is not verified, the conditions of this HSP will be re-evaluated and amended as necessary to address applicable hazards that maybe associated with newly encountered project conditions or newly defined project tasks. In the event that recorded air monitoring data indicates that site workers are or may be exposed to site COC concentrations in excess of established OELs, work shall immediately cease until such engineering or administrative control measures and/or PPE are implemented to reduce potential worker exposures to acceptable levels.

1.4 HAZWOPER-Regulated Tasks

Where certain work tasks include the handling, removal, containment, investigation, or other physical site management of hazardous waste/material or other regulated materials, execution of such tasks and potential employee exposure to chemical hazards associated with these tasks may be regulated under 29 Code of Federal Regulation (CFR) 1910.120/29 CFR 1926.65. For this task order, following activities will be considered Hazardous Waste Operations (HAZWOPER)-regulated tasks because of the potential worker exposure to identified site contaminants.

- **Groundwater-Surface Water Interface Sampling at Mere Brook and Merriconeag Stream including**
  - Monitoring Well Installation
  - Groundwater Sampling
  - Pore Water Sampling
  - Surface Water Sampling
  - Sediment Sampling

Personnel performing the above work phase tasks or in conditions where there is potential exposure to site COCS, shall meet the training and medical surveillance requirements established by section 2.0, Employee Medical Surveillance and Training, of this HSP.

1.5 Non-HAZWOPER-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of HAZWOPER regulations under 29 CFR 1910.120/29 CFR 1926.65 may be not applicable. Where this is considered, it must be demonstrated that the assigned tasks can be performed without the possibility of exposure to chemical hazards in order to use personnel who do not meet the criteria established by these standards. A determination from the Health and Safety Program Administrators (HSPA) and/or Program Certified Industrial Hygienist (CIH) is required before project tasks are conducted by personnel who do not meet the requirements of 29 CFR 1910.120/29 CFR 1926.65 and if where there is question to potential exposure to chemical hazards. Where it is not possible that workers could not be exposed to site chemical hazards during the normal execution of assigned tasks, the task can be considered a Non-HAZWOPER Regulated Task. For this project, the following activities can be considered Non-HAZWOPER Regulated Tasks.

- Mobilization and demobilization
- Land and Utility Survey Activities to support the remedial objectives where site soil or water impacted by COC's constituents are not disturbed or there is no potential site worker exposure to identified site COCs.

1.6 Activity Hazard Analysis Basis

Table 1-1 below summarizes identified hazards associated with the phases of work anticipated with the project execution. Table 1-1provides the basis for the development of Activity Hazard Analysis documents, which must be implemented as part of the AGVIQ-CH2M HILL Health and Safety Program, Behavior Based Loss Prevention System (BBLPS). Please refer to Section 4.0 of this HSP for additional detail on the BBLPS.

Attachment 7 of HSP contains applicable Activity Hazard Analysis (AHA) documents, which in addition to the content of this HSP/APP, are intended to reinforce project or program requirements and present project control measures for anticipated or encountered hazards that may occur during the execution of an employee's assigned tasks.

TABLE 1-1
Activity Hazard Analysis Basis

Potential Hazards	Project Activities – WE06				
	Mobiliz. & Demob.	Land & Utility Surveys	Drilling/DPT	Equipment Cleaning	Groundwater-Surface Water Interface Sampling at Mere Brook / Merriconeag Stream
Adverse Weather	X	X	X	X	X
Biological	X	X	X	X	X
Buried Utilities			X		
Brushcutters/Mowers					
Chemical Hazards			X	X	X
Compressed Gas Cylin.					
Concrete and Masonry					
Confined Space Entry					
Cuts/Abrasions	X	X	X	X	X
Cranes					
Demolition/dismantling					
Electrical Safety	X		X		
Drilling (HSA/DPT)			X		
Excavations					
Fall Protection					
Fire/Explosion Hazards					
Forklifts					
Fire Prevention			X	X	X
Hand & Power Tools	X			X	X
Haul Truck Operations					
Heat/Cold Stress	X	X	X	X	X
Heavy Equipment	X		X	X	
Housekeeping	X	X	X	X	X
Ladders & Stairs			X		X
Land Clearing / Stripping					
Lockout /Tagout					
Manual Lifting	X	X	X	X	X
Material Handling			X		X
Machine Guarding			X		
Noise	X		X	X	
Overhead Utilities	X		X		
Pinch/Struck by/Caught	X	X	X		
Pressure Washing				X	
Pressurized Lines/ Equip.				X	
Rigging					
Scaffolding					
Slips/Trips/Falls	X	X	X	X	X
Spill Prevention			X	X	X
Suspended Loads					
Vacuum Truck Ops.					
Vehicle Traffic	X	X			
Visible Lighting	X	X	X	X	X
Welding and cutting					
Working Alone					
Working over water					

2.0 Project Organization and Personnel

2.1 Employee Medical Surveillance and Training

All AGVIQ-CH2MHILL personnel performing Hazwoper Regulated Tasks are enrolled in a Comprehensive Health and Safety Program, which at a minimum, meets the requirements of 29CFR1910.120/29CFR1926.65 or 29CFR1910.134. These medical surveillance and training requirements are summarized below.

Training or Medical Surveillance Requirement	Applicability
29CFR1910.120(e)(3)/29CFR1926.65(e)(3) Note: 40 hr or 24 training as applicable to employee assigned duties.	All site personnel performing Hazwoper regulated activities identified in section 1.5 of this HSP.
29CFR1910.120(e)(8)/29CFR1926.65(e)(8) annual basis	All site personnel performing Hazwoper regulated activities identified in section 1.5 of this HSP.
29CFR1910.120(e)(4)/29CFR1926.65(e)(4)	All site manager, supervisory or SSHO personnel performing Hazwoper regulated activities identified in section 1.5 of this HSP.
First Aid/CPR 1st Aid – typically 3 yr renewal CPR – 1 or 2 yr renewal (depending on sponsor)	All designated manager, supervisory or SSHO site personnel (2 per site).
29CFR1910.120(f)/29CFR1926.65(f) annual basis under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine	All site personnel performing Hazwoper regulated activities identified in section 1.5 of this HSP.
29CFR1910.134(e) annual basis under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine	All site personnel performing Hazwoper regulated activities identified in section 1.5 of this HSP and required to utilize respiratory protection

Initial training required by 29CFR1910.120(e)(3)/29CFR1926.65(e)(3) shall be 40-hour or 24-hour training initial training, and 3-day/1 day on-the-job experience in accordance with employee's normal assigned duties and anticipated site conditions as applicable to the requirements of CFR1910.120(e)(3)(i)-(iv)/29CFR1926.65(e)(3) (i)-(iv). Site personnel performing operations falling under the requirements of 29CFR1910.120/29CFR1926.65 shall also have 8 hours of "refresher training" on an annual basis, in accordance with 29CFR1910.120(e)(8)/29CFR1926.65(e)(8).

On-site management and supervisors directly responsible for, or who supervise employees engaged in, hazardous waste operations and individuals designated as an SSHO shall also have an additional 8 hours of "management and supervisor" training defined by 29CFR1910.120(e)(8)/29CFR1926.65(e)(8).

Subcontractors performing operations applicable to the 29CFR1910.120/29CFR1926.65 requirements must also adhere to the above training and medical surveillance requirements.

In addition, each employee with SSHO responsibilities shall have received an OSHA 10 hr Outreach Construction Safety training course (OSHA 10hr), or equivalent (i.e. CH2MHILL Site Safety Coordinator (SSC) training), where construction related operations are also occurring on-site.

At a minimum, personnel designated with management, supervisor, or SSHO responsibilities must all have current American Red Cross or American Heart Association sponsored First Aid and Cardio-Pulmonary Resuscitation (FA-CPR) certifications. At least two FA-CPR designated employees must be present during all tasks performed in exclusion or decontamination zones. However, when a medical facility or physician is not accessible within five (5) minutes of an injury to a group of two or more employees for treatment of injuries, at least two employees on each shift shall be trained to administer First Aid and CPR. Individuals certified in FA and CPR and have received training in exercising universal precautions against exposure to bloodborne pathogens as a component to FA/CPR training which meets the intent of 29CFR1910.1030. This employee training is also complemented by other regularly scheduled employer training curriculums that are typically executed for the HAZWOPER industry, regulated under 29CFR1910.120/29CFR1926.26.

In addition, certain key project site personnel will have received training in accordance with 49CFR172.700.

Pregnant employees are to be informed of and are to follow the procedures in the CH2M HILL, Inc. Standard of Practice (SOP) HSE-120, *Reproduction Protection*, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

The designated AGVIQ-CH2MHILL key site personnel, listed below, maintain current training and are enrolled in a medical surveillance program meeting the requirements of 29CFR1910.120/29CFR1926.65 for hazardous waste operations. However, employees performing certain assigned tasks (e.g., confined-space entry, scaffold, fall protection, forklift operations etc.) will involve additional training. Employees being exposed to certain air borne chemicals or contaminants may require medical monitoring requirements defined by OSHA standards, as applicable to anticipated site conditions.

Employee Name	Responsibility	Completed Requirements
Mike Niebauer	Supervisor	Training: 29CFR1910.120(e)(3), (e)(4), (e)(8) FA-CPR, SC-H (OSHA 10hr equiv.), 29CFR1926, Subpart P, 49CFR172.700 Medical Surveillance: 29CFR1910(f) and 29CFR1910.134(e)
Kyle Block	SSHO	Training: 29CFR1910.120(e)(3), (e)(4), (e)(8) FA-CPR, SC-H (OSHA 10hr equiv.), 29CFR1926, Subpart P, 49CFR172.700 Medical Surveillance: 29CFR1910(f) and 29CFR1910.134(e)

2.2 Project Safety Responsibilities

The Project Manager has the overall responsibility for this project and will ensure that the requirements of the contract are attained in a manner consistent with this HSP and other contract-specific requirements. The Project Manager will coordinate and verify with the SSHO to ensure that the executed work is completed in a manner that is consistent with this HSP and the procedures adopted by the AGVIQ-CH2M HILL Joint Venture Program.

The SSHO will be the main contact in any onsite emergency coordination or communication situation and will ensure offsite emergency agencies have been contacted prior to the start of and verify that emergency contact numbers contained in this HSP are accurate/operational work. The SSHO will communicate with all potential emergency response organizations that would respond to an on-site emergency condition. In the event that during an emergency situation, the primary SSHO is not available or not capable of performing this function, an alternate SSHO or Site Superintendent can fulfill these duties.

The Health and Safety Program Administrator(s) (HSPA) or CIH is responsible for formulating and reviewing the HSP and ensuring that the HSP is complete and accurate. The HSPA or CIH also provides technical and administrative support for the AGVIQ-CH2M HILL Health and Safety Program and will be available for consultation when required. The CIH shall review and "approve" the HSP for field implementation and also be available for consultation project Industrial Hygiene and worker exposure matters, as may be required by the project team.

Each employee is responsible for their personal safety as well as the safety of others in the work area.

2.2.1 Key Safety Personnel

The following individuals AGVIQ-CH2M HILL share responsibility for health and safety at the site:

AGVIQ-CH2M HILL Joint Venture Program Manager
Sidney Allison: (843) 242-8018/843-813-2672 (cell)

AGVIQ-CH2M HILL Joint Venture Deputy Program Manager
Michael Halil: (904) 777-4812/904-219-6277 (cell)

AGVIQ-CH2M HILL Joint Venture Project Manager (overall)
Venky Venkatesh: (215) 640-9391 / 216-235-8613 (cell)
AGVIQ-CH2M HILL Joint Venture Project SSHO
Will Knox: (678) 758-8206 (cell)
AGVIQ-CH2M HILL Joint Venture Project SSHO
Kyle Block: (617)626-7013
AGVIQ-CH2M HILL Joint Venture H&S Program CIH
Angelo Liberatore, CIH, CSP: (678) 530 4210/ (770) 335-2076 (cell)

AGVIQ-CH2M HILL Joint Venture H&S Program Administrator(s)
Mark Orman, CSP, CHMM: (414) 847-0597/ (414) 712-4138 (cell)
Glen Jackson, CHST, ASP: (757) 318-9420 x12/ (757) 644-8293 (cell)

2.2.1.1 Project Manager

The AGVIQ-CH2M HILL Project Manager is responsible for providing adequate resources (budget and staff) for project-specific implementation of the Health, Safety and Environment (HS&E) management process. The Project Manager has overall management responsibility for the project tasks identified herein. The Project Manager may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this HSP.

- Include standard terms and conditions, and contract-specific HS&E roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:
  - Obtaining, reviewing, and accepting or rejecting subcontractor pre-qualification questionnaires.
  - Ensuring that acceptable certificates of insurance, including AGVIQ-CH2M HILL as named additional insured, are secured as a condition of subcontract award.
  - Including HS&E submittals checklist in subcontract agreements, and ensuring that appropriate site-specific safety procedures, training and medical monitoring records are reviewed and accepted prior to the start of subcontractor's field operations.
- Maintain copies of subcontracts and subcontractor certificates of insurance (including AGVIQ-CH2M HILL as named additional insured), bond, contractor's license, training and medical monitoring records, and site-specific safety procedures in the project file accessible to site personnel.
- Provide oversight of subcontractor HS&E practices per the site-specific safety plan.
- Manage the site and interface with third parties in a manner consistent with our contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that both the overall and job-specific HS&E goals are fully and consistently implemented.

2.2.1.2 Health and Safety Program Administrator(s)

The Health and Safety Program Administrator(s) (HSPA) responsibilities include the following:

- Develop and/or review the project HSP for final approval by the CIH.
- Review and accept or reject subcontractor pre-qualification questionnaires that fall outside the performance range delegated to the Contracts Administrator (KA).
- Review and accept or reject subcontractor training records and site-specific safety procedures prior to start of subcontractor's field operations.
- Support the SSHO's oversight of subcontractor (and lower-tier subcontractors) Health, Safety, and Environment (HS&E) practices and interfaces with third parties, as necessary.

- Support and assist program staff in executing the HS&E policies and procedures adopted by the program for implementation, including the program Behavior Based Loss Prevention System (BBLPS). Provide consultation and direction to project staff with regard to HS&E project and program requirements and industrial hygiene practices.

2.2.1.3 Certified Industrial Hygienist

The Health and Safety Program certified Industrial Hygienist (CIH) include the following:

- Shall review and approve the project specific HSP for field implementation.
- Also be available for consultation/direction with regard to project Industrial Hygiene and worker exposure matters, as may be required by the project team/HSPA.
- Perform the same roles and responsibilities as the HSPA, where required.

2.2.1.4 Site Safety and Health Officer

The SSHO is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify this HSP remains current and amended when project activities or conditions change.
- Verify AGVIQ-CH2M HILL site personnel and subcontractor personnel read, or have been briefed on the contents of this HSP, and sign **Attachment 2** "Employee Signoff Form" prior to commencing field activities.
- Verify AGVIQ-CH2M HILL site personnel and subcontractor personnel have completed any required specialty training (e.g., fall protection, confined space entry) and medical surveillance as identified in Section 2, and maintain the Subcontractor H&S Tracking Form, where applicable (**Attachment 3**).
- Verify adherence with the requirements of this HSP and applicable the subcontractor's health and safety plan(s).
- Act as the project "Hazard Communication Coordinator".
- Act as the project "Emergency Coordinator" and perform the responsibilities outlined in this HSP or as maybe required to properly coordinate the on-site response of emergencies, as they arise.
- Verify that safety meetings are conducted at least daily or more frequently as project tasks or hazards change and documented for the project record in accordance with the requirements of the BBLPS.
- Verify that project H&S forms and permits, found in **Attachment 4**, are being used as intended.
- Verify that Project Activity Self-Assessment Checklists, found in the CH2M HILL, Inc. SOPs referenced in this HSP, are being used as intended.
- Implement the Drug-Free Workplace Program.
- Verify that project files available to site personnel include copies of executed subcontracts and subcontractor certificates of insurance (including named additional insured), bond,

contractor's license, training and medical monitoring records, and site-specific safety procedures prior to start of subcontractor's field operations.

- Manage interface with third parties in a manner consistent with our contract/ subcontract agreements and the applicable standard of reasonable care.
- Coordinate with the HSPA(s) or CIH regarding AGVIQ-CH2M HILL and subcontractor operational performance, and third-party interfaces.
- Ensure that the overall, job-specific, HS&E goals are fully and continuously implemented.

The SSHO is responsible for coordinating with the AGVIQ-CH2M HILL individual responsible for site operations (i.e., Site Superintendent/Manager or Field Team Leader) and Project Manager, as necessary. In general, the Project Manager will contact the client in the event accidents, injuries or property damage occurs on the project site. The CIH or HSPA(s), as necessary, should be contacted by the SSHO as appropriate.

2.3 Subcontractors

Subcontractors covered by this HSP must be provided a copy of it to read and accept prior to initiating work on this site. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., electrical, excavation, demolition). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to AGVIQ-CH2M HILL for review before the start of field work. It is critical that subcontractor work be performed in a manner that is consistent with applicable OSHA standards (29CFR1910, 29CFR1926), EM 385 1-1 or other applicable health and safety plan(s)/protocols. The AGVIQ-CH2M HILL SSHO should verify that subcontractor employee training, medical clearance, and fit test records 9where applicable) are current and must monitor and verify Subcontractor adherence with the established plan(s). AGVIQ-CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s), protocols, or established safety regulations.

AGVIQ-CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This goal should be reasonable, and include observing for hazards or practices and procedures that are not consistent with established Health and Safety (H&S) requirements that are both readily observable and occur in common work areas. AGVIQ-CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSHO is responsible for confirming AGVIQ-CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment measures. Project Activity Self-Assessment Checklists contained in referenced CH2M HILL, Inc. Standard of Practice (SOP) documents are to be used by the SSHO to review subcontractor performance.

Health and safety related communications with AGVIQ-CH2M HILL subcontractors should be conducted as follows:

- Request subcontractor personnel to read the HSP and then require them to sign the Employee Signoff Form included in **Attachment 2** of this HSP.

- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent conditions, actions, or practices are observed that are not consistent with this HSP, AGVIQ-CH2M HILL Health and Safety Program, or other Health and Safety protocols, notify the subcontractor safety representative and require corrective action—the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When identified conditions or practices/actions that are not consistent with AGVIQ-CH2M HILL Health, Safety and Environment (HS&E) policies and procedures, or other applicable Health and Safety protocols are repeated or persist, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented. See Stop Work Order (SWO) Form in **Attachment 4** of this HSP.
- When an apparent imminent danger exists, immediately remove all affected AGVIQ-CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented (see SWO form). Notify the Project Manager and CIH and/or the HSPA(s) as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.
- Subcontractor Management requirements are also defined in Section 5.0 of the APP (**Attachment 1** of this HSP).

3.0 Project-Specific Hazards

Exposure to certain project specific hazards in the work place may include injury/accidents or property damage due to execution of a variety of assigned tasks or as a result of existing site conditions. This section of the HSP is provided to aid in the recognition of potential specific and general project hazards and identify procedures and practices to be implemented on the job site that may reduce or eliminate accidents/injuries and property damage that may be attributed to these hazards. All AGVIQ-CH2M HILL personnel are required to contact the designated Health and Safety Program Administrators (HSPA) or Certified Industrial Hygienist (CIH) identified in this HSP regarding any questions or concerns to ensure the execution of this task order in a healthy and safe manner.

The following areas/activities are not specifically covered under this HSP and must not be performed unless this HSP is amended and approved accordingly.

- Areas presenting exposed energized electrical equipment.
- Areas where there is an unprotected (e.g., no guardrail) fall exposure greater than 4'.
- Areas where Unexploded Ordinance (UXO)/ Munitions and Explosives of Concern (MEC) maybe encountered.
- Activities requiring the use of scaffolding, an aerial lifts or hoisted personal platforms.
- Activities where potential radiological exposure hazards may exist
- Any other section identified in this HSP or APP marked as **(Reserved).**

3.1 Adverse Weather

Sudden inclement weather can rapidly encroach upon field personnel. Because of the time of year (fall) that this project is being executed and its geographical location (central Maine) Field crew members could experience a variety of adverse weather conditions during the course of a normal work assignment. Personnel performing work outdoors should carry clothing appropriate for foul weather conditions (rain gear, hard hat liners, rubber boots, lined gloves etc). In severe weather conditions, (i.e., high wind, rain squalls, blizzards, electrical storms), the field crews must evacuate from an outdoor work environment area and find safe shelter until the weather abates and until a decision is made to resume the field activities. The following field procedures must be exercised where adverse weather is encountered or is expected to occur during an assigned work day.

- Frequently observe the skyline for developing rain squalls, thunder storms or other severe weather systems that may be developing. Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with the NAS Brunswick security office if severe weather systems appear to be developing. NAS Brunswick may be able to provide an update local forecast. If not check with home office support

personnel who may be able to determine the severity of developing storm systems through internet access or other methods.

- Bring clothing suitable for anticipated daily weather conditions.
- Shut down operations during heavy rain/lightning events, high wind or heavy snow conditions and identify "safe haven" location. Safe haven locations should be identified prior to the start of work. Safe haven structures must be grounded where there is a potential for a lightning event.
- Implement cold or heat stress monitoring, as necessary, defined in this HSP.

3.1.1 Lightning

Preparedness and caution are the best defenses against lightning. Many lightning deaths and injuries happen before or after a thunderstorm's peak. The site manager or SHSO shall monitor weather forecasts for predictions of electrical storms in the area. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The site manager or SHSO shall monitor weather conditions to determine when it is appropriate to resume work. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area.
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae and towers.
- Stay away from lakes, streams, pools, or any water.
- Stay away from railroad tracks that can carry lightning charges for long distances.
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding. Do not stand on top of a hill.
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands.
- Do not use telephones during electrical storms, except in the case of emergency.

3.2 Aerial Lifts

(Reserved)

3.3 Air Compressor Operations

Air compressor operations may be engaged during demolition operations, free product or residual fuel management, dewatering operations, during the installation of the excavation sheeting system and other potential activities that are ancillary to primary project tasks. When air compressors are operated at the site the following safe work practices shall be executed.

- All hoses, connections, and valves should be rated for the maximum pressure to be used in the system.
- All energized hoses must have safety lashes or tie/whip lines attached to hoses in the event that the hose coupling come loose from the compressor connection or adjacent hose coupler fittings.
- Inspect transfer lines/hoses, valves and all connections for wear, damage and security prior to use each day and replace when defective/worn.
- Wear hearing protection when working in the immediate vicinity of operating air compressors.
- The air compressor receiver tank must be equipped with a functioning pressure gauge and with one or more spring-loaded safety valves
- The total relieving capacity of the safety valve must be such to prevent pressure in the receiving tank from exceeding the tank's maximum allowable working pressure by more than 10 percent.
- No valve of any type must be placed between the air receiver tank and it's safety valve.
- All safety valves must be tested monthly, or more frequently as necessary, to determine whether they are in good operating condition.

3.4 Asbestos

(Reserved)

3.5 Chemical Injections

(Reserved)

3.6 Concrete Work

(Reference SOP # HSE&Q 302, Concrete & Masonry)

(Reserved)

3.7 Confined Space Entry

(Reserved)

3.8 Constituents of Concern

Tables 3-1 below identifies the maximum concentration of site COCs that have been identified for the project sites to be accessed under this task order. Established OELs and symptoms and effects of overexposure to such COCs are also identified.

3.8.1 Constituents of Concern

Contaminants of concern for **NAS Brunswick** are listed in Table 3-1.

TABLE 3-1
Constituents of Potential Concern
(Refer to Project Files for more detailed contaminant information)

Constituents	Location & Maximum Concentration (ppb)	Exposure Limit in ppm (PEL)	IDLH (ppm)	Symptoms and Effects of Exposure	PIP[d] (eV)
1,1-Dichloroethane (1,1-DCA)	GW: 60.8 Eastern Plume only	100 ppm	3,000 ppm	CNS depression, skin irritation; liver, kidney, and lung damage	11.06
1,1-dichloroethylene (1,1-DCE)	GW: 144 Eastern Plume only	1 ppm	NL Ca	Eye, skin, and throat irritation; dizziness; headache; nausea; difficult breathing; liver and kidney dysfunction; pneumonitis	10.0
1,2-dichloroethylene (1,2-DCE)	GW: 48.5 Eastern Plume only	200 ppm	1000 ppm	Irritation of eyes, respiratory system; central nervous system depression	9.65
Lead	SED: 34,7 Eastern Plume only	0.05 mg/m^3	100 mg/m^3	Weakness lassitude, facial pallor, pal eye, weight loss, malnutrition, abdominal pain, constipation, anemia, gingival lead line, tremors, paralysis of wrist and ankles, encephalopathy, kidney disease, irritated eyes, hypertension	NA
1,1,1-Trichloroethane (1,1,1-TCA)	GW: 397 Eastern Plume only	350 ppm	700 ppm	Irritation of eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage	11.0
Tetrachloroethylene (PCE)	GW: 175 Eastern Plume only	25 ppm	150 Ca	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
Trichloroethylene (TCE)	GW: 226 Eastern Plume only	10 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Vinyl Chloride	GW: 1.7 Eastern Plume only	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99

Footnotes:
[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water), SED (Sediment).
[b] Appropriate value of PEL, REL, or TLV listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.
[e] Denotes a ceiling value (15 minutes) unless otherwise identified.
f Denotes a value established by the ACGIH.
[g] Denotes a value established by the ACGIH and a ceiling value (15 minutes).
ppb Denotes sample concentration is in Parts per Billion unless otherwise noted.
REL = NIOSH Recommended Exposure Limit
PEL = Denotes OSHA Permissible Exposure Limit unless otherwise identified.
Ca = Potential Occupational Carcinogen

3.8.2 Benzene

(Reserved)

3.8.3 Respiratory Protection

(Reference SOP # HSE&Q 121, Respiratory Protection)

For the individual tasks associated with the execution of the NAS Brunswick project, it is not anticipated that worker respiratory protection measures will be required. However, unanticipated site conditions may be encountered excavation dewatering or remedial soil excavation operations where the use of respiratory protective equipment may be required or advisable. Under these circumstances, it is essential that the following criteria are met:

- The correct type of respiratory protection equipment is selected and used.
- The selected respiratory protection equipment is clean and in good working order.
- The selected respiratory protection equipment provides an appropriate fit for the user/wearer.
- The user/wear is adequately trained in the use, care, and limitations of the selected respiratory protection device.

To accomplish these requirements, a Respiratory Protection Program must be implemented to facilitate reduction of employee exposure to toxic chemical agents, asbestos, lead based paint, and potentially hazardous work environments and to ensure employees are made aware of and familiar with, respirator use, fit, maintenance, cleaning procedures and associated application limits.

All site personnel who wear a respirator shall be given a medical evaluation prior to such use. A licensed physician must conduct the evaluation and provide written authorization for respirator use and the authorization must be included in the employee's permanent record. At a minimum, the medical evaluation must be repeated annually.

To ensure proper wearer fit, an annual "fit test" must be provided for a specific make, model, and size of a selected respiratory protection device. An additional fit test must be performed whenever the employee reports or the employer or employer's representative makes visual observations of changes in the employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight. Fit tests will be repeated, at least, annually or sooner if there is any doubt as to a respirator's fit.

To minimize employee exposure to potentially hazardous chemical substances, the primary objective shall always be to achieve the needed control, whenever feasible, through engineering methods (such as exhaust ventilation) or administrative control. It is recognized, however, that for certain operations, the use of engineering controls may not be feasible or practical. Under these circumstances or during an interim period while engineering controls are being developed or installed, the use of personal respiratory protection equipment may be necessary.

Prior to using any respiratory protective equipment, affected personnel shall review and implement all applicable components of CH2M HILL SOP # HSE&Q-121, Respiratory Protection or implement other company Respiratory Protection Programs that may be more applicable to the employee.

3.8.4 Radiological Hazards and Controls

(Reserved)

3.9 Cranes

(Reserved)

3.10 Demolition/Dismantling

(Reserved)

3.10.1 Manual Removal of Walls and Masonry

(Reserved)

3.10.2 Manual Removal of Floors

(Reserved)

3.10.3 Demolition Using Heavy Equipment

(Reserved)

3.10.4 Material Chutes

(Reserved)

3.10.5 Debris Storage and Disposal

(Reserved)

3.10.6 Demolition Housekeeping

(Reserved)

3.11 Drilling/Direct Push Technology

Drilling activities will be required during the execution of this project. Drilling or Direct Push Technology (DPT) will be required to collect additional confirmation samples and install additional ground water monitoring wells. Where it is identified that drilling operations may be required to facilitate the completion of the project, at a minimum, the following drilling practices must be implemented.

- Prepare and implement and AHA associated with the required drilling operations. At this time one is not prepared as it is not a specifically identified site task.
- Prior to conducting any onsite intrusive activities, it must be verified that subsurface utilities will not be impacted by proposed site operations. See Procedures for Locating Underground Utilities in this HSP.

- PPE and air monitoring requirements shall be executed in accordance with Sections 5.0 and 6.0, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern during all drilling activities. In addition, good personal hygiene practices and procedures must be maintained (see section 7.0 of this HSP).
- Drill rig inspections and maintenance and documentation of such inspections and maintenance shall be performed daily prior to the start of onsite work.
- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the drill rig is properly leveled and stabilized (extension of stabilizers on firm ground) before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. A minimum distance of 10 ft between mast and overhead lines (<50 kV) is recommended. Increased separation will be required for lines greater than 50 kV. See Electric Safety in this HSP for proper separation requirements and other standard operating procedures associated with working near power transmission lines.
- Personnel should stand clear before equipment startup. Maintain eye contact with operator prior to/while approaching drill rig.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used.
- Do not wear loose-fitting clothing, watches, etc., that may get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around drill rig.
- The drill rig must be equipped with a kill wire or switch and personnel associated with the drilling operation are to be informed of its location.
- For drill rig where pressurized lines are associated with the operation, safety lashings/whip line checks, clips or other suitable restriction means should be in place on hoses/connections to prevent injury in the event connections become dislodged or hoses ruptures.
- Be aware and stand clear of heavy objects that are hoisted overhead by the drill rig.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig and stay as far away as possible. Notify emergency personnel immediately.

Where it may be required to limit access and prevent inadvertent entrance of unauthorized and untrained personnel into the active drilling areas, the erection of warning tape, suitable signage, orange safety fencing or other appurtenances around the active drilling area may be necessary.

3.12 Electrical Safety

(Reference SOP # HSE&Q 206, Electrical Safety)

Several types of electrical hazards may be encountered during the execution of the project. These hazards might include, but not be limited the following:

- use of generators, power cords, and electric hand tools during site operations identified herein,
- during inadvertent contact of operating drilling equipment with overhead or underground electrical or communication utilities

Where electrical exposure hazards are possible in the work environment, the following standard work practices must be implemented.

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q-206, Electrical Safety.**
- Do not connect electric sampling or groundwater well purge equipment directly to 12 volt vehicle/tractor/boat batteries as an electrical power source. Use generators and power cords equipped with ground fault circuit interrupters (GFCIs)
- Only qualified personnel (by training, experience, and/or licensure) are permitted to work on electrical systems.
- Do not tamper with or access electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until hazardous energy control procedures (i.e., lock-out/tag-out) are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment and remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have GFCIs installed.
- Extension cords must be:
  - Equipped with third-wire grounding
  - Covered, elevated, or protected from damage when passing through work areas
  - Protected from pinching if routed through doorways
  - Not fastened with staples, hung from nails, or suspended with wire
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.

- Protect all electrical equipment, tools, switches, and outlets from environmental elements.
- Maintain safe clearance distances between overhead power lines and operating heavy equipment and haul trucks unless the power lines have been verified as being de-energized and grounded or where insulating barriers have been installed to prevent physical contact. To determine proper clearance from energized overhead electric lines, please consult the reference table below.

Nominal System Voltage (kV)	Minimum Rated Clearance (feet)
0-50	10
51 - 200	15
201 - 300	20
301 – 500	25
501 – 750	35
751 – 1000	45

- Do not swing heavy equipment or other components of operating heavy equipment toward overhead utilities. Do not allow haul trucks operators to raise dump bed bodies underneath overhead utilities or haul trucks to pull toward overhead utilities with dump bodies raised.
- Be cognizant of utility pole guy wires in relation to operating heavy equipment and haul trucks.

3.13 Excavation Activities

(Reserved)

3.14 Fall Protection

(Reserved)

3.15 Fire Prevention

The information provided below is the minimum Fire Prevention procedures that must be engaged for the project site.

- Be cognizant of and adhere to any specific NAS Brunswick Fire Prevention Procedures and Requirements.
- Secure a “hot work permit” from the designated NAS Brunswick Fire Department Official, when necessary. This task shall be the responsibility of the AGVIQ-CH2M HILL individual responsible for site activities or SSHO. The AGVIQ-CH2M HILL individual responsible for site activities or SSHO shall review established hot work procedures and appropriate emergency contact requirements with the designated NAS Brunswick Fire

Department and review this information with all site AGVIQ-CH2M HILL and applicable subcontractor personnel.

- Only smoke in designated areas. Designated area must be free of combustible or flammable materials.
- Remove all flammable or combustible materials from where welding, cutting or other hot work operations are to occur and institute a "fire watch" for at least one hour after welding, cutting or other hot work operations have ceased.
- Use only metal safety cans for storage and transfer of fuel and use funnels and nozzles during fueling operations.
- Fire extinguishers will be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - Be maintained in a fully charged and operable condition.
  - Be visually inspected each month.
  - Undergo a maintenance check each year.
  - The area in front of extinguishers must be kept clear.
  - Appropriately sized, easily accessible ABC fire extinguisher in work area. Fire extinguishers must be inspected monthly (inspection tag) and have an annual maintenance/inspection certification (tag) attached to the extinguisher.
  - Fire extinguishers shall be approved by a nationally recognized testing laboratory and labeled to identify the listing and labeling organization and the fire test and performance standard that the fire extinguisher meets or exceeds.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire-resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.
- Personnel shall consider their safety when engaging only incipient stage fires. Fires resulting from residual product in lines or tanks should be handled by Fire and Emergency Services.

3.16 Flight Line Safety

(Reserved)

3.17 Hand and Power Tools

(Reference SOP # HSE&Q 210, Hand and Power Tools)

Hand and power tools may be during the support of mobilization operations, sampling operations, and drilling operations. When the use of hand and power tools is necessary to properly complete assigned tasks, the following work practices must be implemented, where applicable.

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q 210, Hand and Power Tools.**
- Tools will be inspected prior to use, and damaged tools will be tagged and removed from service.
- Hand tools will be used for their intended use and operated in accordance with manufacturer instructions and design limitations.
- Maintain all hand and power tools in a safe condition.
- Do not set power tools down in muddy or wet areas, which may damage the tool and/or or create a potential for electric shock.
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool.
- Do not carry or lower a power tool by its cord or hose.
- Portable power tools will be plugged into GFCI-protected outlets.
- Portable power tools will be UL listed and have a three-wire grounded plug or be double insulated.
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters).
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed.
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials.
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications.
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).
- When using a knife or blade tool, stroke or cut away from the body with a smooth motion. Be careful not to use excessive force that could damage the tool, the material being cut, or unprotected hands.
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

3.17.1 Knife Use

Knives (fixed/utility) shall not be used. If it is demonstrated that a knife is the right tool for the job, this plan will be amended and the activity that knife use will be used for shall be reviewed. An AHA shall also be developed to address hazards and subsequent controls, PPE, and training.

3.17.1.1 Responsibilities

- Supervisors with assistance from the FTL/SSHO are responsible for funding and ensuring the correct tool is being used, employees wear the proper PPE when using knives, and they have reviewed this policy.
- Employees are responsible for having and utilizing the proper PPE while performing an activity requiring the use of a knife. Employees are also responsible for understanding the proper use of a knife.

3.17.1.2 Glove Requirements

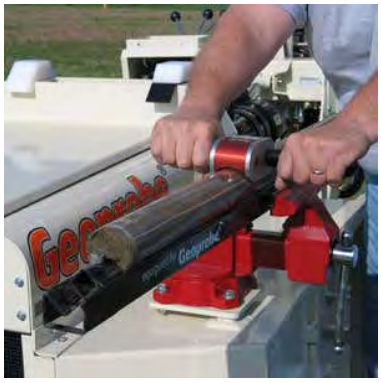
- In general, Kevlar cut resistant gloves are to be worn when using a knife in an occupational setting.
- Other types of gloves may be required and will be identified within the AHA / written procedure. Example - Leather gloves may be worn when using the acetate sleeve cutter.

3.17.1.3 Standard Control Measures for Knife Use

- All employees that will use a knife must be trained in the proper use.
- When using a knife always cut away from yourself.
- Many tasks using a utility knife require a knife edge but not a sharp point. For these tasks you can add protection against puncture wounds by using a rounded-tip blade.
- If you use a folding knife, it must be a locking blade type.
- Never use a knife that will fold under pressure.
- If you use a fixed blade knife, make sure there is a handle guard to keep your hand from slipping forward. Also, make sure the handle is dry and non- greasy/slippery to assure a better grip.
- When cutting, make the force of the cut carry the blade away from any part of your body. If you have a peculiar situation where this is not possible, protect yourself with a leather apron, or other material placed between you and the blade. Consider putting the material to be cut in a vise, or other holding device.
- If you carry a fixed blade knife, use a sheath or holder.
- Store utility knives safely, retract the blade or sheath an open blade before storing. Never, leave a knife with the blade exposed on the floor, on a pallet, on a work surface, or in a drawer or cabinet.
- Keep your knife sharp. A dull blade requires you to use more force to cut, and consequently increases the risk of slip or mistake.

- Knives used on the job, but not carried with you, must be properly stored when not in use.
- Never use a defective knife.
- Utility knife blades are brittle and can snap easily. Don't bend them or apply side loads to them by using them to open cans or pry loose objects. Use the knife only to cut. It was not designed to work as a pry bar, screw driver, hole punch, and other assorted things that make it seem so easy.
- **Stay focused on the cutting job.** It only takes a second of inattention with a sharp blade to produce a serious cut. Letting the mind wander or talking with others while using a knife greatly increases the risk of an accident and injury. If you are interrupted while working with a knife, stop cutting, retract the blade, and place the knife down on a secure surface before dealing with the interruption. You should never continue cutting while distracted! As always, utilize the hierarchy of controls and first attempt to engineer out the hazard and frequently ask ourselves do we have the right tool for the job.
- If you do get cut, seek medical attention to treat the injury and notify your supervisor. **For CH2M HILL employees** injured on the job, contact WorkCare at 866-893-2514 for assistance with the management of the injury. *For work-related injuries or illnesses to CH2M HILL personnel, inform the AGVIQ-CH2M HILL Project Manger (overall) and the AGVIQ-CH2M HILL HSPA/CIH and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.
- **For AGVIQ employees** who are injured at work, see the closest qualified medical facility for medical attention notify your supervisor and the Human Resource office for injury management assistance. See Sections 10.3, 10.7 and **Attachment 11** of this HSP for additional information.

3.17.1.4 Examples of Preferred Tools and Kevlar Cut Resistant Gloves



A safety spring provides for automatic blade "shoot-back" into the handle when contact w/cutting surface is lost.

3.18 Haul Trucks

It is anticipated that the use of haul trucks will be limited to the delivery of products or materials to be incorporated into the project (i.e. aggregate, common fill, sheeting), delivery and pick-up of heavy equipment or materials to be utilized in the execution of the project or for the transportation of contaminated soil or C&D material to off-site disposal or recycling facilities. Where haul trucks are utilized on the project, the following standard work practices shall be implemented.

- **All haul trucks must follow the designated Haul Route established for the NAS Brunswick project and as defined by the project Remedial Action Work Plan.**
- Haul truck operators should be familiar with their equipment and inspect all equipment before use.
- Haul truck operators should ensure all persons are clear before moving their equipment. Before moving, operators should sound horn or alarm. All haul truck equipment should be equipped with an operational backing alarm.
- Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots. Alternatively Haul Route drivers should be provided with spotters where there are blind spots associated with loading or off-loading operations.
- Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator.
- If possible, consider eliminating a designated haul route that includes steep grades.
- Trucks are to be operated within the manufacturer's recommendations.
- Haul roads should be well lit, sufficiently wide to allow for the passage of trucks.
- Haul roads should have adequate right-of-way signs indicating haul directions, where appropriate.

- Haul trucks should be loaded evenly for proper weight distribution and on stable competent ground.
- Stay out of the operating envelop of haul trucks. Do not walk in front of or in back of haul trucks. Ensure you are in the haul truck operator's field of vision. Ground personnel shall not be within a haul trucks "flip-over radius" when off loading delivered fill or aggregate materials.
- Haul truck operators shall not be allowed to raise the dump bodies of their hauling vehicles underneath or within 10'ft of Overhead utilities. See Electric Safety in this HSP for proper additional separation requirements when working near power transmission (electric) lines.

3.19 Heavy Equipment

(Reference SOP # HSE&Q 306, Earth Moving Equipment)

It is anticipated that heavy equipment may be utilized drilling operations. The following work procedures shall be exercised by AGVIQ-CH2M HILL or subcontract personnel who may be designated to operate site heavy equipment.

- AGVIQ-CH2M HILL authorizes only those employees qualified by training or previous experience to operate heavy equipment.
- Where applicable, an Earthmoving Equipment Operator Evaluation Form will be completed and maintained in the project files by the SSHO for all persons who operate equipment (**Attachment 3)**.
- Equipment must be checked at the beginning of each shift to ensure the equipment is in safe operating condition and free of apparent damage. The check should include: service brakes, parking brakes, emergency brakes, tires, horn, back-up alarm, steering mechanism, coupling devices, seat belts and operating controls. All defects will be corrected before the equipment is placed in service.
  - Documentation of this inspection must be maintained on-site at all times.
  - Refer to the Earthmoving Equipment Inspection Form found in **Attachment 3** of this document.
- Equipment must be on a stable foundation such as solid ground or cribbing; outriggers are to be fully extended.
- Seat belts shall be used by all personnel operating AGVIQ-CH2M HILL equipment.
- Equipment must not be used to lift personnel; loads must not be lifted over the heads of personnel.
- Equipment, or parts thereof, which are suspended must be substantially blocked or cribbed to prevent shifting before personnel are permitted to work under or between them. All controls will be in a neutral position, with the motors stopped and brakes set.
- Equipment that is operating in reverse must have a reverse signal alarm distinguishable from the surrounding noise or a signal person when the operator's view is obstructed.

- When equipment is used near energized power lines, the closest part of the equipment must be at least 10 ft from power lines < 50 kV. Provide an additional 4 ft for every 10 kV over 50 kV. A person must be designated to observe clearances and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. All overhead power lines must be considered to be energized until the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded.
- Underground utility lines must be located before excavation begins; "Procedures for Locating Buried Utilities" contained in this HSP for additional information.
- Operators loading/unloading from vehicles are responsible for seeing that vehicle drivers are in the vehicle cab or in a safe area.
- The parking brake will be set whenever equipment is parked; wheels must be chocked when parked on inclines.

When heavy equipment is not in operation, the blade/bucket must be blocked or grounded; the master clutch must be disengaged when the operator leaves the cab. When equipment is unattended, power must be shut off, brakes set, blades/buckets landed and shift lever in neutral.

3.20 Land Clearing Operations - General

(Reserved)

3.20.1 Land Clearing Via Hydraulic Mowing

(Reserved)

3.20.2 Brush/Sapling Clearing – Chainsaws/Brushcutters

(Reserved)

3.20.3 Land Clearing - Tree Felling via Chainsaws

(Reserved)

3.21 Lock-Out/Tag-Out

(Reserved)

3.22 Machine Guarding

Machine guarding procedures for the anticipated work will likely be applicable to, power and hand tool use (grinders, drills), drill rig operation, operation of mechanized equipment that may be used during the installation of ESC measures or equipment used in the installation of the excavation sheeting system. For these identified activities, the following machine guarding precautions may be applicable to executed work.

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, pinch points, mechanically energized equipment, or any other sources of mechanical injury.

- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated, and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

3.23 Manual Lifting

(Reference SOP # HSE&Q 112, Manual Lifting)

Manual lifting is likely to occur during many phases of the project. Personnel executing assigned tasks where manual lifting is required should implement the following procedures to help reduce the potential for personal injury.

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q 112, Manual Lifting.**
- AGVIQ-CH2M HILL personnel should notify supervisors or designated safety representatives of pre-existing medical conditions that may be aggravated or re-injured by lifting activities, such that the AGVIQ-CH2M HILL may evaluate safe operational procedures with regard to the required task.
- Proper lifting techniques (use of knees and not back) must be used when lifting any object:
- Plan storage and staging to minimize lifting or carrying distances.
- Use drum dollies/carts with a latching mechanism when handling drums containing groundwater well purge water or other waste. Avoid "chiming" drums wherever possible.
- Split heavy loads into smaller loads.
- Use mechanical lifting aids whenever possible.
- Have someone assist with the lift— especially for heavy (>40 lbs.) or awkward loads. Note: If AGVIQ-CH2M HILL personnel are not capable of lifting 40 lbs., seek assistance from a team member to split the load.
- Make sure the path of travel is clear prior to the lift.

3.24 Noise

(Reference SOP # HSE&Q 108, Hearing Conservation Program)

Unprotected exposure to excessive noise levels may lead to gradual and permanent hearing loss. The greater the intensity of a noise and the longer a person is exposed to the noise, the greater the chance of hearing loss. A hearing loss can be permanent or temporary. After certain noise exposures, a person may experience a temporary threshold shift (hearing loss) that results in the inability to hear certain sounds. The ability to hear will usually return. However, repeated or intense noise exposure can prevent this recovery, resulting in permanent hearing loss.

Employee hearing conservation is particularly important for the following site conditions/operations:

- Working around heavy earthmoving equipment or operation of heavy earthmoving equipment with open cabs or with the cab doors open
- During the installation of the excavation sheeting system
- Working around drilling/DPT equipment
- Working around haul trucks delivering fill or aggregate materials
- Operations of pneumatic equipment.
- Operation or rotary or impact hand tools

Each employee is responsible for the following:

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q 108, Hearing Conservation Program**, or implement other Hearing Conservation Programs may be most applicable to the employee.
- Notify the SSHO of high-noise-level areas.
- Wear hearing protection when required.
- Complete noise training and audiometric testing (as required).
- Hearing protection is required in work environments exceeding 85 decibels (dB).
- Hearing protection will be worn when operations occur within or adjacent to high-noise sources (i.e., potentially exceeding 85 dB).

3.25 Pressure Vessels Systems

(Reserved)

3.26 Pressure Washing Operations

Pressure washing operations may occur prior to the final demobilization of equipment used at the site or drilling equipment and tools which may be contaminated with site COC constituents. Whenever pressure washing operations are performed at the site, the following procedures must be implemented.

- Rain gear (disposal coated chemical suits for Hazwoper operations), 16-inch-high, steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves should be worn, at a minimum during pressure washing operations.
- Only trained, authorized personnel may operate the high-pressure washer.
- Rinse waste from pressure washing operations must be collected and properly disposed.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm dead man switch fully operational.

- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches from the trigger to the tip.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.

3.27 Sample Collection or Handling

Sample handling, packaging, and preservation will be conducted in support of soil remediation goals and during the Groundwater-Surface Water Interface Sampling at Mere Brook and Merriconeag Stream. When employees perform sample collection or handling activities to support for waste characterization or confirmation sampling, the work practices and procedures identified below must be followed.

- Skin contact with water, soil, sediment, or debris of undetermined chemical characterization shall be avoided at all times.
- PPE and air monitoring requirements shall be executed in accordance with Sections 5.0 and 6.0, respectively, of this HSP to minimize potential dermal and respiratory exposures to identified site contaminants of concern while conducting sample collection or characterization of potentially contaminated media (debris or other waste inadvertently discovered while excavating.). In addition, good personal hygiene practices and procedures must be maintained (see Section 7.0 of this HSP).
- Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns.
- Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents.

3.27.1 Handling or Sampling of Drummed Waste

During the execution of the contract, various types and quantities of generated waste materials will be generated and may include, but not be limited to PPE, decontamination fluids, or Investigation Derived Waste. Personnel are permitted to handle and/or sample drums containing known waste sources/materials, but handling or sampling of other drums (unknowns) requires a HSP revision or amendment approved by the AGVIQ-CH2M HILL Program CIH. The following control measures must be taken when managing drums containing waste sources/materials:

- Minimize transportation of drums or other containers with generated waste materials. However, where this is deemed necessary appropriate drum "dollies"/hand trucks or other suitable material handling equipment shall be used to transfer drums of generated waste materials.
- Sample or open only labeled drums or drums known to contain generated waste materials. Unknown drums or drums that show evidence of excessive buckling/bulging, corrosion, vapors, crystallization, unusual discoloration or other abnormalities may not be sampled without the evaluation of engineering controls, proper PPE air monitoring equipment and the use properly trained personnel familiar with the sampling of unknown drum contents. If there is any question to the proper handling or opening of drums.
- Use caution when sampling bulging or swollen drums. Relieve pressure slowly and step away from the drum as pressure is being released.
- If drums contain, or potentially contain, flammable materials, use non-sparking (i.e., brass) tools to open the drum.
- Picks, chisels, and firearms may not be used to open drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer the content of drums using a method that minimizes contact with material.
- PPE and air monitoring requirements shall be executed in accordance with Sections 5.0 and 6.0, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern. In addition, good personal hygiene practices and procedures must be maintained (see Section 7.0 of this HSP).
- Spill-containment procedures specified in Section 8 of this HSP must be appropriate for the material to be handled.
- Institute and maintain good housekeeping practices. Remove debris from work areas and stow unused tools.

3.28 Slips, Trips and Falls

Slip, trip and fall hazards exist in virtually all work environments. Even though slip, trip and fall hazards are typically thought of as posing low risk to workers, they account for a large percentage of worker injuries. As such, workers should be exercise caution about becoming complacent to recognizing and removing slip, trip and fall hazard from designated work areas. To eliminate slip, trip and fall hazards from the work place the following should be implemented.

- Walk or climb only on equipment and/or surfaces designed for personnel access.

- Observe and avoid areas of unprotected holes, ramps, and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). If these conditions cannot be corrected, mark these hazards (i.e. high visibility pant, traffic cones etc) so that workers may recognize and avoid them.
- Employees walking in ditches, swales and other drainage structures adjacent to roads, across undeveloped land or in controlled industrial work/process areas must use caution to prevent slips and falls, which can result in twisted or sprained ankles, knees, and backs.
- Whenever possible work from areas which have flat, stable surfaces and do not enter steep sided ditches/excavations.
- Sturdy, hard toe boots that provide sufficient ankle support shall be used on JV III sites.

3.29 Stairways and Ladders

(Reference SOP # HSE&Q 214, Stairways and Ladders)

As part of the execution of the contract work employees may need to utilize stair ways or ladders during access/egress of the upper portion of the excavation sheeting system during the installation of the systems internal struts and bracing, access/egress of properly sloped trench excavations, or during the operation or monitoring of ground water dewatering treatment systems. Where stairways/ladders must be accessed, the following procedures must be implemented

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q 214, Stairways and Ladders.**
- A Stairway or ladder is generally required when a break in elevation of 19 inches or greater exists.
- Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions.
- Ladders must be inspected for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Ladders must be used only for the purpose for which they were designed and will not be loaded beyond their rated capacity.
- Only one person at a time will climb on or work from an individual ladder.
- User must face the ladder when climbing; keep belt buckle between side rails.
- Ladders will not be moved, shifted, or extended while in use.
- User must use both hands to climb; use rope to raise and lower equipment and materials.
- Straight and extension ladders must be tied off to prevent displacement.
- Ladders that may be displaced by work activities or traffic must be secured or barricaded.

- Portable ladders must extend at least 3 feet above landing surface.
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder.
- Stepladders are to be used in the fully opened and locked position.
- Users are not to stand on the top two steps of a stepladder, nor are users to sit on top or straddle a stepladder.

Fall protection shall be provided when working from extension, straight, or fixed ladders greater than 6 feet (construction operations) and 4 feet (general operations) from lower levels, where both hands are needed to perform the work or when reaching or working outside of the plane of ladder side rails.

3.30 Unknown or Suspect Objects/Materials

If unknown or suspect objects/materials are encountered (i.e. exposed or partially buried drums, biological waste, cylinders, munitions of explosive concern, unexpected stained/discolored soil) are encountered during site operations, ongoing activities shall be immediately suspended. AGVIQ-CH2M HILL or subcontractor personnel encountering unknown or suspect objects/materials shall 1) secure the area and identify the location of the object/material to the extent possible, without causing bodily injury to yourself or others and without disturbing the object, 2) evacuate the work area, 3) immediately notify the project manager of the encountered condition and 4) not provide additional disturbance or otherwise handle the suspect object/material. The site supervisor, SHSO, or Field Team Leader (FTL) shall contact the Project Manager and the HSPAs/CIH to evaluate potential hazards associated with the specific situation encountered. The project team will then address the need for the use of special procedures, engineering controls, PPE or specialized subcontract personnel to safely mitigate the situation.

3.30.1 Munitions and Explosives of Concern

(Reserved)

3.31 Vacuum Truck Operations

(Reserved)

3.32 (Exposure to) Vehicular Traffic

(Reference SOP # HSE&Q 216, Traffic Control)

The following standard work practices must be exercised when personnel are working in or around haul truck routes or near an area where traffic controls have been established. Exposure to vehicular traffic will be especially prevalent during haul truck operations or transfer of on-site delivered materials or during the transfer and on-site management of excavated soil impacted by GRO constituents.

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q 216, Traffic Control.**

- When parking your vehicle, park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so it can serve as a barrier.
- Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle.
- Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic-related hazards and required controls— sun glare, rain, wind, limited sight-distance, hills etc.
- Always remain aware of an escape route, such as behind an established barrier or parked vehicle.
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from a haul truck to perform assigned duties, a "buddy system" should be used, where one worker is looking toward traffic.
- Work area should be protected by a physical barrier.
- Lookouts should be used when physical barriers are not available or practical.

In addition to the above work practices, AGVIQ-CH2M HILL personnel and AGVIQ-CH2M HILL subcontractors shall adhere to the following procedures while operating motor vehicles or other motorized equipment on military/government facilities.

- Always use a seat belt while driving on military/government facilities.
- Always observe posted speed limits, traffic signs and signals.
- Never use a cell phone or two-way radio while driving on military/government facilities.

Violating these requirements may result in loss of military/government facility driving privileges.

3.33 Vinyl Chloride

(Reference CH2M HILL, SOP HSE-512, *Vinyl Chloride*)

Vinyl Chloride is considered a "Confirmed Human Carcinogen." Vinyl Chloride has a mild, sweet, chloroform-like odor.

AGVIQ-CH2M HILL is required to control employee workplace exposure to vinyl chloride when personal exposures are at or above 1.0 ppm as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the Occupational Safety and Health Administration (OSHA) Vinyl Chloride standard, 29 CFR 1910.1017. The elements of the AGVIQ-CH2M HILL vinyl chloride program include the following:

- Exposure monitoring
- Methods of control, including personal protective equipment (PPE) and respirators
- Medical surveillance
- Training on hazards of vinyl chloride and control measures
- Record keeping requirements

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the CIH to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

3.34 Visible Lighting

Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness (including dusk and dawn) requires the set-up of supplemental lighting equipment. (Note: A general "rule of thumb" is that the illumination intensity must be sufficient to read a newspaper without difficulty). The chart below provides a reference for illumination requirements for various construction related work environments.

Illumination (Foot Candles)	Illumination (Lux)	Area of Operation
5	~ 55	General construction area lighting
3	~ 33	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas
5	~ 55	Indoors: warehouses, corridors, hallways, and exit ways
5	~ 55	Tunnels, shafts, and general underground work areas: (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved caplights shall be acceptable for use in the tunnel heading)
10	~ 108	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active store rooms, mess halls and indoor toilets and workrooms.)
30	~ 323	First aid stations, infirmaries, and offices

Notes:
A **foot candle** is a unit of illumination on a surface that is everywhere one foot from a point source of one candle.

A **lux** is a unit of measurement of the intensity of light. It is equal to the illumination of a surface one meter away from a single candle.

CONVERSIONS

Foot Candles (FC) = Lux x .0929

Lux = Foot candles x 10.76 - (i.e.: 50 FC = 538 LUX)

The following safe work practices shall be considered with regard to lighting in the workplace.

- Do not enter poorly lit areas without first providing portable illumination.
- Do not use non-explosion proof lighting in areas of flammable or combustible gases or liquids.

3.35 Welding or Cutting Operations

(Reserved)

3.36 Working Alone

(Reserved)

3.37 Working Around Material Handling Equipment

Where material handling equipment (earthmoving equipment, cranes, haul trucks) may be operating on or adjacent to the project work sites, it is important to observe the following measures when working in the same areas as heavy equipment and haul trucks.

- Never approach operating equipment/vehicles from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment/vehicles.
- Never turn your back on any operating equipment/vehicles.
- Never climb onto operating equipment or operate subcontractor/client equipment/vehicles.
- Never ride AGVIQ-CH2M HILL, subcontractor, or client equipment/vehicles unless authorized to do so and unless it is designed to accommodate passengers (equipped with firmly attached passenger seat).
- Never work or walk under a suspended load.

- Never use equipment as a personnel lifts; do not ride excavator buckets, crane hook, or material handling equipment forks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment/vehicles on cross slopes and unstable terrain.
- AGVIQ-CH2M HILL personnel will pull to the side of the road when encountering a forklift/heavy equipment. Even if the forklift/heavy equipment is not loaded with cargo, AGVIQ-CH2M HILL personnel will still pull to the side of the road and stop until the forklift has passed.

3.37.1 Powered Industrial Trucks

(Reference HSE-309, Forklifts)

Powered Industrial Trucks (i.e. forklifts, material handlers) may be required for materials movement during project activities (i.e. excavation sheeting system). Powered Industrial Trucks present the potential for damage to equipment, materials and personnel by impaling or striking personnel or materials with the fork tines. Additionally, Powered Industrial Trucks may tip if they are incorrectly loaded, driven at excessive speeds, operated with the forks too high or during excessively windy conditions.

The following rules apply whenever a forklift is used on the project:

- **Review and implement all applicable components of CH2MHILL SOP # HSE-309, Forklifts**.
- Only trained and authorized drivers will operate Powered Industrial Trucks. Powered Industrial Truck Operators must receive training in accordance with 29 CFR 1910.178.
- A rated lifting capacity must be posted in a location readily visible to the operator.
- A Powered Industrial Truck must not be used to elevate employees unless a platform with guardrails, a back guard, and a kill switch is provided on the vehicle. When guardrails are not possible, fall arrest protection is required.
- The subcontractor operating the forklift must post and enforce a set of operating rules for forklift trucks.
- Stunt driving and horseplay are prohibited.
- Employees must not ride on the forks.
- Employees must never be permitted under the forks (unless forks are blocked).
- The driver must inspect the forklift once a shift and document this inspection.
- The operator must look in the direction of travel and must not move the vehicle until all persons are clear of the vehicle.
- Forks must be carried as low as possible.

- The operator must lower the forks, shut off the engine, and set the brakes (or block the wheels) before leaving the forklift operator's position unless maintenance or safety inspections require the forklift to be running.
- Trucks must be blocked and have brakes set when Powered Industrial Trucks are driven onto their beds.
- Extreme care must be taken when tilting elevated loads.
- Every forklift must have operable brakes capable of safely stopping it when fully loaded.
- Powered Industrial Trucks must have parking brakes and an operable horn.

When the operator is exposed to possible falling objects, industrial trucks must be equipped with overhead protection (canopy).

3.37.2 Rigging

(Reference SOP # HSE&Q 316, Rigging)

Rigging may be employed during the execution of this task order for the lifting and/or lowering of materials associated with the set-up and operation of equipment during project execution. Where rigging equipment is required on the project, the following work practices shall be applicable.

- **Review and implement all applicable components of CH2MHILL SOP # HSE&Q-316, Rigging.**
- All rigging equipment must be inspected by a competent person prior to use for signs of excessive wear; equipment found to be damaged will be tagged and removed from service.
- Suspended loads will not pass over workers at any time. Site personnel are prohibited from passing under suspended loads.
- Rigging use, maintenance and inspection shall be performed in accordance with the applicable standards of 29CFR1926.250 and Army Corps of Engineers Manual EM 385 1-1, section 15, Rigging, whichever is more stringent.
- Only load rated (tagged or labeled) rigging shall be utilized on AGVIC/CH2M HILL projects. User shall familiarize themselves with design load rate capacities (i.e. vertical, basket/cradle or choker applications) for the selected rigging.
- Tag lines shall be attached to every load being lifted. Tag lines will be used for all suspended loads so that riggers and tenders will not have to be in direct contact with any suspended load while controlling position or orientation. **NO PERSON SHALL BE IN CONTACT WITH A LIVE LOAD AT ANY TIME**.
- Rigging shall be properly stored in a vertical position, where possible, and inspected daily, by a qualified person, before use. An inspection log must be maintained to document inspection findings and condition of the rigging. Rigging identified as "damaged" must identified as such and removed from service.

- AGVIG-CH2M HILL and subcontractor personnel shall not "ride" on materials under control loads being lifted.

3.37.3 Suspended Loads

- Suspended loads will not pass over workers at any time.
- Site personnel are prohibited from passing under suspended loads.
- Tag lines will be used for all suspended loads so that riggers and tenders will not have to be in direct contact with any suspended load while controlling position or orientation.

3.38 Working on or Over Water

(Reserved)

3.39 General Hazards

3.39.1 General Practices and Housekeeping

Maintaining proper site housekeeping measures promotes the elimination of slip, trip and fall hazards and exhibits a perception of pride in our work product and habits. Poor housekeeping can result in the basis of citations under 29CFR1926.25(a) or other applicable regulations. Good housekeeping practices must be implemented on every AGVIQ-CH2MHILL controlled project site and at a minimum shall be as follows:

- Maintain good housekeeping at all times in all project work areas.
- During the course of executed project operations, construction, alteration, or repairs, form and scrap lumber with protruding nails, and all other debris, shall be kept cleared from work areas, passageways, and stairs, in and around buildings or other structures.
- Combustible scrap and debris shall be removed at regular intervals during the course of construction. Safe means shall be provided to facilitate such removal.
- Containers shall be provided for the collection and separation of waste, trash, oily and used rags, and other refuse. Containers used for garbage and other oily, flammable, or hazardous wastes, such as caustics, acids, harmful dusts, etc. shall be equipped with covers and appropriately labeled. Garbage and other waste shall be disposed of at frequent and regular intervals.
- Establish common paths of travel and keep them free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Designate specific areas for the proper storage of materials.
- Store tools, equipment, materials, and supplies in an orderly manner.

- As work progresses, neatly store scrap and unessential materials or remove them from the work area.
- Provide containers for collecting trash and other debris and remove them at regular intervals.
- Clean up all spills quickly. Clean oil and grease from walking and working surfaces.

3.39.2 Hazard Communication

A hard copy of the AGVIQ, LLC, and CH2MHILL, Inc. Hazard Communication program information and MSDS material shall be provided at the project site.

In general, the SSHO will be the main contact in any onsite emergency coordination or communication situation and will ensure offsite emergency agencies have been contacted prior to the start of and verify that emergency contact numbers contained in this HSP are accurate/operational work. The SSHO will communicate with all potential emergency response organizations that would respond to an on-site emergency condition. In the event that during an emergency situation, the primary SSHO is not available or not capable of performing this function, an alternate SSHO or Site Superintendent can fulfill these duties. The SSHO or designee will serve as the Hazard Communication Coordinator (SSHO), and will perform the following:

- Review the COC and other applicable hazard communication information contained this HSP.
- Complete an inventory of chemicals brought onsite. See **Attachment 6** of this HSP. Give employees required chemical-specific HAZCOM training information using the format included in **Attachment 6** of this HSP.
- Confirm that an inventory of chemicals brought onsite is available.
- Request or confirm locations of MSDSs from the client, contractors, and subcontractors or material vendors for chemicals to which AGVIQ-CH2M HILL employees are potentially exposed. Maintain MSDSs in this HSP (**Attachment 5**).
- Before, or as chemicals arrive onsite, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

3.39.3 Shipping and Transportation of Chemical Products

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the AGVIQ-CH2M HILL Project Manager, HSPA/CIH or program regulatory specialist for additional information.

3.39.4 Heat Stress

It is recommended that personnel drink 16 ounces of water before beginning work. Disposable cups or containers and water maintained at 50°F to 60°F shall be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.

- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Whenever possible, avoid direct sun, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSHO to avoid progression of heat-related illness.
- To counteract the onset of heat stress symptoms, a work-break regimen must be established during the executed work. Workers in Level C PPE shall be allowed to rest and lower core body temperature to normal status when any one condition is exceeded:
  - Visual signs and symptoms of heat stress are present in a worker.
  - It is determined that a worker's core body temperature exceeds 100.4 degrees F.
  - Active work duration in Level C PPE in ambient temperatures in excess of 70 degrees F (without regard to humidity evaluation) occurs for more than 1 hour, or less where personnel reactions, physical conditions or extreme atmospheric conditions dictate.
  - For employees in permeable work clothing, Wet Bulb Globe Temperature (WBGT) Index or physiological monitoring shall be conducted and work/rest regimens established.

SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	**Heat Rash**	**Heat Cramps**	**Heat Exhaustion**	**Heat Stroke**
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature (104F or above).
Treatment	Remove to cooler area. Remove outer impermeable protective clothing. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Increase fluid intake. Recovery usually is prompt and complete. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Remove outer impermeable protective clothing. Remove to cooler area. Remove outer impermeable protective clothing. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Remove outer impermeable protective Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Increase fluid intake. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Administer fluids by mouth. Seek medical attention immediately. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body.	Remove to cooler area. Rest victim lying down in supine position (on back, facing up) with head shoulders slightly elevated. Where effected person is conscious, have them loosen their clothing to promote cooling surface between clothing/body. Call ambulance, and <u>get medical attention immediately!</u> Provide <u>sips</u> of cool water to if fully conscious and not nauseous or vomiting. Cool rapidly by soaking clothing in cool–but not cold–water. This procedure shall only be performed where directed by someone with medical training/ licensure (i.e. EMT, physician) and only as a life saving precaution. Evaluate employee's condition by an occupational physician prior to resuming normal assigned duties.

3.39.5 Monitoring Heat Stress

Heat Stress monitoring procedures must be implemented when the ambient air temperature exceeds 70˚F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress, or when workers are required to wear impermeable protective clothing (Saranex, Tyvek or Rain Gear) to perform their assigned duties. When AGVIQ-CH2M HILL employees are required to wear impermeable protective clothing (Saranex, Tyvek or Rain Gear) to perform their assigned duties, Level C PPE and are exposed to ambient air

conditions in excess of 70°F, physiological monitoring of employees is required. This monitoring will be facilitated by the use of automatic blood pressure monitors and by taking body temperature measurements monitored with aural or oral thermometers. All temperature measurement devices shall be affixed with disposable covers or protectors to ensure exposure to bloodborne pathogens does not occur.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

3.39.6 Cold Stress

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-chill index is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- NSC Guidelines for Work and Warm-Up Schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SHSO to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast— be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	Frostbite	Hypothermia
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment	Remove victim to a warm place. Re-warm area quickly in warm–but not hot water. Have victim drink warm fluids, but not coffee or alcohol. Do not	Remove victim to a warm place. Have victim drink warm fluids, but not coffee or alcohol. Get

	immediately.	break blisters. Elevate the injured area, and get medical attention.	medical attention.

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

3.40 Procedures for Locating Buried Objects/Utilities

Local Utility Mark-Out Service
Name: DIG SAFE
Phone: 888-344-7233
Email: http://www.digsafe.com/

Do not begin subsurface construction activities (e.g., excavation, drilling) or other ground disturbing activities until a check for underground utilities and similar obstructions has been conducted. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor to identify additional and undiscovered buried utilities. Examples of the type of geophysical technologies include:

- **Ground Penetrating Radar (GPR),** which can detect pipes, including both metallic and non-metallic gas pipes, tanks, conduits, and cables, at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.

- **Radio Frequency (RF)** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.
- **Dual RF** is a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF.
- **Ferromagnetic Detectors** are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g., a 100-mm iron disk to a depth of about one meter or a 25-mm steel paper clip to a depth of about 20 cm.
- **Electronic markers** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

3.40.1 Procedure

- The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project.
- The survey subcontractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project, based on the survey contractor's experience and expertise, types of utilities anticipated to be present, and specific site conditions.
- The survey contractor shall employ the same geophysical techniques used on the project to identify the buried utilities, to survey the proposed path of subsurface construction work to confirm no buried utilities are present.
- Identify customer specific permit and/or procedural requirements for excavation activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.
- Contact utility companies or the state/regional utility protection service at least three working days prior to excavation activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation.
- Schedule the independent survey.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances are to be in writing, signed by the party conducting the clearance.
- Underground utility locations must be physically verified by hand digging using wood or fiberglass-handled tools when any adjacent subsurface construction activity (e.g., mechanical drilling, excavating) work is expected to come within 5 feet of the marked underground system. If subsurface construction activity is within 5 feet and parallel to a marked existing utility, the utility location must be exposed and verified by hand digging every 100 feet.

- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Conduct a site briefing for employees regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., change in color, texture, or density during excavation that could indicate the ground has been previously disturbed).
- In addition to the information contained in this section, personnel performing hand auguring operations should use a fiberglass ground probe to search ahead to the next sample interval prior to advancing the hand auger. When performing environmental sampling, decontamination of the fiberglass ground probe shall apply.
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the AGVIQ-CH2M HILL individual responsible for site operations shall confirm the arrangement and be available onsite to verify the location of underground utilities or identified subsurface anomalies that may be in question and require further investigation measures.

3.41 Biological Hazards and Controls

The following sections provide information on potential biological hazards. Site personnel shall notify their overall supervisors and their project site supervisor of any potential allergic reactions that may occur as a result of contact with biological hazards in the workplace. If employee antidotes are required to counteract allergic reactions from biological hazard exposure, employees shall make personnel, who may be required to administer personal antidotes, aware of the location, type, and quantity of antidotes needed to counteract any potential allergic reaction(s).

3.41.1 Venomous Snakes

(Reserved)

3.41.2 Poisonous Plants

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12" to 30" high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in Spring and Summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in Fall, but plants lose its (yellowed, then brown) leaves in Winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

3.41.2.1 Exposure

Contamination with poison oak, ivy or sumac can happen through several pathways. These include

- Direct skin contact with any part of the plant.
- Contact with clothing that has been contaminated
- Contact from removing shoes that have been contaminated. (your shoes are coated with oil)
- Sitting in a vehicle that has become contaminated
- Contact with any objects or tools that have become contaminated.

Exposure to poison oak, ivy or sumac often becomes an OSHA recordable illness. Take proper action if you are potential contaminated. The dermatitis is so severe that many people seek medical care and get prescription cortisone creams or steroid shots to reduce the suffering caused by the itch.

For CH2M HILL employees exposed on the job, contact WorkCare at 866-893-2514 for assistance with the management of the exposure. For work-related injuries or illnesses to CH2M HILL personnel, inform the AGVIQ-CH2M HILL Project Manger (overall) and the AGVIQ-CH2M HILL HSM and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

For AGVIQ employees who are injured at work, see the closest qualified medical facility for medical attention notify your supervisor and the Human Resource office for injury management assistance. See Sections 10.3, 10.7 and **Attachment 11** of this HSP for additional information.

3.41.2.2 Best Work Practices

If you must work on a site that has been identified to potentially contain poison oak, ivy or sumac, the following precautions are necessary:

- Identify plants containing urushiol – The best way to prevent exposure is to recognize the plant and avoid working in areas where poison oak, ivy or sumac is present.
- If you must work in areas with urushiol containing plants, contact you project manager and health and safety manager to determine the best procedures to prevent contamination.
- Do not drive vehicles onto the site where it will come into contact with poison oak, ivy or sumac. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed and decontaminated as soon as possible after leaving the site.
- All tools used in the area, including those used to cut back the plants, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated. If working on or near the ground surface, place plastic on the ground to cover the grass and foliage.
- Personal protective equipment (PPE), including Tyvek coveralls, gloves, and boot covers must be worn. PPE and plastic used to cover the ground must be placed into separate plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- Shower as soon as possible to remove any potential contamination. Any body part with suspected or actual exposure should be washed with "Tecnu" or other product designed for removing urushiol. If you do not have Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Zanfel™ may also be used to treat exposed areas that are experiencing signs and symptoms of poison oak, ivy or sumac contamination. The CH2M HILL warehouses carry Zanfel™ products, which must be carried in First Aid Kits as deemed appropriate. Refer to the Zanfel™ information guide below for specific product and contact information.
- Use products such as IvyBlock™ to prevent poison oak, ivy and sumac contamination. IvyBlock™ is approved by the FDA to prevent the rash caused by poison oak, ivy and sumac.

If there is exposure use the following first aid procedures, or others you may find to alleviate the pain and itching.

3.41.2.3 Poison Oak, Ivy, and Sumac First Aid

Are there any of these problems?

- Swelling in the throat, tongue and/or lips
- A hard time breathing or swallowing
- Weakness, dizziness
- Bluish lips and mouth
- Unconsciousness

YES

Use emergency kit with adrenalin, if available, and Get Emergency Care.

NO

Do you have any of these problems?

- Skin that is very bright red.
- Pus.
- Rash that has spread to the mouth, eyes or genitals.
- Rash on large areas of the body or the face.

YES

Give first aid before seeing doctor:

- Take a hot shower (only after rash develops), put the rash area in hot water or pour hot water over it. Make sure the water is not too hot to burn the skin. The hot water causes itching at first, but brings relief later. Do not use soap.
- Take an over-the-counter antihistamine, such as Benadryl, as stated on the label.
- For weeping blisters:
- Mix 2 teaspoons of baking soda in 1 quarter (4 cups) of water.
- Dip squares of gauze in this mixture.
- Cover the blisters with the wet gauze for 10 minutes, four times a day. (Do not apply this to the eyes.)

NO

Self-Care/First Aid

- Wash (decontaminate) all affected areas with warm water and a strong soap.
- Keep your hands away from your eyes, mouth and face.
- Do not scratch or rub the rash.
- Apply any of these to the skin rash:
- Calamine (not Caladryl) lotion
- Zanfel™ lotion
- Zinc oxide ointment
- Paste made with baking soda - mix 3 teaspoons of baking soda with 1 teaspoon of water
- Take an over-the-counter antihistamine such as Benadryl, as stated on the label

  If self-care/first aid measures don't bring relief, call your doctor.

3.41.2.4 Urushiol Plant Facts

Urushiol Oil is Potent

- Only 1 nanogram (billionth of a gram) needed to cause rash
- Average is 100 nanograms for most people
- 1/4 ounce of urushiol is all that is needed to cause a rash in every person on earth
- 500 people could itch from the amount covering the head of a pin
- Specimens of urushiol several centuries old have found to cause dermatitis in sensitive people.
- 1 to 5 years is normal for urushiol oil to stay active on any surface including dead plants
- Derived from **urushi**, Japanese name for lacquer.

Myth	Fact
Poison oak, ivy, and sumac are contagious	Rubbing the rashes won't spread poison ivy to other parts of your body (or to another person). You spread the rash only if **urushiol oil** -- the sticky, resin like substance that causes the rash -- has been left on your hands.
You can catch poison ivy simply by being near the plants	Direct contact is needed to release **urushiol oil**. Stay away from forest fires, direct burning, or anything else that can cause the oil to become airborne such as a lawnmower, trimmer, etc.
Leaves of three, let them be	Poison sumac has 7 to 13 leaves on a branch, although poison ivy and oak have 3 leaves per cluster
Do not worry about dead plants	**Urushiol** oil stays active on any surface, including dead plants, for up to 5 years.
Breaking the blisters releases **urushiol** oil that can spread	Not true. But your wounds can become infected and you may make the scarring worse. In very extreme cases, excessive fluid may need to be withdrawn by a doctor.

3.41.2.5New Cream to Treat Exposure to Poison Plants

Exposure to poison oak, ivy and sumac can be uncomfortable, and in some cases the rash can become so severe that medical care is required. A relatively new product is available Zanfel™ (www.zanfel.com) that helps prevent blistering and itching from becoming severe. If you are working in an area with poison oak, ivy or sumac, you can obtain this cream by

contacting CH2M HILL's regional warehouse or notify your supervisor of the need to purchase this material. :

Please remember, the cream does not replace preventative measures, including:

- Avoiding contact with poison oak, ivy and sumac.
- Wearing Tyvek coveralls and gloves to prevent contact.
- Washing with Tecnu® (or a similar product) after potential exposure.
- Washing clothing and decontaminating equipment with an oil-cutting detergent.

More information about Zanfel (from Zanfel):

Zanfel™ is an effective wash for urushiol-induced contact dermatitis. Urushiol is the toxin known to cause the itching and rash associated with poison oak, ivy, sumac, poisonwood, and related plants. Zanfel works by surrounding urushiol and bonding with it, thereby enabling it to be rinsed away. Unlike some products that require use within 10-20 minutes of contact or that required continued use until the rash is gone (which can take up to 5 weeks), Zanfel offers relief at any stages of the reaction and often with only one wash. Individuals with particularly severe reactions may require additional washes. Most individuals experience relief from the itching within 30 seconds of application. The rash will begin to subside within hours if the reaction is mild to moderate. Severe and systemic cases will still require medical attention. Severe cases are defined as breakouts that are present on more than 15-percent of the body, and new breakouts continue to develop after day 4.

3.41.3 Ticks

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into/taped to boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only N, N-diethyl-meta-polyamide (DEET); and check yourself frequently for ticks. Where exposure to ticks is verified, personnel shall utilize "bug-out" suits, disposal Tyvek type coveralls or dedicated permethrin impregnated clothing to minimize potential exposures to ticks or other biting insects (i.e., chiggers). However, when this type of protective clothing is used and ambient air temperatures are elevated (> 70 degrees) heat stress preventive measures and monitoring protocols must be implemented. See the Heat Stress section in this HSP for additional information.

3.41.3.1 Hazard Control

The methods for controlling exposure to ticks include, in order of most-preferred to least:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventive antibiotic treatment after a bite is generally not recommended.

3.41.3.2 Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These tick varieties include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick (American and Brown)
- Rocky Mountain Wood Tick
- Western Black-legged tick

3.41.3.3 Illnesses and Signs/Symptoms

There are six distinguishable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite – normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

1. Lyme (bacteria)
2. Rocky Mountain Spotted Fever (RMSF) (bacteria)
3. Ehrlichiosis (bacteria)
4. Southern Tick-Associated Rash Illness (STARI) (bacteria)
5. Tularemia (Rabbit Fever) (bacteria)
6. Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs and symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, and small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. A variety of long-term symptoms may result when untreated, including debilitating effects and death.

3.41.3.4 Tick Removal

1. Use fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. (If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.)

3. Do not squeeze, crush, or puncture the body of the tick because its fluids (saliva, hemolymph, and gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. You may wish to save the tick for identification in case you become ill. Your doctor can use the information to assist in making an accurate diagnosis. Place the tick in a plastic bag and put it in your freezer. Write the date of the bite on a piece of paper with a pencil and place it in the bag. See "First Aid and Medical Treatment" information below.

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

Previously infected individuals are not conferred immunity – re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

3.41.3.5 First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Consult a healthcare professional if infection or symptoms and effects of tick-borne illnesses are developing.

Medical treatments for tick-borne infections include antibiotics and other medical interventions. Diagnosis of specific illness involves both clinical and laboratory confirmations. Preventive antibiotic treatment in non-ill individuals who have had a recent tick bite is recommended in specific cases only.

For CH2M HILL employees who have experienced a tick bite due to work-related activities, CH2M HILL has a protocol in place to test ticks that have been removed from an employee's body for the presence of Borrelia burgdorferi. Employees should contact the IMRTW at WorkCare at 866-893-2514 for assistance with the management of the tick bite. (See **Attachment 11** of this HSP, for details). The employee will be given instructions on how to send the tick to the Clongen Laboratory for analysis as determined by Work Care. If the results indicate that the tick is positive for Lyme disease, they will be referred to a medical provider for further medical evaluation and treatment. WorkCare will follow up with each CH2M HILL employee who reports a tick bite and is at risk of developing Lyme disease to monitor for symptoms and refer them to a medical provider for evaluation and treatment as necessary.

Tick Analysis Procedure for Lyme disease:

- For tick removal, follow the instructions in your tick removal kit using a fine pointed pair of tweezers. If the tick is alive, place it in two layered zip-lock bags. It is highly recommended that you wear gloves when removing the tick from the skin to avoid infection.
- It is important to remove the entire tick and place it in a zip-lock bag.
- Place the zip-lock bag in an envelope and fill out the sample Clongen submission form included in **Attachment 11** of this HSP as directed by Work Care. Please identify

yourself as a CH2M HILL employee by completing all the contact information in the form. The cost of the analysis will be paid for by CH2M HILL; you do not have to use a credit card or check. The account has an assigned purchase order that is billed directly to Work Care for payment.

Within 1 to 3 days, you will be contacted by Work Care to discuss the tick analysis results, and to discuss any further need for medical evaluation.

For work-related injuries or illnesses to CH2M HILL personnel, inform the AGVIQ-CH2M HILL Project Manger (overall) and the AGVIQ-CH2M HILL HSM and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

For **AGVIQ** employees, who have been bitten by a tick, contact our AGVIQ supervisor and HSPA for management and support of an incident of this type.

3.41.4 Fire Ants

(Reserved)

3.41.5 Spiders - Brown Recluse

The brown recluse is regarded by many as the most dangerous spider in the United States. Poisonings due to spider bites are rare in Northern New England. The brown recluse spiders are not native to this region, however, sometimes they are in with produce, on a truck, in a car or in boxes after people visit or move here from other parts of the country.

Brown Recluse Spiders are usually 1 inch or larger in size, including the legs and can grow as large as 3 inches. Young Brown Recluse spiders are smaller and somewhat lighter in color. Brown recluse spider bites don't always hurt right away.

In fact, you may not know that you have been bitten until other symptoms appear. Symptoms of a brown recluse spider bite may include the following:

- Reddened skin followed by a blister that forms at the bite site.
- Mild to intense pain and itching for 2 to 8 hours following the bite.
- An open sore with a breakdown of tissue (necrosis) that develops within a few hours to 3 to 4 days following the bite and the area may become painful, itchy, hot, swollen, red and tender. An irregular ulcerous sore, caused by necrosis, will often appear that is from 1/4 inch to 10 inches in diameter. Prompt attention is the best defense against preventing the necrosis. The wound is often described as being reddish and surrounded by a bluish area with a narrow whitish separation in between the red and the blue. This gives it the famous "bull's eye" pattern. In just hours, a bite from the highly venomous Brown Recluse spider can create blisters and cause tissue damage.

Some people have a severe, systemic (whole-body) reaction to brown recluse spider bites, including the rapid destruction of red blood cells and anemia. Signs and symptoms include: Fever and chills.

- Skin rash all over the body with many tiny, flat purple and red spots.
- Nausea or vomiting.
- Joint pain.

If you think you have been bitten by a brown recluse spider:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood.
- Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider.
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite.
- Do not apply a tourniquet. It may cause more harm than benefit.
- Try to positively identify the spider to confirm its type.
- Seek prompt medical attention.

A brown recluse bite can be serious and will likely require immediate medical care. Seek medical attention if you believe you have been bitten by a recluse spider, especially if severe symptoms develop throughout your body or an open sore and necrosis develop. A brown recluse spider bite is diagnosed through a physical examination and questions about the bite. You should be prepared to describe the spider, where and when the bite took place, and what you were doing at the time. Your health professional will ask what your main symptoms are, when they began, and how they have developed, progressed, or changed since the bite.

3.41.6 Spiders – Black Widow

Like the Brown Recluse, the Black Widow spider is not indigenous to New England. Females range from 8-15 mm in body length; males are smaller, sometimes very small (2 mm). Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale and/or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day. In nature, most species are found under rocks and logs, but they readily adapt to human-altered environments, where they are most commonly found in outbuildings (sheds, barns, privies), water meter holes, nursery cans, and under any item or structure (e.g., barbeque grill, slide, sand box) that has been undisturbed for a lengthy period. Formerly, most bites by black widows (almost all by female spiders) occurred in outhouses, but presently, widow bites occur most frequently when the spider is trapped against human skin, either by reaching under objects

where the spider is hiding or when putting on clothing, gloves or shoes containing the spider. Widow spiders are generally very timid and only bite in self-defense when they accidentally contact humans.

Bite symptoms are systemic, spreading through the lymphatic system, and usually start about 1-3 hours after the bite. The most common symptoms are intense pain, rigid abdominal muscles, muscle cramping, malaise, local sweating, nausea, vomiting, and hypertension. Other symptoms may include tremors, labored breathing, restlessness, increased blood pressure, and fever. If left untreated, widow bites symptoms usually last 3-5 days.

If bitten, remain calm, and immediately seek medical attention (contact your physician, hospital and/or poison control center). Apply an ice pack directly to the bite area to relieve swelling and pain. Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider. A hospital stay may be recommended, particularly for those with a heart condition or with health problems. A physician may administer a specific antivenin to counteract the venom or calcium gluconate to relieve pain. Calcium gluconate and/or antivenin may be administered to relieve or counteract symptoms.

3.41.7 Bloodborne Pathogens

(Reference SOP HSE-202, *Bloodborne Pathogens*)

Bloodborne pathogens are pathogenic microorganisms present in human blood or other potentially infectious material that can cause disease. These pathogens include, but are not limited to, the Hepatitis B Virus (HBV) and the Human Immunodeficiency Virus (HIV). Other potentially infectious material includes any human body fluid that is visibly contaminated with blood, such as saliva or vomit. It also includes all body fluids in situations where it is difficult or impossible to differentiate between body fluids, such as during an emergency response and any unfixed tissue (other than intact skin) from a human (living or dead).

In emergency medical situations, certain employees may need to render first aid as a collateral duty in response to workplace accidents or injuries. This category includes the SSHO, site managers/supervisors, or individuals certified in FA and CPR and shall have received training in exercising universal precautions against exposure to bloodborne pathogens as a component to FA/CPR training, which meets the intent of 29CFR1910.1030. This employee training is also complemented by other regularly scheduled employer training curriculums that are typically executed for the HAZWOPER industry, regulated under 29CFR1910.120/29CFR1926.26. The only worker exposure to bloodborne pathogens anticipated for this project will potentially be to those individuals providing FA/CPR to an injured or “down” worker.

However, additional worker training programs in to bloodborne pathogens may also be required when it is expected that employees could contact landfill waste or other waste streams containing potentially infectious material. This situation is not reasonably expected for this project.

To eliminate or minimize employee exposure to bloodborne pathogens, workers who may be exposed to bloodborne pathogens or potentially infectious material must implement the following hazard control measures.

Employees expected to render first aid shall be cognizant of and adhere to the following with regard to potential exposure to bloodborne pathogens:

- First aid kits and a Bloodborne Pathogens Protection Kit shall be immediately available at the site. The kit is commercially available through most safety or medical supply vendors.
- These kits shall contain gloves, masks, CPR protectors, biohazard disposal bags, antiseptic cleanser, splash-proof goggles, towels, wipes, and an absorbent powder to clean up spills. Gloves, masks, and other PPE measures must be donned by personnel responding to emergency or first aid situations where exposure to Bloodborne Pathogens could occur.
- A portable eye wash station or means of conducting eye washing or flushing shall be readily available at each designated project site location.
- Always wash your hands and face with antiseptic soap and running water after contacting potentially infectious material. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes. When antiseptic cleansers or towelettes are used, always rewash your hands and face with soap and running water as soon as available. **Do not consume food or beverages, smoke, chew tobacco, or perform another hand to eye/face/mouth activity until after thoroughly cleaning your hand (with antiseptic soap and water), then your face and only after the employee has removed themselves from the designated work area that contains materials that can be reasonably considered being contaminated with bloodborne pathogens.**
- Use universal precautions when dealing with materials or situations where there is a potential for bloodborne pathogens. Universal precaution is an approach to infection control whereby all human blood and potentially infectious material are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.
- Personnel who may be exposed to Bloodborne Pathogens should **review and implement all applicable components of CH2M HILL SOP # HSE&Q 202, Bloodborne Pathogens.**

3.41.8 Mosquito Bites

Because of the recent detection of the West Nile Virus in the United States, it is recommended that **preventive measures** be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent.

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.

- Spray clothing with repellents containing pyrethrum or DEET because mosquitoes may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET. DEET in high concentrations (greater than 35%) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

3.41.8.1 Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3 to 15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

3.41.9 Rabid Animals

Encounters with a rabid animal can lead to rabies transmission when virus from the animal's saliva, brain tissue, or spinal fluid enters open cuts or wounds in skin or mucous membranes. Therefore, not every encounter with a rabid animal is a true exposure requiring intervention. Treatment is often provided unnecessarily to people who have encountered but had no true exposure to a potentially rabid animal.

Any penetration of the skin by an animal's teeth is considered a "bite exposure." Local wound care should be performed immediately on anyone bitten by an animal. Local treatment of wounds involving immediate and extensive washing of all bite wounds, scratches, or other sites of potential exposure for 10 minutes with soap and water is arguably the most important measure for preventing rabies following an exposure to a rabid animal. Experiments done in animals suggest that thorough and vigorous cleansing to the depth of the wound with a 20% soap solution can reduce the risk of developing rabies. Tetanus booster vaccine (Td) should be given if indicated. A health care provider should be consulted to determine whether other measures are necessary. When a bite exposure has been determined, laboratory testing of the animal, if available, may be indicated depending upon the circumstances of the exposure (such as whether it was provoked or not) and the species involved. The risks associated with bites from different animals vary from place to place. For work on this particular contract, contact with rabid dogs, cats, raccoons, and rats could be possible.

"Non-bite exposures" include any scratches, abrasions, or contamination of mucous membranes by an infected animal's saliva, brain tissue, or spinal fluid. Other types of contacts (such as with the blood, urine, feces, or fur of an animal) would not by themselves

be considered exposures capable of transmitting rabies even if the animal were known to be rabid. The virus is not hardy; once dry, saliva containing rabies virus is considered non-infectious.

4.0 Behavior Based Loss Prevention System

(Reference SOP # HSE&Q 103, Behavior Based Loss Prevention System)

A Behavior Based Loss Prevention System (BBLPS) has been implemented on this project. BBLPS is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The four basic loss prevention tools that will be used to implement the BBLPS on this project include:

- Activity Hazard Analysis (AHA)
- Pre-Task Safety Plans (PTSP)
- Loss Prevention Observations (LPO)
- Loss and Near Loss Investigations (NLI)
- Drug Free Workplace Program (DFWP)

The Project Manager and/or AGVIQ-CH2M HILL individual responsible for site operations (site supervisor) are responsible for implementing the BBLPS on the project site and ensuring that project team members have received the BBLPS training prior to initiating field activities. These personnel typically delegate authority to the SSHO for the project specific implementation of the BBLPS, but the Project Manager and/or individual responsible for site operations remains accountable for its implementation. The SSHO will only verify the subcontractor's implementation of their AHAs and PTSPs for their assigned work.

Should it be determined that AGVIQ-CH2M HILL project personnel have not received a BBLPS orientation, the Superintendent or Project Manger shall contact their designated safety representative so this orientation can be provided. Subcontractors may not necessarily be required to receive this AGVIQ-CH2M HILL BBLPS orientation, but shall be informed of, be covered by, or separately implement the four basic loss prevention tools of the BBLPS.

In an effort to provide a safe and healthy workplace for all program participants, AGVIQ-CH2M HILL promotes and implements a Drug Free Workplace Program (DFWP). All AGVIQ-CH2M HILL personnel must participate in and adhere to the requirements of the DFWP.

4.1 Activity Hazard Analysis

An AHA defines the activity being performed, the hazards posed, and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited before, during, and after the performance of work to further identify the hazards posed and control measures required.

AHA will be implemented before beginning each project activity posing H&S hazards to project personnel using the AHA forms provided in **Attachment 7**. The AHA will identify the work tasks required to perform each activity, along with potential H&S hazards and

recommended control measures for each work task. In addition, a listing of the equipment to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified.

An AHA will be prepared for all field activities performed by AGVIQ-CH2M HILL and subcontractors during the course of the project and should be reviewed and accepted by the Health and Safety Manager or other designated program H&S professional. The Project-Specific, General, and Biological Hazards, the Hazard Analysis Table (Table 1-1) and respective applicable AGVIQ-CH2M HILL partner Standards of Practice (SOPs) should be used as a basis for preparing these AHAs.

AGVIQ-CH2M HILL subcontractors will be required to provide AHAs specific to their scope of work on the project for acceptance by the SSHO. Each subcontractor will submit AHAs for their field activities, as defined in their work plan/scope of work, along with their project-specific HSP. Additions or changes in AGVIQ-CH2M HILL or subcontractor field activities, equipment, tools or material to perform work, or additional/different hazard encountered that require additional/different hazard control measures requires either a new AHA to be prepared or an existing AHA to be revised.

4.2 Pre-Task Safety Plans

Daily safety meetings are held with all project personnel in attendance to review the hazards posed and required H&S procedures/AHAs that apply for each day's project activities. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in **Attachment 8**, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools, and equipment that will be used to perform these tasks are listed, along with the hazards posed and required H&S procedures, as identified in the AHA. The use of PTSPs better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required H&S procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

4.3 Loss Prevention Observations

LPOs will be conducted by the AGVIQ-CH2M HILL individual responsible for site operations/SSHO for specific work tasks or operations comparing the actual work process against established safe work procedures identified in the project-specific HSP and AHAs. LPOs are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss. The AGVIQ-CH2M HILL individual responsible for site operations/SSHO will perform at least one LPO each week for tasks/operations addressed in the project-specific HSP or AHA. The AGVIQ-CH2M HILL individual responsible for site operations/SSHO will complete the LPO form in **Attachment 9** for the task/operation being observed, following the process below.

4.4 Loss/Near-Loss Investigations

Loss/near-loss investigations will be performed for the all AGVIQ-CH2M HILL and subcontractor incidents involving:

- Person injuries/illnesses and near-miss injuries
- Equipment/property damage
- Spills, leaks, regulatory violations
- Motor vehicle accidents

The causes of loss and near-loss incidents are similar, so by identifying and correcting the causes of near-loss incidents, future loss incidents may be prevented. The following is the loss/near-loss investigation process:

- Gather all relevant facts, focusing on fact-finding, not fault-finding, while answering the who, what, when, where, and how questions.
- Draw conclusions, putting facts together into a probable scenario.
- Determine incident root cause(s), which are basic causes on why an unsafe act/ condition existed.
- Develop and implement solutions, matching all identified root causes with solutions.
- Communicate incident as a lesson learned to all project personnel.
- File follow-up on implemented corrective action to confirm solution is appropriate.

Site Supervisors/SSHO will perform an incident investigation as soon as practical after incident occurrence during the day of the incident, for all loss and near-loss incidents that occur on the project. Loss and near-loss incident investigations will be performed using the following incident investigation forms provided in **Attachment 10**:

- Incident Report Form (IRF) *
- Incident Investigation Form
- Root Cause Analysis Form

  * For work-related injuries or illnesses to CH2M HILL personnel, Inform AGVIQ-CH2M HILL Project Manger overall and AGVIQ-CH2M HILL HSPA/CIH contact and help Human Resources administrator complete a HITS (Hours and Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

All loss and near-loss incidents involving personal injury, property damage in excess of $1,000, or near-loss incidents that could have resulted in serious consequences will be investigated by completing the incident investigation forms and submitting them to the Project Manager and HSPA within 24 hours of incident occurrence. A preliminary Incident Investigation and Root Cause Analysis will be submitted to the Project Manager and HSPA/CIH within 24 hours of incident occurrence. The final Incident Investigation and Root Cause Analysis will be submitted after completing a comprehensive investigation of the incident.

4.5 Drug-Free Workplace Program

(Reference SOP # HSE&Q 105, Drug Free Workplace)

AGVIQ-CH2M HILL does not tolerate illegal drugs, or any use of drugs, controlled substances, or alcohol that impairs an employees work performance or behavior. AGVIQ-CH2M HILL has established a policy that its employees and subcontractors will not be involved in any manner with the unlawful manufacture, distribution, dispensation, possession, sale, or use of illegal drugs in the workplace. The use or possession of alcohol in the workplace is also prohibited. Any violation of these prohibitions may result in discipline or immediate discharge.

In order to remain consistent with the requirements of the DFWP, review CH2M HILL, Inc. Standard of Practice HSE 105, *Drug-Free Workplace*, for more information.

AGVIQ-CH2M HILL reserves the right to randomly test program participants in accordance with the conditions of the DFWP.

5.0 Personal Protective Equipment

Personal protective equipment (PPE) specifications are listed in Table 5-1 for anticipated Project Operations.

Table 5-1 Personal Protective Equipment[a]

Task	Level	Body	Head	Respirator [b]
▪ Mobilization & Demobilization operations ▪ Land and Utility Survey Activities to support the remedial objectives where site COC constituents <u>are not disturbed</u> or there <u>is no potential</u> site worker exposure to identified site COCs.	D	▪ Designated and appropriate work clothes ▪ Steel toe work boots that provide sufficient ankle support ▪ Work gloves (cut resistant), reflective safety vest ▪ Reflective traffic vest	▪ Hardhat [c] ▪ Safety glasses ▪ Hearing protection (as applicable)[d]	▪ None required
Any function identified in this HSP where potential dermal contact with site COCs **<u>IS limited to the hands only.</u>** ▪ Mobilization operations where COC constituents <u>are disturbed</u> or there <u>is a potential</u> site worker exposure. ▪ Land and Utility Survey Activities to support the remedial objectives where site there <u>is a potential</u> site worker exposure to site COCs. ▪ Groundwater/surface water/ and sediment sample collection for the East Plume. ▪ Drilling/DPT and monitoring well installation on the East Plume.	Modified D_1	▪ Designated and appropriate work clothes; ▪ Steel toe work boots that provide sufficient ankle support (preferable leather) ▪ Work gloves (cut resistant) ▪ Reflective safety vest; ▪ Inner surgical-style nitrile and outer chemical resistant nitrile gloves.	▪ Hardhat [c] ▪ Safety glasses ▪ Ear protection (as applicable) [d] ▪ Face shields (as applicable)	▪ None required.
Any function identified in this HSP where potential dermal contact with site COCs is **<u>NOT</u>** limited to the hands only. ▪ Land and Utility Survey Activities to support the remedial objectives where site soil or water impacted by site COCs. ▪ Pressure washing operations ▪ Drilling/DPT and monitoring well installation and groundwater/sediment sampling on the East Plume if contact with sediment or groundwater cannot be limited to the hands.	Modified D_2	▪ **Coveralls:** Poly coated or uncoated Tyvek® chemical resistant disposable cov **Poly c**oated will be used for exposure to liquid chemicals or other dangerous s hazards. ▪ **Boots:** Hard toe work boots that provide sufficient ankle support (preferable lea with outer rubber boot covers or hard toe chemically resistant rubber boots with shank ▪ **Gloves:** Inner & Outer surgical-style nitrile chemical-resistant nitrile gloves.	▪ Hardhat [c] ▪ Safety glasses ▪ Ear protection (as applicable) [d] – Face shields (as applicable)	▪ None required.
Contact HSPA/CIH prior to implementing Level C PPE upgrade. ▪ Site conditions where defined action levels are exceeded or where unknown site conditions are encountered and confirmed by AGVIQ-CH2M HILL HSPA/CIH that Level C PPE is required to ensure a negative exposure to site workers. Contact AGVIQ-CH2M HILL HSPA/CIH prior to upgrading to Level C PPE.	C	▪ **Coveralls:** Polycoated Tyvek® ▪ **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots wi rubber boot covers ▪ **Gloves:** Inner surgical-style nitrile and outer chemical resistant nitrile gloves.	▪ Hardhat [cc] ▪ Ear protection (as applicable) [d] ▪ Spectacle inserts (as applicable)	▪ Full Face APR with organic vapor cartridges, applicable to appropriate respiratory protection measures for against specific site compounds & with P100 HEPA combination cartridges for particulate exposures, as necessary.

Table 5-1 Personal Protective Equipment[a] (continued)

Reasons for Upgrading or Downgrading Level of Protection

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

NOTES:

[a] Modifications are as indicated. AGVIQ-CH2M HILL will provide PPE only to AGVIQ-CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SSHO.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range --then at least every 4 hours.
If encountered conditions are different than those anticipated in this HSP, contact the HSPA/CIH. **Where** AGVIQ-CH2M HILL **personnel are required to use a respirator to provide respiratory protection,** AGVIQ-CH2M HILL **personnel shall receive respiratory protection awareness training. Contact the HSPA/CIH to receive this training, prior to using any respiratory protective device.**
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level D modified/Level C) is permitted only when the PPE requirements have been approved by the HSPA/CIH, and an SSHO qualified at that level is present.

6.0 Air Monitoring

Air monitoring requirements for anticipated project activities are listed in Table 6-1.

TABLE 6-1
Air Monitoring Equipment Specifications

Instrument	Tasks	Action Levels[a]	Level of Protection or Action	Frequency [b]	Calibration
Dust Monitor - Visual	▪ Drilling/DPT, and soil handling operations	No visible dust	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection. Continue work	Whenever visual dust is observed	NA
		Visible dust	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection. Suspend operations, institute dust control measures (water application) until visible dust is abated. If dust cannot controlled to an acceptable condition (no visible dust), contact the HSPA/CIH before implementing respiratory protection devices.		
Photo Ionization Detector (PID) **10.6 eV lamp or higher**	▪ Any activities where soil or groundwater is removed, disturbed or handled that is impacted by identified site COCs. (i.e. groundwater sampling or drilling/DPT) ▪ Pre-demolition removal and handling/management of Oil/Hazardous Materials (OHM) from the UST system ▪ Removal of all the UST system components (USTs, canopy, piping, fuel island, concrete pads etc) ▪ Pressure washing operations ▪ CSE Operations	0 – 1 ppm (in worker BZ)	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection	1) Initially during start up of a task, upon opening ground of each water monitoring well heads/cover, 2) During any activity where unusual odors, vapors, discolored soil/sediment or free phase product is observed during the execution of tasks.	Daily (before & after daily use or more frequently to verify accuracy)
		1 - 5 ppm (sustained 5 mins in worker BZ)	Level D, Modified Level D_1 or D_2 as identified by Table 5-1 for dermal protection and begin compound specific monitoring using Sensidyne indicator tubes. (See below).	Continuously or until 1) level is below 1 ppm, 2) Compound specific action level is exceeded (see below).	
		> 5 ppm (sustained 5 mins. in worker BZ)	Stop work. Evacuate area for 10 minutes and recheck BZ and work area and verify Action Levels are not exceeded. If levels persist or Action Levels are exceeded, consult HSPA/CIH for proper engineering and/or administrative controls and PPE requirements or before working in environments were COCs are potentially in excess of established Occupational Exposure Limits (OELs).	1) Continuously upon re-start of work to verify PID level 0-1 ppm in WBZ and 2) Until it is determined that compound specific concentrations are less than the established Action Level.	

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the HSO; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., “Breathing Zone/MW-3”, “at surface/SB-2”, etc.).
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d] Refer to SOP HSE 207 for instructions and documentation on radiation monitoring and screening.
[e] Noise monitoring and audiometric testing also required.

6.1 Perimeter Air Monitoring

Because of the conservative approach of determining worker exposures of site contaminants at the point source of the worker's breathing zone engaged in intrusive site operations, work zone perimeter concentrations of site COCs should not exceed those identified at the worker breathing zone and in theory, be significantly reduced from those concentrations identified at the point source. With this process in mind, and with the required site safe guard actions that are required when elevated air monitoring results are encountered, perimeter air monitoring should not be necessary

However, in the event that 1) more aggressive soil or ground water disturbance operations were performed at the site, 2) on-site air monitoring data identified and gross exceedances of the established site air monitoring AL's 3) new data/information about the site is identified, then the perimeter air monitoring requirements could be applicable or 4) the general public could be effected by air bourn site COC concentrations, then this approach will be modified, with client approval. .

6.2 Calibration Specifications

Air Monitoring equipment calibration specifications are listed in Table 6-2.

TABLE 6-2
Air Monitoring Equipment Calibration Specifications

Instrument	Gas	Span	Reading	Method
PID *	"zero air" gas and 100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing/ tedlar bag "zero air" gas followed by methane

** Daily (before & after daily use or more frequently to verify accuracy and in accordance with the manufacturer's requirements).*

*** Daily before and after each sample collection event and in accordance with the manufacturer's requirements.*

Note: Worker breathing zone and ambient air monitoring results and air monitoring equipment calibration measures must be logged on an Air Monitoring Log (**See Attachment 4**) or a daily field log/book.

7.0 Decontamination

For the execution of this contract task order, it is not anticipated that Level C PPE, however, level D modified PPE maybe required to ensure a negative worker exposure to identified site COCs. Regardless of worker PPE requirements, proper site worker hygiene and decontamination (when required) procedures are important to eliminate any inadvertent exposure to unhealthy conditions that could occur but have yet been identified and it is important for site personnel to exercise to the following procedures:

1) Eating, drinking, smoking and other tobacco use shall only be conducted in designated and unrestricted areas and not in any areas where there is any exposure to hazardous material/waste, flammable/combustible liquids, and gases.
2) Wash hands and face, if applicable, before eating, drinking, smoking or otherwise using tobacco.
3) Shower as soon as feasible after completing field activities.

The SSHO must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSHO. The SSHO must ensure that procedures are established for disposing of materials generated on the site.

7.1 Decontamination Specifications

Where Level D modified or Level C PPE is required for worker protection, it is essential for workers to maintain the good personal hygiene practices. Proper and specific decontamination procedures will be required where Level D modified or Level C PPE is required for this project, to ensure negative worker exposure to any identified contaminants or hazardous materials. These procedures are identified and illustrated below. Contact lenses are not permitted in HAZWOPER exclusion or decontamination zones.

Personnel	Sample Equipment	Heavy Equipment
▪ Boot wash/rinse ▪ Glove wash/rinse ▪ Outer-glove removal ▪ Body-suit removal ▪ Inner-glove removal ▪ Respirator removal ▪ Hand wash/rinse ▪ Face wash/rinse ▪ Shower ASAP ▪ Collect, properly containerize, label and dispose of all spent of PPE ▪ Collect, properly containerize, label and dispose of all spent decontamination fluid contain for offsite disposal	▪ Wash/rinse equipment ▪ Solvent-rinse equipment ▪ Contain solvent waste for offsite disposal ▪ Collect, properly containerize, label and dispose of all spent of decontamination fluid and residual solids for offsite disposal	▪ Power wash ▪ Steam clean ▪ Collect, properly containerize, label and dispose of all spent of decontamination fluid or residual solids

7.2 Diagram of Personnel-Decontamination Procedures

Figure 7-1 is a flow chart of the Personnel Decontamination Line. No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSHO should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones. In all cases, whether Level D modified or Level C is required, it is essential for workers to maintain good positive personal hygiene practices.

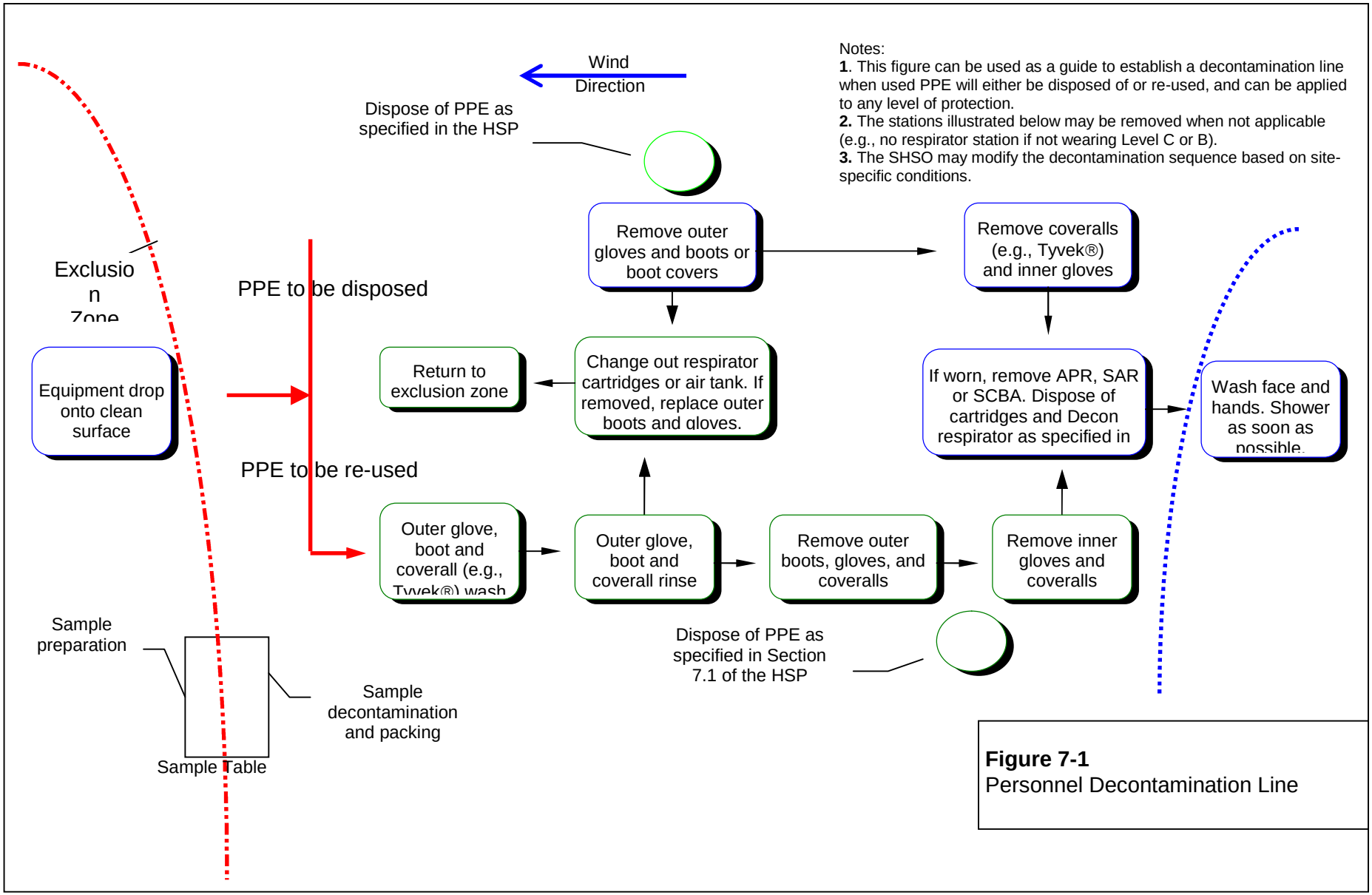


Figure 7-1
Personnel Decontamination Line

8.0 Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

8.1 Procedure for Containing/Collecting Spills

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If for some reason a chemical spill is not contained within a dike or sump area, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or a pipeline rupture, an initial isolation of at least 100 feet in all directions will be used. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe will require evacuation of at least 50 ft in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area. If possible, the area will be roped off or otherwise blocked.

If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire) and its release (due to high vapor pressures under ambient conditions), further evacuation must be engaged. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled. (Consult the Department of Transportation (DOT) Emergency Response Guide for isolation distances for listed hazardous materials.)

If an incident may threaten the health or safety of the surrounding community, the public will be informed (via proper local and state emergency management planning agencies) and possibly evacuated from the area. The onsite emergency coordinator will inform the proper agencies in the event this is necessary. A Project Emergency Contact List is provided in **Attachment 11**.

As called for in regulations developed under the comprehensive Environmental Response Compensation Liability Act of 1980 (Superfund), AGVIQ-CH2M HILL's practice is to report a spill of a pound or more of any hazardous material for which a reportable quantity has not been established and which is listed under the Solid Waste Disposal Act, Clean Air Act, Clean Water Act, or the Toxic Substances Control Act (TSCA). TSCA also follows the same practice for any substances not listed in the Acts noted above but which can be classified as a hazardous waste under Resource Conservation and Recovery Act (RCRA).

Response/containment personnel shall take the following measures:

- Immediately warn any nearby workers and notify individual responsible for site operations.

- Assess the spill area to ensure that it is safe to respond.
- Evacuate area if spill presents an emergency.
- Ensure all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources, and use only spark- and explosion-proof equipment for recovery of material.
- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- Stop source of spill.
- Establish site control for spill area.
- If wastes reach a storm sewer, dam the outfall by using sand, earth, sandbags, etc. Pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g., clay, sand, lime) to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, sand, clay, or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank. Follow proper ground and bonding procedures of equipment during recovery efforts. Intrinsically safe equipment must be used in recovery operations.

8.2 Anticipated Hazardous Materials

The following is a list of hazardous materials or chemicals that may be brought onsite and incorporated as part of the final completion of the work, generated during the execution of the work for offsite disposal or recycling or otherwise used to facilitate site work. These hazardous materials or chemicals may require spill prevention and countermeasure control processes to ensure sensitive environmental receptors are not adversely impacted in the event of a spill or release of these materials.

- Gasoline (small metal safety containers for fueling small engine equipment).
- Diesel fuel in heavy equipment.
- Minor quantities of sample preservatives (e.g., nitric acid, hydrochloric acid, sulfuric acid, sodium hydroxide/zinc acetate, phosphoric acid).

8.3 Notification

In the event a spill occurs that requires notification, a project person shall follow the AGVIQ-CH2M HILL Incident Notification Process and Chain of Command" structure identified in Figure 10-2, of this HSP.

In addition, the AGVIQ-CH2M HILL overall Project Manager shall make notification to the designated NAVFAC Remedial Project Manager (RPM) or Resident Officer In Charge of Construction (ROICC) or other designated client POC, as applicable, such that additional appropriate community and/or federal/state agencies may be engaged and notified, as applicable. The AGVIQ-CH2M HILL Project Manager (overall) shall coordinate with the designated Project Environmental Compliance Manager for support with regard to adhering to local, state, or federal regulations for spill notification clean-up and closure requirements.

9.0 Site-Control Plan

9.1 Site-Control Procedures

Project managers and team leaders are to perform the following tasks:

- Evaluate and ensure worker safety in remote/secluded work areas.
- Confirm if potentially dangerous activities (such as hunting seasons, live ordinance use, military field exercises/activities, transfer of dangerous or explosive cargo/materials, location of explosive arc zones) could be occurring in or adjacent to any AGVIQ-CH2M HILL work areas that may jeopardize worker health and safety.
- Reschedule field activities when potentially dangerous activities are occurring adjacent to AGVIQ-CH2M HILL work locations. Ensure proper two-way communications with workers in remote work areas. Use the buddy system.
- Site workers and visitors shall sign-in and sign-out as they enter and exit the site work boundaries (**see Attachment 4**).
- **Designate an emergency evacuation route.**
- **Designate an evacuation assembly area.**
- The SSHO, or designee, will conduct a site safety briefing (section 4.0 of this HSP) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSHO records safety briefing attendance in a logbook and documents the topics discussed.
- Ensure that applicable AGVIQ-CH2M HILL personnel have received the BBLPS Training
- Be aware of any potential for hazardous chemical exposure and know what precautions/training are required.
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Know how an emergency should be reported.
- Identify exact facility location and position (where possible) when contacting EMS/Fire Dispatch.
- Have readily available copy of the Hospital Route Map.

- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Know how, what, when injuries/accidents are reported and treated.
- Initial air monitoring is conducted by the SSHO in appropriate level of protection.
- The SSHO or other authorized designee is to conduct periodic inspections of work practices to determine the effectiveness of this plan. Such inspections should identify site conditions or actions that are not consistent with the policies and procedures of the H&S program, report to the AGVIQ-CH2M HILL Project Manager (overall) and the AGVIQ-CH2M HILL HSPA/CIH. The project team shall develop and implement corrective action procedures in a timely manner.

9.2 Specific Site Control Measures

To prevent both exposure of unprotected personnel and migration of contamination, work areas and personal protective equipment requirements will be clearly identified when operations that fall under the requirements of 29 CFR 1910.120/29 CFR 19126.65 are executed. This HSP recommends that the area surrounding each of the work areas be divided into three distinct zones; the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone (SZ).

Only individuals who meet the requirements of 29 CFR 1910.120/29 CFR 1926.65 and who are authorized by the AGVIQ-CH2M HILL individual responsible for site operations (i.e., site supervisor) or the SSHO shall be allowed entry into the EZ and CRZ. Suitable means and methods (high visibility fencing, caution tape signage, other physical barriers) shall be employed to demarcate the EZ and CRZ boundaries at this site to prevent unauthorized entry into these controlled work zones. A CRZ for decontamination shall be established adjacent to the EZ. The SZ shall be kept free from contamination.

A typical EZ/CRZ/SZ representation is illustrated in Section 7.0 Decontamination, Figure 7-1.

9.2.1 Exclusion Zone

An EZ will be constructed to surround each work area where the greatest potential for worker exposure to identified site COCs may exist. The EZ may need to be transient as the work progresses, depending upon the type of work that is being executed. Because of potential site space limitations, the exclusion zone fencing may also include any available permanent perimeter fencing or other established physical barriers. Note that the term "permanent" is often used to describe the outer limits (or perimeter) of a work site or designated site area. Other temporary barriers (e.g., caution tape, high visibility construction fencing) maybe used to supplement existing permanent barriers to demarcate the EZ to identify the restricted access. Access to the EZ will be restricted to personnel wearing the

prescribed level of protective equipment and meeting the training and medical criteria of this plan.

All personnel entering established EZs/CRZs shall log-in and log-out on a daily basis (see **Attachment 4**).

9.2.2 Contamination Reduction Zone

Each CRZ zone will be a clearly marked corridor between the EZ and the SZ. The CRZ for each area will be located immediately adjacent to the EZ. This area will be identified with yellow tape, high visibility construction fencing, or other suitable barriers.

The CRZ is where personnel will begin the sequential decontamination process when exiting the EZ. To prevent cross contamination and for accountability purposes, all personnel must enter and leave the EZ through the CRZ.

Contaminated personnel and equipment will exit the EZ directly to the CRZ. Each CRZ will contain constructed decontamination stations for personnel and equipment. If possible, the CRZ will be located upwind of each EZ; however, due to site constraints, this may not be possible. Temporary support zones for each work area will be located adjacent to the CRZs.

9.2.3 Support Zone

Temporary support zones and staging areas will be established at the entrance of each control area. Potable water, an eye wash, and first aid supplies will be located at each temporary support zone. No hazardous or potentially hazardous materials will be allowed in the support zone unless it is in a properly labeled container that has no external contamination. Eating, drinking and, smoking will only be allowed in this area, at designated locations.

Portable bathroom facilities will be located near the work areas. In addition, potable water and water and soap for hand washing will be available at the support zone, along with containers for solid waste for use by site personnel, in addition to first aid stations and administrative information.

9.3 HAZWOPER Compliance Plan

Certain parts of the site work are covered by state or federal HAZWOPER standards and therefore require training and medical monitoring. Anticipated HAZWOPER tasks (Section 1.4 or otherwise determined) might occur consecutively or concurrently with respect to Non-HAZWOPER tasks. This section outlines procedures to be followed when approved activities specified in Section 1.6 do not require 24- or 40-hour training. Non-HAZWOPER-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-HAZWOPER-trained personnel are allowed on the site, or while non-HAZWOPER-trained staff are working in proximity to HAZWOPER activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSPA/CIH must approve the interpretation of these data.

- When non-HAZWOPER-trained personnel are at risk of exposure, the SSHO must post the exclusion zone and inform non-HAZWOPER-trained personnel of the following:
  - Nature of the existing contamination and its locations
  - Limitations of their access
  - Emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-HAZWOPER-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminated media.
- When exposure is possible, non-HAZWOPER-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.

10.0 Emergency Response Plan

10.1 Pre-Emergency Planning

(Reference SOP # HSE&Q 106, Emergency Planning)

The SSHO performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with AGVIQ-CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- **AGVIQ-CH2M HILL personnel shall review and implement all applicable components of CH2M HILL SOP # HSE&Q 106 Emergency Planning**.
- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.
- The SSHO will evaluate emergency response actions and readiness status and initiate appropriate follow-up actions. The SSHO in conjunction with the project team management will develop and implement solutions, matching all identified emergency preparedness criteria and implement corrective actions as necessary. Communicate deficiencies in emergency response preparedness as a “lesson learned” to all project personnel.

- File follow-up on implemented corrective action to confirm solution is appropriate.

10.2 Emergency Equipment and Supplies

The SSHO should mark the locations of emergency equipment on the site map and post the map. Equipment and locations are listed below.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes)	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye wash	Support and Decon Zone/Field Vehicle
Potable water	Support and Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify): Mobile phone and contact information	Support Zone/Field Vehicle
Spill Control/Clean-up Materials/Proper Spill Response PPE	Support Zone& Decon. Zone and/or active work area(s)

10.3 Incident Reporting, Investigation, and Response

For any accident meeting the definition of **Recordable Occupational Injuries or Illnesses or Significant Accidents**, the NAVFAC Contracting Officer and Navy Technical Representative (NTR) will be notified by the AGVIQ-CH2M HILL Project Manager (overall) soon as practical, **but not later than 4 hours after occurrence.** In the event that the overall AGVIQ-CH2M HILL Project Manager is not available, the designated AGVIQ-CH2M HILL individual responsible for site operations may make notification, but **only** after consultation with the AGVIQ-CH2M HILL Program or Deputy Program Managers. All other incidents must be reported to NAVFAC within 24 hours of incident occurrence. Only authorized AGVIQ-CH2M HILL personnel (Program Manager and/or Deputy Program Manager, overall AGVIQ-CH2M HILL Project Manager) may make notification to NAVFAC Northwest Division regarding project accidents, injuries, or illnesses.

In order for the incident to be assessed for the purposes or meeting reporting requirements, it is imperative that **all personal injuries, near misses, or property damage incidents involving** AGVIQ-CH2M HILL **or subcontractor project personnel be reported IMMEDIATELY to the chain of command personnel identified in Section 10.7 and Attachment 11 of this HSP.** The following information shall be provided:

- Date and time of incident
- Project name and project number
- Name and worker classification
- Extent of known injuries
- Level of medical attention
- Injury cause
- Witnesses

A written incident investigation will be performed and submitted to the HSPA/CIH within 24 hours of incident occurrence by the completing the Incident Report, Near-Loss Investigation and Root Cause Analysis provided in the HSP Attachments.

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down AGVIQ-CH2M HILL operations and evacuate the immediate work area
- Notify appropriate response personnel
- Account for personnel at the designated assembly area(s)
- Assess the need for site evacuation, and evacuate the site as warranted

Instead of implementing a work-area evacuation, small fires or spills posing minimal safety or health hazards may be controlled by onsite personnel, assuming that personnel who respond to these emergencies are properly trained to do so and wearing appropriate PPE to protect themselves against hazards that may be associated with the response.

10.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. AGVIQ-CH2M HILL employee injuries and illnesses must also be reported to the Human Resources contact in **Attachment 11**, once the notification requirements identified in Figure 10-7 have been fulfilled. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the designated medical consultant, as applicable. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities (e.g., 911).
- The SSHO will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- For life threatening emergencies, get or summon medical attention immediately.
- Perform decontamination on a down a person requiring medical attention in the following manner. Perform personnel decontamination as quickly and through as the condition will allow and initiate lifesaving, first aid or medical treatment as a priority.
- In the event a worker in an Exclusion Zone (EZ) needs medical assistance primary consideration must be given to remove all site contaminants before transfer of the employee to an uncontaminated area or atmosphere or before being handled by untrained/protected medical response personnel. Decontamination of personnel exposed to site COC's should be done as quickly as possible via the following procedures:

    1. After removal from the contaminated area, the exposed individual(s) will be decontaminated by washing the contaminated areas with appropriate decontamination solutions and flushing with potable water. In particular, direct skin (dermal) contact must be addressed via decontamination with soapy water. Decontamination operations must be performed as quickly as possible, as time is off the essence in emergency medical situations. Field team personnel shall utilize

disposable PPE wherever possible to promote rapid decontamination of personnel in the EZ.

2. If a respirator is used in the EZ, the respirator mask is left on the exposed individual until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to decontaminate.
3. After decontamination, the contaminated clothing is removed and skin contamination washed away. If possible, decontamination is completed before the exposure individual is taken to a medical facility.
4. ONLY potable water will be used when flushing the eyes or mouth.
5. All receptacles used for containing protective clothing shall be equipped with lids that can be closed to prevent the release of contaminants and the introduction of rainfall.
6. Initiate first aid and CPR, upon completion of decontamination operations.
7. Make certain that the injured person is accompanied to the emergency room.

- When contacting the medical consultant, give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 10.3.
- **A map showing the route to the local hospital is shown on Figure 10-1.**
- For CH2M HILL personnel who experience a minor non-life threatening emergency that requires medical attention, please refer to **Attachment 11** for the "Emergency Nurse Instructions" and "Initial Medical Treatment Form".

FIGURE 10-1

HOSPITAL ROUTE MAP, NAS Brunswick

Hospital

Hospital Name/Address:	Hospital Phone #:
Mid Coast Hospital Brunswick	(207) 729-0181
123 Medical Center Drive, Brunswick ME 04011	911 for emergency

Directions to Hospital

START	1: Start out going NORTHEAST on FITCH AVE toward BATH RD/ME-24.	1.0 mi
	2: Turn RIGHT onto ME-24/BATH RD. Continue to follow BATH RD.	1.1 mi
	3: Turn RIGHT onto MEDICAL CENTER DR.	0.8 mi
END	4: End at 123 Medical Center Dr Brunswick, ME 04011-2652	

Estimated Time: 7 minutes Estimated Distance: 2.93 miles

10.5 Evacuation

- Evacuation routes and assembly areas will be specified at the commencement of field work.
- Evacuation route(s) and assembly area(s) will be designated by the SSHO before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SSHO and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSHO will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s), as may be established to meet project site conditions.

10.6 Evacuation Signals

Evacuation signals are listed below.

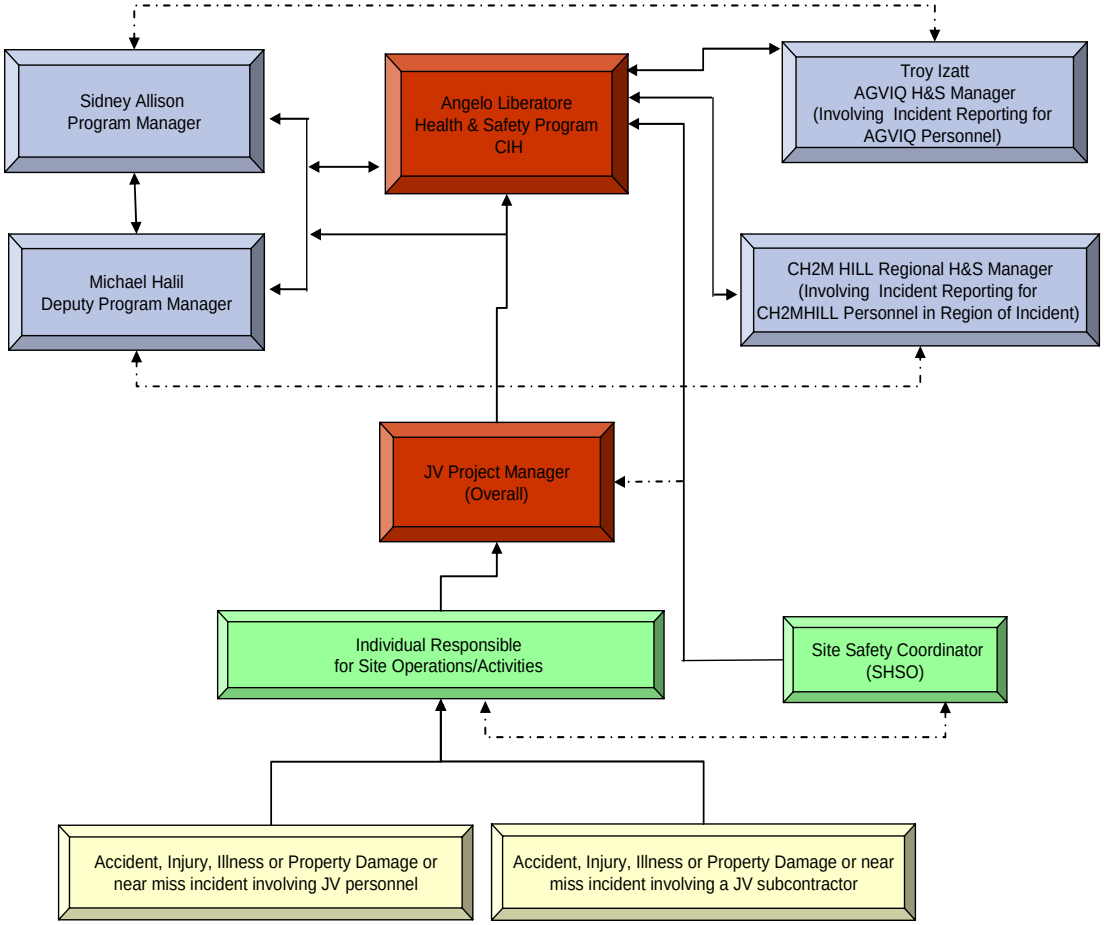
Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

10.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, accident, injury/illness, near miss, property damage, death, etc.), immediately notify the Project Manager (overall) and HSPA/CIH. Figure 10-2 identifies the AGVIQ-CH2M HILL Incident Reporting Process.
- For AGVIQ-CH2M HILL work-related injuries or illnesses, contact the respective resources on the emergency contact list in **Attachment 11** of this HSP. For AGVIQ-CH2M HILL incidents, the SSHO or individual responsible for site operations completes an Incident Report Form (IRF). In some cases, this can be completed by the employee. The IRF must be completed within 24 hours of incident.
- For AGVIQ-CH2M HILL subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSPA/CIH.

FIGURE 10-2

AGVIQ-CH2MHILL JV III (SB RAC)
Incident Notification Process and Chain of Command



11.0 Approval

This site-specific Health and Safety Plan has been written for use by AGVIQ-CH2M HILL only. AGVIQ-CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

11.1 Original Plan

Prepared By: Josh Painter, CSP **Date: August 30, 2010**
CH2M HILL, Inc., Principle Health & Safety Officer
509-*380-4166 (Cell)*

Approved By: Angelo Liberatore, CIH **Date: August 30, 2010**
Joint Venture H&S Program Manager CIH
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Approved By: Venky Venkatesh, Project Manager **Date:**
Venky Venkatesh, Project Manger
215-640-9391 / 216-235-8613 (cell)

Revisions
Revisions Made By: Date:

Revisions to Plan:

Attachment 1
Accident Prevention Plan

Accident Prevention Plan

Merriconeag Stream Sampling

Naval Air Station Brunswick
Brunswick, Maine

Revision No. 00
Contract No. N62472-08-D-1006
Task Order No. WE09

Submitted to:

U.S. Naval Facilities
Engineering Command
LANT

Prepared by:

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August 2010

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Acronyms and Abbreviations

ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASTM	American Society for testing and Materials
CFR	Code of Federal Regulation
CIH	Certified Industrial Hygienist
CPR	cardiopulmonary resuscitation
EMT	emergency medical technician
HSP	Health and Safety Plan
AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Joint Venture
NIOSH	National Institute for Occupational Health
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
ROICC	Resident Officer in Charge of Construction
SSHO	Unexploded Ordnance Safety Officer
TBD	to be determined

1.0 Signature Sheets

Plan Prepared By:

Prepared By: Josh Painter, CSP **Date: August 30, 2010**
CH2M HILL, Inc., Principle Health & Safety Officer
509-380-4166 (Cell)

Plan Approval:

Approved By: Angelo Liberatore, CIH **Date: August 30, 2010**
Joint Venture H&S Program Manager CIH
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Plan Concurrence:

Name:	Venky Venkatesh, AGVIQ-CH2M HILL Joint Venture Project Manager
Title:	Project Manager
Company:	AGVIQ-CH2M HILL Joint Venture
Telephone:	215-640-9391 / 216-235-8613 (cell)

Signature: _____

Venky Venkatesh, AGVIQ-CH2M HILL Joint Venture Project Manager **Date:**

2.0 Background Information

Background information for this project is fully detailed in Sections 1.0 through 1.2 of the Health and Safety Plan (HSP), as well as the project specific Remedial Action Work Plan, for which this Accident Prevention Plan (APP) and HSP are integral components.

3.0 Statement of Safety and Health Policy

The measurement of a successful program includes our ability to execute profitably, on time, without violations and safely. Success can only be achieved when all four components are integrated; therefore, health and safety must be part of every operation, at every responsibility level. It is the intent of the AGVIQ-CH2M HILL Joint Venture (AGVIQ-CH2M HILL) to comply with established standards concerning the health and safety of our employees and create work environments that are free of recognized hazards that may result in an accident, injury or illness. To do this, we must be vigilant in the identification and elimination of acts and conditions that can produce or lead to accidents, injuries, and illnesses in our workplace.

Knowledge of an unsafe act or condition does not make the work safe. When an act or work area condition that is not consistent with the established practices of the AGVIQ-CH2M HILL Health and Safety Program (HSP) is recognized, it is the inherent responsibility of each employee to report such inconsistencies to a supervisor so the act or condition may be evaluated, corrected, controlled, or engineered to a status that does not pose a significant threat. Where an act or condition in the workplace is determined to be Immediately Dangerous to Life and Health of AGVIQ-CH2M HILL employees, work must stop until the condition has been abated.

Management, supervisory, and worker personnel are all entrusted with implementing the policies and procedures of the AGVIQ-CH2M HILL HSP and prepared site specific health and safety documents. Prevention of accidents, injury, and illness is an achievable objective for all employees, at all responsibility levels, for all program operations. It is a basic requirement that each manager and supervisor make the safety of employees under their tenure an integral component of his or her regular management practices. Additionally, it is the duty of each employee to accept and follow established safety policies and procedures established by AGVIQ-CH2M HILL.

No employee shall be required to work at a location that would jeopardize their life or health. Employee cooperation in detecting, controlling, and reporting workplace hazards is a condition of employment. It is critical for AGVIQ-CH2M HILL employees to immediately inform their supervisor of any situation or work area condition that is beyond their ability to correct or control. Employees will not be disciplined or suffer any retaliation for reporting acts or conditions that are not consistent with the policies and procedures outlined by the AGVIQ-CH2M HILL HSP or project specific health and safety documents.

Every effort should be made to provide adequate training to employees; however, if an employee is ever in doubt about how to do a job or task safely, it is his or her duty to ask a qualified person for help. Fellow employees that need help should be assisted. Employees are expected to assist management in accident prevention activities. Everyone is responsible for executing their assigned duties in a safe manner. Every incident (including a near-miss) that occurs in the workplace shall be reported to a first-line supervisor, as soon as possible. Under no circumstances, except in the instance of emergency medical care, should an employee leave the work site without reporting an accident, injury, or illness that occurs in

the workplace. When a workplace accident, injury, or illness occurs, everyone is affected. The success and longevity of our program is directly related to maintaining a healthy and safe working environment for everyone.

3.1 Objective

The AGVIQ-CH2M HILL Joint Venture Program objective is to provide a place of employment free of all recognized hazards that are causing or will likely to death or serious physical harm to our employees. This objective can be facilitated by developing and administering an overall Environmental and Health and Safety Program, which establishes written policies and procedures to serve as vehicles through which the program requirements will be implemented.

3.2 Purpose

The purpose of this Accident Prevention Plan (APP), in conjunction with the project specific Health and Safety Plan (HSP), is to define the policies, procedures, and requirements that must be implemented for the AGVIQ-CH2M HILL Joint Venture (AGVIQ-CH2M HILL) projects and to establish the responsibilities requirements for management, supervisors, employees, and subcontractors that may participate in the execution of the program projects. It is the intent of this APP and HSP to address applicable requirements set forth by 29 CFR 191029 CFR 1926, EM 385 1-1, Appendix A, and AGVIQ-CH2M HILL policies and procedures incorporated by reference, herein.

3.3 Goals

The health and safety goal of the AGVIQ-CH2M HILL program is to eliminate workplace accidents, gain worker acceptance through cooperation and training, and provide our clients with a responsible, well-trained, safety-oriented work force.

AGVIQ-CH2M HILL considers safety the highest priority during work at all project sites and its business offices and has established a goal of **zero incidents.** Projects will be conducted in a manner that minimizes the probability of near misses, injury, illness, and equipment/property damage.

3.4 Primary Environmental Health and Safety Program Functions

Following are the primary functions of the Environmental and Health and Safety Program:

- Define the health and safety responsibilities of AGVIQ-CH2M HILL personnel.
- Administer the medical surveillance program.
- Prepare the site health and safety documents that identify project hazards, present appropriate hazard control measures to mitigate identified hazards, and establish guidelines by which program participants shall be expected to operate.
- Provide safety training/maintaining training records.

- Provide safety procedures and protocols to be used at project sites, shops, and offices.
- Conduct accident investigations and maintaining records.
- Verify OSHA adherence to 29 CFR 1910, 29CFR1926, and EM 385 1-1, as applicable to executable contract work.
- Provide guidance and assistance with preparation of safety protocols for specific tasks.
- Promote safety and health consciousness within the program.
- Designate the functional organization of stakeholders with respect to employee safety and health to facilitate corporate and project specific safety and health needs.

3.5 Organization and Responsibility for Health and Safety

With AGVIQ-CH2M HILL, the safety and protection of employees, clients, and the community is the first priority. The concern for the implementation of appropriate health and safety measures is focused on field operations but extends to other areas over which we have stewardship. If an activity or condition at a location under our control is determined to be not consistent with our health and safety policies and procedures, all efforts shall be made to correct the situation immediately or as soon as feasibly possible. At no time shall any AGVIQ-CH2M HILL program participant perform duties in a work environment that is immediately dangerous to life and health or in an imminently dangerous situation. In these situations, the task will not proceed until the situation is corrected.

The information included below is intended to supplement the AGVIQ-CH2M HILL project responsibilities included in Sections 2.2 and 10.7 of the HSP, as well as Section 4.0 of this APP.

The **Program Manager** is the primary operational safety official of AGVIQ-CH2M HILL and has overall responsibility for ensuring that AGVIQ-CH2M HILL program participants adhere to the health and safety policies and procedures adopted by AGVIQ-CH2M HILL.

The **Health and Safety Program Administrator (HSPA)** administers the safety program for the AGVIQ-CH2M HILL program and reports directly to the Program Manager with regard to AGVIQ-CH2M HILL program matters. The HSPA is responsible to support and assist program staff in executing the required health and safety policies and procedures adopted by the program for implementation.

The **Health and Safety Program Certified Industrial Hygienist (CIH)** and meets established qualification, training and experience criteria requirements and exhibits sufficient knowledge in health, safety and/or industrial hygiene matters. The CIH acts as the responsible program officer to review and approve all developed project specific Health and Safety Plan and to provide consultation or recommendations with regard to project worker protection and exposure issues. The CIH may also be required to perform the exercise the project/program roles and responsibilities of the HSPA, where required.

The **Site Safety and Health Officer (SSHO)** is responsible for administration and enforcement of the safety procedures and protocols on the project site(s). The SSHO is the primary safety official at the working level. The responsibility for safety is delegated and

shared by project managers, alternate site safety officers, and subcontractors' supervisors. At a minimum, the SSHO must perform, or otherwise supervise the performance of, the following:

- Motivate employees and supervisors of subcontractors to adhere to AGVIQ-CH2M HILL's safety policy in each work situation.
- When delegated to do so, the SSHO will schedule, organize, and lead work phase meetings prior to initiating project activities relevant to definable features of work. To do so, the SSHO should have a working knowledge of the appropriate process safety measures for the jobs and tasks they are defining. When in doubt, the SSHO should seek assistance prior to initiating a task. This is the only acceptable way to perform the task. If the task cannot be accomplished without increasing the potential for an employee accident, injury, illness, or property damage, it will not be attempted.
- Explain the safety procedure involved with a task to each employee and check frequently to see that the employee understands and works as instructed.
- Allocate sufficient time for the training and coaching of all employees to ensure that everyone knows the correct procedure for safely accomplishing required tasks. New employees will not be allowed to perform any work until required training is completed.
- Immediately correct unsafe conditions that involve AGVIQ-CH2M HILL employees or subcontractors.
- Ensure that employees are outfitted with and wear PPE as specified by this plan, EM385-1-1, and other AGVIQ-CH2M HILL procedures.
- Set a good safety example.
- Obtain the cooperation of employees and subcontractors. Subcontractor safety performance records will be verified prior to contract award and will be continually monitored during operations.
- Report all accidents, near misses, and property damage in accordance with the Incident Management and Reporting Procedure.

Every Employee, regardless of job title, shares the responsibility for safety and must report any "unsafe" or "deficient" work conditions or acts without fear of reprisal. It is imperative that employees observe the following minimum requirements in order to achieve a safe and healthy workplace:

- Each employee must be familiar with this Accident Prevention Plan and the general safety rules herein.
- Each employee will practice procedures and follow all safety rules and regulations for the successful completion of any job task.
- All employees will wear the necessary PPE required for the job or task as specified by the HSP, APP, and other applicable AGVIQ-CH2M HILL requirements.

- The employee will notify their immediate supervisor of any potential workplace hazard or work practice that is not consistent with the AGVIQ-CH2M HILL health and safety policies and procedures and could result in an accident, injury, illness, or destruction of property.
- The employee will report all accidents to an immediate supervisor regardless of whether injury or property damage resulted. This includes all near misses (accidents without injury or damage). This requirement serves to bring unsafe conditions to the attention of management.
- Each employee will be subject to contraband search for safety purposes and for the safety of fellow employees.
- Violations of published safety policies and procedures may be cause for disciplinary actions up to and including dismissal.
- All employees who are taking prescribed medications that could affect work performance or might alter the manner in which they could be treated in an emergency will so advise their supervisor prior to beginning work.

3.6 Regulator Compliance Policy

It is the intention of AGVIQ-CH2M HILL to adhere to federal, state, local, and client requirements that are applicable to our assigned contract work regarding the health and safety of our employees. It is the responsibility of all personnel to perform all work in accordance with established program requirements. All project personnel will immediately bring any condition regarding safety and health compliance to the attention of supervisory personnel.

AGVIQ-CH2M HILL will also endeavor to ensure that our procured subcontractors adhere to applicable regulatory compliance, by verifying safety performance records, relevant training, and medical surveillance, as applicable.

3.7 AGVIQ-CH2M HILL Medical Surveillance

All employees who perform work at hazardous waste sites or perform emergency response in accordance with 29CFR1910.120(a)(1)(i)-(v)/29CFR1926.65(a)(1)(i)-(v) will be subject to the AGVIQ-CH2M HILL medical surveillance program requirements. This program conforms to the requirements established by 29 CFR 1910.120/1926.65 (f), medical surveillance.

3.8 Position Statement on Modified Work

AGVIQ-CH2M HILL will attempt to eliminate all accidents through strict compliance with OSHA regulations and AGVIQ-CH2M HILL health and safety procedures, as well as supervisor and employee safety training, safety audits, and constant attention to safety. Should an employee be injured or become ill in the course of and arising from his employment, AGVIQ-CH2M HILL will attempt to provide modified work. Modified work ("light duty") will be made available in order to bring the injured employee back to the

work environment, for the benefit of the employee and the company, whenever medically appropriate.

Employees are expected to return to modified work when medically capable. The work assigned to the injured employee will meet the restrictions set forth by the treating and/or company physician. Examples of modified work include but are not limited to office work, dispatching, and light shop work.

3.9 First Aid

Each facility and work location must be evaluated to determine the potential requirement for medical emergencies. At a minimum, an industrial first-aid kit will be provided. An adequate number of employees with current certification in first aid and cardiopulmonary resuscitation (CPR) will be maintained on the project sites.

The SSHO will ensure that emergency medical attention is readily available. For emergency response and remediation operations, the SSHO will establish the requirement for medical emergency response and identify an emergency medical facility with chemical contamination trauma capability. If site conditions require, a subcontract emergency medical technician (EMT) and/or the availability of ambulance service onsite will be implemented.

Medical Support requirements are also defined by Section 9.2.6 of this APP. Personnel First Aid and CPR training requirements are also identified in Section 2.1 of the HSP.

3.10 Review of Health and Safety Statistics

A designated representative from AGVIQ-CH2M HILL will review and tabulate safety statistics as necessary, from the following:

- OSHA 300A forms
- Incident Reports

3.11 Specific Written Safety Procedures/Permits

In order to provide a safe workplace and communicate specific work requirements, specific tasks are incorporated by reference to our procedures/permits. These procedures/permits deal with specific areas such as confined space, hot work, lock out tag out, etc. Please refer to the HSP for specific reference, by SOP type, to procedures/permits applicable to the execution of this project.

All AGVIQ-CH2M HILL personnel who may be subject to these procedures will receive appropriate training and will be held accountable for adherence to procedure requirements.

3.12 State, OSHA, and Other Regulations

Where state regulations or other requirements differ from federal regulation cited in this plan, the more stringent regulation will apply.

3.13 Changes

Any user of this plan is welcome to recommend changes. Changes normally result from finding errors, regulatory changes, equipment modification, new equipment purchases, and changes to operation procedures or site conditions. Following is the format for making a recommended change:

Submit a written recommendation to the AGVIQ-CH2M HILL HSPA/CIH via your immediate supervisor. The AGVIQ-CH2M HILL HSPA/CIH will review the recommendation.

After review, the AGVIQ-CH2M HILL HSPA/CIH will determine if the suggestions should be included as an amendment or as new procedure in this plan. Changes to this plan will be distributed immediately upon approval.

4.0 Responsibilities and Lines of Authorities

The following listed AGVIQ-CH2M HILL Small Business Remedial Action Contract (SBRAC) personnel will have the authority to intervene and suspend work in the interest of ensuring adherence to Health and Safety policies and procedures defined by the HSP and APP:

- Sidney Allison — AGVIQ-CH2M HILL Program Manager
- Michael Halil — AGVIQ-CH2M HILL Deputy Program Manger
- Venky Venkatesh — AGVIQ-CH2M HILL Project Manager (overall)
- Mike Niebauer — AGVIQ-CH2M HILL Site Supervisor
- Will Knox — AGVIQ-CH2M HILL SSHO
- Kyle Block — AGVIQ-CH2M HILL SSHO
- Angelo Liberatore — AGVIQ-CH2M HILL Program CIH
- Mark Orman — AGVIQ-CH2M HILL HSPA
- Glen Jackson — AGVIQ-CH2M HILL HSPA/ SSHO alternate

4.1 Employee Competency

Employee competency, as defined by 29 CFR 1926.32(f) and for areas of executable contract work for which an employee has responsibility, shall be established by the appropriate employer only. Competency shall be determined by employee training, total work experience, professional certification and/or educational degrees. It is the opinion of AGVIQ-CH2M HILL that the above professionals are competent in their areas of expertise with regard to the management, field execution of the contract work, or in the implementation of AGVIQ-CH2M HILL site specific or program health and safety requirements, as applicable. Executable onsite contract work, for which there is a requirement for a competent person to oversee, will not be conducted unless a competent person is available onsite.

Employee training records are available at corporate offices, by electronic means, and maintained on the project site. Depending on the size of the project crew and because of work crew dynamics and scheduling, provision of hard copy employee training and medical surveillance records within the content of this APP or HSP is impractical. AGVIQ-CH2M HILL endeavors to maintain these documents onsite for review and will provide them to government officials for verification upon request.

In addition to the above, the AGVIQ-CH2M HILL Health and Safety Program utilizes a team of Health and Safety Professionals who qualified by experience, training, educational degrees and professional certification (CIH, CSP, CHST, ASP, CHMM) to act as the responsible program officers with regard to the overall project specific and program wide implementation of the AGVIQ-CH2M HILL Health and Safety Program.

4.2 Pretask Safety and Health Analysis

Requirements for completing Pre-Task Safety and Health Analysis for performing onsite work must be, at a minimum, in accordance with Sections 4.1 and 4.2, respectively, of the

HSP. Activity Hazard Analysis documents applicable to this project are included in **Attachment 7** of the HSP.

The AGVIQ-CH2M HILL individual responsible for site operations (hereinafter designated as Field Team Lead), SSHO or authorized designate, will conduct daily safety meetings at the start of each work shift for onsite personnel and will require subcontractors to follow similar meeting procedures or participate in the AGVIQ-CH2M HILL daily safety meetings. These meeting will be executed in accordance with Section 4.2 of the HSP.

4.3 Lines of Authority

Safety responsibilities, accountability, and lines of authority are discussed in Section 2.2 of the HSP and Sections 3.5, 4.0, and 4.5 of this APP. The AGVIQ-CH2M HILL Chain of Command and Incident Reporting Process for this project is included in Sections 10.3 and 10.7 of the HSP.

4.4 Non Compliance with Safety Requirements

The AGVIQ-CH2M HILL Joint Venture is composed of two separate and distinct businesses/corporations operating together in a business partner arrangement. Personnel are not "hired" by the AGVIQ-CH2M HILL Joint Venture, but rather by their respective employer, which may be AGVIQ, LLC, their parent company TIKIGAQ Corporation or any of its authorized subsidiaries, or CH2M HILL, Inc. and any of their authorized subsidiaries. Employees of their respective employer are then selected for participation in the AGVIQ-CH2M HILL Joint Venture at the program or project level, or both.

As such, the duty for employee disciplinary action must only be exercised by the employee's line manager, supervisor, or corporate official, as appropriate. Verbal or written reprimands, suspensions, or terminations shall be in accordance with the requirements established by the individual employer's policies and procedures and therefore cannot be executed by the AGVIQ-CH2M HILL Joint Venture. However, where AGVIQ-CH2M HILL Joint Venture Program Officers identify program participants who do not adhere to the policies and procedures adopted by the AGVIQ-CH2M HILL Joint Venture Program, program officers and/or corporate officials may request that these identified personnel only participate in certain areas of responsibility or not participate in the program at all.

4.5 Managers and Supervisors Safety Accountability

It is the duty of the first line supervisor to motivate employees to adhere to AGVIQ-CH2M HILL's safety policy and procedures in each work environment. A first line supervisor, for these purposes, is defined as that person designated to give immediate onsite supervision to personnel involved in a task.

All manager and supervisors will have complete knowledge of the safe procedure for all jobs and tasks under their supervision. When in doubt, they will seek assistance of the HSPA/CIH, or other authorized program safety professional, prior to initiating a task. This is the only acceptable manner in which to perform the task. If the task cannot be accomplished safely, it will not be attempted.

Managers and supervisors will:

- Explain the safety procedure involved with a task to each employee and check frequently to see that the employee understands and works as instructed.
- Allocate sufficient time for the training and coaching of all employees to ensure that everyone knows the correct procedure for safely accomplishing required tasks.
- Prevent new employees from performing any tasks until required training is completed.
- Immediately correct unsafe conditions that involve AGVIQ-CH2M HILL employees or contractors.
- Ensure that the employees are outfitted with and wear PPE as specified by this APP, site-specific health and safety plan, other AGVIQ-CH2M HILL procedures, or as directed by the HSPA/CIH, Project Manager, or SSHO.
- Set a good safety example.
- Obtain the cooperation of employees and contractors.
- Provide a safe work environment for employees and contractors.
- Confirm contractor safety performance records have been verified prior to contract award and monitor contractor performance during operations.
- Report all accidents, near misses, and property damage in accordance with the Incident Management and Reporting Procedure.

Establish a safety culture, using the elements of the AGVIQ-CH2M HILL Safety Improvement process, which promotes awareness, encourages participation, and recognizes excellence.

4.6 AGVIQ-CH2M HILL "Employee" Responsibility Requirements

Each employee is responsible for their personal safety as well as the safety of others in the area and is expected to participate fully in the ***Safety Improvement Process,*** particularly the Loss Prevention Observation (LPO) process. The employee must use all equipment provided in an appropriate and responsible manner as directed by the SSHO. All AGVIQ-CH2M HILL personnel will follow the policies set forth in the AGVIQ-CH2M HILL Health and Safety Plan. Site personnel concerned with any aspect of health and safety will bring it to the attention of the Project Manager or SSHO. All project personnel have the authority to stop work, if it is their judgment that serious injury could result from continued activity. The Field Team Lead or SSHO will be notified immediately if this becomes necessary. Additional notifications must be made to project and program managers in accordance with Figure 10-2 of the HSP. Personnel that knowingly disregard safety policies/procedures may be subject to disciplinary actions in accordance with their employer's established procedure.

5.0 Subcontractors and Suppliers

5.1 Subcontractor/Supplier Coordination and Control

AGVIQ-CH2M HILL subcontractor safety performance and compliance with federal alcohol and drug testing requirements will be reviewed prior to being issued a contract for site work. AGVIQ-CH2M HILL subcontractors will comply with the requirements for site safety as outlined in AGVIQ-CH2M HILL HSP, APP, or other policies and procedures to which they have been made aware.

All subcontractors who may be required to execute this contract may not be identified at the time that health and safety documents are prepared for submission or implementation. Because of the potentially dynamic and evolving nature of contract requirements and resultant project scheduling at many points during the project evolution, only partial identification of potential subcontractors who may be selected for our projects is likely. To this end, continuously updating and amending this APP or HSP with potentially selected, newly selected, or approved subcontractors would not be practical or cost effective for all parties concerned.

The AGVIQ-CH2M HILL Joint Venture Program maintains an extensive and detailed process for subcontractor procurement with the Federal Acquisition Regulations (FAR) as the primary driver. The subcontractor selection is based on scope of work pricing, qualifications, safety performance, and best value evaluations.

5.2 Subcontractor/Supplier Responsibilities

All subcontractor employees are subject to the same training and medical surveillance requirements as AGVIQ-CH2M HILL personnel, depending on job activity. All activities involving the potential for exposure to hazardous waste materials will require medical and training certification as mandated by 29 CFR 1910.120. All subcontractor personnel will be required to sign in/sign-out of the site daily (**see Attachment 4**) and either conduct or attend a daily AGVIQ-CH2M HILL meeting discussing operations, site specific hazard awareness, or other pertinent issues associated with the scheduled work. All subcontractors involved in construction/remedial activities will document the details of the daily meeting prior to the start of work at the site. At the discretion of the AGVIQ-CH2M HILL Field Team Lead or the SSHO, this function may be completed by AGVIQ-CH2M HILL to facilitate the requirement.

Subcontractors will submit Activity Hazard Analyses for their work activities to the AGVIQ-CH2M HILL SSHO, HSPA or CIH for review. The subcontractor reports directly to the AGVIQ-CH2M HILL Project Manager (overall). The AGVIQ-CH2M HILL Project Manager may designate subcontractor reporting requirements to the AGVIQ-CH2M HILL Field Team Lead/SSHO, or other appropriate designee. All incidents involving subcontractor employees will be reported to the AGVIQ-CH2M HILL Field Team Lead/SSHO and a copy of the subcontractor's injury/illness report will be submitted to the AGVIQ-CH2M HILL Project Manager (overall) and HSPA/CIH, as soon as possible, but no later than 24 hours.

AGVIQ-CH2M HILL subcontractors are required to acknowledge and adhere to all requirements of the AGVIQ-CH2M HILL Site-Specific HSP, which includes this APP and/or their own HSP, where specifically applicable to the subcontractor's specialized work or where subcontractor's work is not addressed by the AGVIQ-CH2M HILL HSP and APP. Plans to address specific hazards may be added to the HSP/APP during the course of work. AGVIQ-CH2M HILL subcontractors will be required to sign off and comply with any such supplemental plans. Subcontractors not in compliance will be immediately dismissed from the site.

Suppliers delivering materials to the project site or providing equipment and equipment maintenance will comply with all rules and regulations specified by the owner. Supplier personnel will not be permitted into contaminated areas unless training and medical surveillance is in accordance with 29 CFR 1910.120(f). Contractors will not ride on tractors, forklifts, or similar vehicles unless specific seats are provided. They will follow Facility hot work rules if hot work is required for vehicle or equipment maintenance. Trucks will be loaded and unloaded in a safe and effective manner and materials will be stored safely in designated locations only. Associated packaging will be properly disposed and litter will not be permitted to be scattered or blown from truck beds. Operators of mobile equipment onsite must observe all traffic rules such as speed limits and pedestrian rights-of-way.

6.0 Training

6.1 Safety Training

AGVIQ-CH2M HILL engages in environmental remediation, construction, and other services, and endeavors to comply with the numerous health and safety training requirements mandated by governmental agencies, clients, and internal policies.

Personnel will be provided sufficient training to execute their jobs in a safe and healthy manner.

Direct supervisors are responsible to determine the training requirements of a task and ensure employees have the necessary training to complete the task safely. Designated Health and Safety personnel will assist with this determination and training.

Designated employer personnel and electronic databases will facilitate the maintenance of training records and applicable experience documentation. When an employee is identified as lacking sufficient training or experience to perform an assigned task, every effort will be made to provide the necessary training or to provide a trained and experienced alternate until the employee has achieved the required criteria.

Employee training records are available at corporate offices, electronically, and on the project site. Depending on the size of the project crew, provision of hard copy employee records within the content of this APP or HSP would be impractical, but must be maintained onsite and will be provided to government officials for verification upon request.

6.2 Safety Indoctrination Subjects

Outlines of the site safety orientation for AGVIQ-CH2M HILL and subcontractor personnel and visitors are provided in Sections 1.0 and 2.2 of the HSP.

6.3 Mandatory Training and Certifications

Mandatory training and certification requirements are identified in Section 2.1 of the HSP, Employee Medical Surveillance and Training. All site personnel entering an exclusion zone (EZ) or performing designated Hazardous Waste Operations, Emergency Response Operations, or other tasks that may require specific training will be trained to meet the requirements that may be applicable to the individual's assigned tasks.

7.0 Safety and Health Inspections

The AGVIQ-CH2M HILL Project Manager, Field Team Lead, or SSHO are required to perform site inspections using the designated checklists included herein by reference or contained in referenced SOPs. The inspection will be made by the Site Superintendent or Supervisor, Field Team Lead, SSHO, or other designated AGVIQ-CH2M HILL representative. Discrepancies found during inspections will be corrected as soon as practicable and documented in a deficiency tracking log (**Attachment 4** of the HSP) or Loss Prevention Observation form (**Attachment 9** of the HSP). Serious inconsistencies will be corrected immediately. Inspections that identify Imminent Danger or Immediately Dangerous to Life and Health situations will require that work be immediately stopped and personnel removed from the work area until the situation is abated, corrected, or controlled to a non-hazardous condition.

The Field Team Lead or SSHO is responsible for conducting and preparing reports of daily inspections of work processes, site conditions, and equipment conditions, and submitting them for the project record, as necessary. Corrective actions resulting from discrepancies identified during inspections will be reviewed with the Project Manager (overall) and implemented, as necessary. Copies of these reports are maintained on file at the project locations. Additionally, copies will be forwarded to the AGVIQ-CH2M HILL HSPA.

The AGVIQ-CH2M HILL HSPA/CIH or his designated representative may periodically conduct site visits and perform Site Safety Assessments. Additionally, the AGVIQ-CH2M HILL HSPA/CIH or designated representative may make periodic unannounced inspections of work sites at their own discretion or at the request of an employee, supervisor, manager, or client. Any discrepancies identified as part of these inspection processes will be addressed with the Project Manager (overall), or may be corrected in the field if minor in nature.

AGVIQ-CH2M HILL does not anticipate, but may consider the use of outside sources to provide safety inspections on an as-necessary basis.

As required, AGVIQ-CH2M HILL safety equipment will comply with appropriate OSHA, National Institute for Occupational Safety and Health (NIOSH), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and U.S. Coast Guard or other recognized certification organizations.

8.0 Accident Reporting and Investigation

8.1 Accident Investigation

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Completion of incident and near-miss incident investigation reports for the AGVIQ-CH2M HILL Joint Venture shall be performed using the forms in **Attachment 10** of the HSP and generally via the procedures identified herein. The AGVIQ-CH2M HILL Program CIH, HSPA, or their designee (SSHO, site supervisor, project manager), conducts accident/incident investigations and prepares the required incident or near-miss incident investigation reports for the following conditions:

- Near Miss Incidents
- DART or other OSHA recordable cases
- Spills, releases, discharges, or environmental violations
- Property damage incidents resulting in over $1,000 of loss
- A fatal injury *
- A hospitalization of three or more people resulting from a single occurrence *
- A weight-handling equipment incident
- A permanent total disability
- A permanent partial disability

* Within eight (8) hours after the death of any employee from a work-related incident or the in-patient hospitalization of three or more employees as a result of a work-related incident, you must orally report the fatality/multiple hospitalization by telephone or in person to the Area Office of the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, that is nearest to the site of the incident. You may also use the OSHA toll-free central telephone number, 1-800-321-OSHA (1-800-321-6742).

Completed incident and near miss incident investigation reports are be reviewed by the CIH/HSPA, Project Manager (overall), site management (SSHO, site Supervisor) team and Program Management team. Incident and near-miss incident reports must be submitted to the Project Manager , Program CIH/HSPA and the Program Management team, as soon as possible, but no longer than 24 hours. At a minimum the Project Manager and Program Management personnel, including the Program CIH must be verbally notified, immediately or in a case where emergency medical treatment is required, as soon as injured personnel have been transported to and received by a medical treatment facility.

In addition to the above, the Project Manager (or site supervisor when designated by the Project Manager or Program Management team) must also be responsible for reporting all injuries to NAVFAC as soon as reasonably possible but no later than 24 hours. Where an incident has, or appears to have, any of the consequences listed below, these incidents shall be <u>immediately</u> reported to NAVFAC.

a. Fatal injury/illness;
b. Permanent totally disabling injury/illness;

c. Permanent partial disabling injury/illness;
d. Three or more persons hospitalized as inpatients as a result of a single occurrence;
e. $200,000 or greater accidental property damage or damage in an amount specified by USACE in current accident reporting regulations
f. Arc Flash Incident/Accident

Except for rescue and emergency measures, the accident scene shall not be disturbed until it has been released by the investigating official. The Contractor is responsible for obtaining appropriate medical and emergency assistance and for notifying fire, law enforcement, and regulatory agencies. The Contractor shall assist and cooperate with personnel conducting investigations on behalf of NAVFAC.

In addition to the incident and near-miss incident investigation report forms contained in Attachment 9 of this APP, for all OSHA recordable accidents, property damage in excess of $2000 a Contractor Significant Incident Report (CSIR) must also be completed. If the CSIR is being used as initial notification of a Fatality or High Visibility Mishap. The initial form is due within 4 hours of a serious accident. A CSIR form marked 'Follow-up' or 'Final' is required within 5 days.

8.1.1 Best Management Practices for Incident Investigation

The causes of loss and near-loss incidents can be similar, so by identifying and correcting the causes of loss and near-loss incidents, future loss incidents may be prevented. When loss or near-loss incidents occur, identifying and correcting conditions or acts that create these incidents can be achieved by engaging the following processes:

1. Gathering all relevant facts, focusing on fact-finding, not fault-finding, while answering the "who, what, when, where, and how" questions.
2. Draw conclusions, putting facts together into a probable scenario.
3. Determine the incident root cause(s) and contributing factors of incidents. These are basic factors on why or how conditions or acts are created that result in incidents.
4. Develop and implement solutions, matching all identified root causes and contributing factors with solutions so that future conditions or acts that have attributed to incidents are eliminated in the future.
5. Communicate incident as a lesson learned to all project personnel.
6. File follow-up on implemented corrective action to confirm solution is appropriate.

The purpose of an incident investigation is to understand how the incident happened, analyze the root causes, and prevent recurrence by implementing corrective actions. To conduct an effective investigation, all information must be as detailed and comprehensive as possible. The investigation must be based on facts that clearly identify the sequence of events and the factors that contributed to the incident. The investigation team should not be involved with any punitive actions resulting from the investigation. Fairness and impartiality are essential. The following provides general Best Management Practice guidance in completing incident investigations.

1. An unbiased approach is necessary to obtain objective findings.
2. Visit the accident scene as soon as possible while the facts are fresh and before witnesses forget important details.
3. If possible, interview the injured worker at the scene of the accident and "talk" through re-enactment.
4. Conduct all interviews as privately as possible. Interview witnesses individually and separately. Talk with anyone who has knowledge of the accident/incident, even if he/she did not actually witness it. Only retrieve witness statement from individuals who actually observed the accident/incident. Document witness interviews.
5. Document details graphically. Use the IRF as well as sketches, diagrams, and photographs as needed. Take measurements where appropriate.
6. Focus on the causes and hazards leading to the accident/incident. Develop an analysis of what happened, how it happened and how it could have been prevented. Determine what caused the accident/incident itself, not just the injury.
7. Include a Corrective Action plan in every investigation. Describe how you will prevent such accidents in the future. Completion of the Root Cause Analysis may assist in the formulation of such plans.

Save any evidence if a third party or defective product contributed to the accident/incident. It should be critical to the recovery of claims costs.

The AGVIQ-CH2M HILL HSPA/CIH may also request that a specific written accident investigation be conducted in case of an unusual or serious injury or accident. In general accident, injury, illness, and property damage incident reports will be performed in accordance with the requirements in Section 4.4 of the HSP.

8.2 Exposure Data (Man-hours Worked)

Because the AGVIQ-CH2M HILL Joint Venture is composed of two separate and distinct corporations operating together in a business partner arrangement, both corporations separately record and report information related to annual labor hours and workplace injuries and illnesses as required by 29 CFR 1904. Where annual summary postings are required under 29 CFR 1904.32(b)(6), they will be posted as separate documents by AGVIQ, LLC, and by CH2M HILL, Inc., in our appropriate workplace environment(s). In addition, because AGVIQ-CH2M HILL operates as a business partnership and not as a single business entity, AGVIQ-CH2M HILL <u>does not maintain a jointly established Experience Modification Rate.</u>

However, designated employee representatives from the AGVIQ-CH2M HILL Joint Venture programs tabulate and track labor hours posted to the AGVIQ-CH2M HILL program and lost work day and recordable incident information attributable to the execution of all AGVIQ-CH2M HILL Joint Venture program contracts and issued contract task orders. This process is executed for the purpose of establishing a safety performance history associated for our business partnership. AGVIQ-CH2M HILL safety performance data is extrapolated from the following:

- Tabulated Employer Labor Hours

- Established Incident Reporting Processes
- Incident Investigation Reports
- Formal Project Audits

To date, the AGVIQ-CH2M HILL Joint Venture programs has expended over 666,820 labor hours, from 2003 through July 2010. During this period, three (3) OSHA other recordable cases and one (1) Days Away, Restriction, or Transfer (DART) or "lost work day" case have been attributed to completed or ongoing AGVIQ-CH2M HILL Joint Venture program projects. With this information available the following can be determined:

- Days Away, Restriction, or Job Transfer (DART) Incident Rate:

  $$\frac{\text{Number of DART Cases x 200,000}}{\text{Number of Hours Worked}}$$

  $$\text{DART Incident Rate} = \frac{1 \times 200{,}000}{666{,}820} = 0.30$$

  AND

- **OSHA Recordable Incident Rate:**

  $$\frac{\text{Number of OSHA Total Recordable Cases x 200,000}}{\text{Number of Hours Worked}}$$

  $$\text{OSHA Total Recordable Case Rate} = \frac{3 \times 200{,}000}{666{,}820} = 0.90$$

No DART cases or other recordable cases have been experienced for AGVIQ, LLC. or CH2M HILL, Inc. employees participating in the AGVIQ-CH2M HILL Joint Venture since 2008.

For the Construction (North American Industry Classification System [NAICS] code -23) and Remediation Services (NAICS code – 56291) industries, which is typical of the contract work that AGVIQ-CH2M HILL typically executes, the AGVIQ-CH2M HILL calculated DART and OSHA Recordable Incident Rates for our entire operating period, are currently well below DART Incident Rate (IR) and OSHA Recordable Incident Rate tabulated by the 2008 United States Bureau of Labor Statistics (USBLS) for these industries (see below).

- USBLS IR Construction Benchmark (2008): 4.7
- USBLS DART Construction Benchmark (2008): 2.51[1]
- USBLS IR Remediation Services Benchmark (2008): 3.1
- USBLS DART Remediation Services (NAICS Code 56291) Benchmark (2008): 1.91[1]

[1] DART total "all sizes"

8.3 Immediate Notification of Major Incidents

AGVIQ-CH2M HILL will immediately notify the Base contact/Navy RPM/ROICC/EIT of any major incident, including injury, fire, equipment or property damage, and environmental incident. A full report will be provided within 48 hours. Procedures to be followed in response to any project incident are detailed in Section 10.3, Incident Reporting, Investigation, and Response of the HSP and Section 10.7, Incident Notification and Reporting of the HSP.

9.0 Plans Required by the Safety Manual

9.1 Layout Plans

Site Layout Plans, drawings, or sketches are included in the project specific Remedial Action Work Plan, for which this APP and HSP are integral components.

9.2 Emergency Response Plans

The emergency response preparedness procedures are included throughout Section 10 of the HSP.

9.2.1 Procedures and Tests

It is the intention of the project team to verify that emergency response processes are in place and capable of being executed, prior to the start of field assignments. Pre-Emergency Planning procedures for this project are included in Section 10.1 of the HSP. However, because response to medical or fire emergencies will be by government facility installation personnel or even by outside public responders, it may be impractical and disruptive to the primary mission of these responders to perform procedural response testing. In this case, the designated responsible party (Field Team Lead) shall verify that emergency services are available for response, that contact information is appropriate, and that responders know how to access anticipated work areas.

9.2.2 Spill Plans

Spill prevention shall be conducted in accordance with the information identified in Section 8.0 Spill Containment Procedures, of the HSP.

9.2.3 Firefighting Plan

AGVIQ-CH2M HILL personnel are not considered Firefighting Organizations. Only small fires that are containable by the use of first response fire protection equipment may be controlled by AGVIQ-CH2M HILL personnel. All other response shall be considered firefighting measures and shall be conducted by facility provided or public agency firefighting teams.

Fire prevention measures and first response fire protection equipment shall be conducted in accordance with the information identified in Section 3.0 Project Hazards – Fire Prevention, and Section 10.2 Emergency Equipment and Supplies, of the HSP.

9.2.4 Posting of Emergency Telephone Numbers

Emergency contact numbers appropriate to project operations are included in **Attachment 11** of the HSP and referenced as the Emergency Contact List. Where temporary construction facilities are established at the project site, this Emergency Contact List shall be posted in a conspicuous location. Where temporary construction facilities are not allowed or provided, the list shall be available for quick reference by the individual(s) responsible for site operations and location shall also be made known to other site personnel.

9.2.5 Man Overboard / Abandon Ship

(Reserved)

9.2.6 Medical Support

Medical support and evacuation processes shall be in accordance with Section 10 of the HSP. Location and direction to medical support facilities shall be posted in a conspicuous location where temporary construction facilities are established at the project site. Where temporary construction facilities are not allowed or provided, the list shall be available for quick reference by the individual(s) responsible for site operations and location shall also be made known to other site personnel.

In addition, the project shall be outfitted with first aid kits of suitable size and quality (contents) to meet health and safety requirements for onsite first aid or CPR response. Personal protective devices shall be provided such that universal precautions against bloodborne pathogens can be exercised while administering CPR or first aid. Eye wash stations, either portable or stationary, will be available.

An effective means of communication and to summon transportation of injured workers to medical treatment facilities must be evaluated and established prior to the start of field activities. Communication devices shall be tested in the area of use to assure functionality.

When a medical facility or physician is not accessible within five minutes of an injury to a group of two or more employees for the treatment of injuries, at least two employees on each shift shall be qualified to administer first-aid and CPR.

9.3 Plan for prevention of Alcohol and Drug Abuse

The AGVIQ-CH2M HILL substance abuse program is in accordance with Section 4.5 of the HSP.

9.4 Site Sanitation Plan

Toilet facilities on construction sites shall be provided as follows:

Minimum Toilet Facilities at Construction Sites	
Number of Personnel	**Number of Toilets**
20 or fewer	One
20 or greater	One toilet seat and one urinal per 40 workers
Greater than 200	One toilet seat and one urinal per 50 workers

The above requirements do not apply to mobile crews or to normally unattended work locations if employees working at these locations have transportation immediately available to nearby toilet facilities. Separate toilet rooms for each sex need not be provided if toilet rooms can only be occupied by one person at a time can be locked from the inside, and contain at least one toilet seat.

Toilet facilities shall be constructed so the occupants are protected against weather and falling objects; all cracks shall be sealed; and the door shall be tight-fitting, self-closing, and capable of being latched. Adequate ventilation shall be provided and all windows and vents shall be screened. Toilet facilities shall be constructed so that the interior is lighted. Provisions for routinely servicing and cleaning all toilets and disposing of the sewage shall be established before placing toilet facilities into operation. The method of sewage disposal and the location selected shall be in accordance with federal, state, and local health regulations.

Washing facilities shall be provided at toilet facilities and as needed to maintain healthful and sanitary conditions. Each washing facility shall be maintained in a sanitary condition and provided with water (either hot and cold running water or tepid running water), soap, and individual means of drying. If it is not practical to provide running water, hand sanitizers may be used as a substitute. Washing facilities shall be close to the worksite.

Trash and garbage generated by the normal site operations must be properly stowed, containerized, and secured such that vermin will not be attracted.

9.5 Access and Haul Road Plan

Site access and haul road delineations are included in the project specific Remedial Action Work Plan, for which this APP and HSP are integral components.

9.6 Respiratory Protection Plan

Section 3.8.8 of the HSP identifies Respiratory Protection requirements for this project. Section 5.0 of the HSP, Table 5-1 identifies when respiratory protection may be required for this project.

9.7 Hazard Control Program

The AGVIQ-CH2M HILL hazard control program is defined by the entire contents of the HSP and APP, as well as documents included by reference.

9.8 Hazard Communication Program

The Site-Specific Hazard Communication information is included in Section 3.0 of the HSP, Project Hazards – Hazard Communication, as well as Section 3.0 of the HSP, Project Hazards – Constituents of Concern. Hazard Communication awareness training can be accomplished using the Chemical-Specific Training and Project-Specific Chemical Product Hazard Communication Forms contained in **Attachment 6** of the HSP. MSDS information associated with this project is not included herein, for submission, due to the potential volume of necessary information. It is the intent of the project to compile MSDS information for inclusion in the hardcopy version of the HSP used for implementation on the project site and inserted in **Attachment 5**, for inclusion in the project record.

9.9 Process Safety Management

(Reserved)

9.10 Lead Abatement Plan

(Reserved)

9.11 Asbestos Abatement Plan

(Reserved)

9.12 Radiation Safety Program

(Reserved)

9.13 Abrasive Blasting

(Reserved)

9.14 Heat/Cold Stress Monitoring Program

The heat stress monitoring program shall be conducted in accordance with the information identified in Section 3.0 of the HSP, Project Hazards - Heat Stress Monitoring and Cold Stress Monitoring, as applicable.

9.15 Crystalline Silica Monitoring Plan

(Reserved)

9.16 Night Operations Lighting Plan

No night operations will be conducted for the execution of this project. However, project visible lighting requirements shall be in accordance with the information provided in Section 3.0 of the HSP, Project Hazards - Visible Lighting.

9.17 Fire Prevention Plan

Fire prevention shall be conducted in accordance with the information identified in section 3.0 of the HSP, Project Hazards - Fire Prevention.

9.18 Wild Land Fire Management Plan

(Reserved)

9.19 Hazardous Energy Control Plan

There are no anticipated conditions in which implementing hazardous energy control will be required for this project. However, because of the importance of its existence it is included herein. This program establishes lock out practices of energy sources that could cause injury to personnel involved at the work site. The lock out program covers all employees and outside contractors affected by the cleaning, repairing, servicing, and adjusting of prime movers, machinery, and equipment. Only authorized employees will perform such work.

- Authorized employees will be instructed in lock out/tag out procedures by their supervisor. Each new or transferred employee will be instructed by the supervisor in lock out procedures. A sufficient number of tags and padlocks will be supplied. During each phase of construction, a representative from AGVIQ-CH2M HILL will be present while the electrical supervisor begins the lock out/tag out process.
- All equipment will be locked out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy-isolating device bearing a lock.
- Documented periodic inspections will be made periodically by supervisors to ensure that each procedure is being properly followed. The SSHO will ensure these inspections are being performed and keep on record the inspection reports on the job site. The inspection must include a review addressing the employee's responsibilities. Documentation is to include the date of the inspection, equipment on which the procedure was being used, the employees involved, and the person performing the inspection.
- Authorized employees will be certain as to which switch, valve, or other energy isolating devices apply to the equipment being locked out. More than one energy source may be involved. Any questionable identification of sources will be cleared through the supervisors.
- To begin the lock out process, use the following items as a guide. If for any reason the following items are in question, contact your immediate supervisor before moving forward. If more than one individual is required to lock out equipment, each person will place his own personal lock on the energy isolating device(s). One authorized individual and a competent person from the prime contractor (AGVIQ-CH2M HILL) with the knowledge of the crew may lock out equipment for the whole crew. In such cases, it is the responsibility of the individual to carry out all steps of the lockout procedure and inform the crew when it is safe to work on the equipment. Additionally, the authorized individual will not remove a crew lock until it has been verified that all individuals are clear and a prime contractor competent person is present.
  - Notify all affected employees that a lock out is required.
  - If the equipment is operating, shut it down by the normal stopping procedure.
  - Operate the switch, valve, or other energy isolating devices so the energy source(s) is disconnected or isolated from the equipment.
  - Stored energy, such as capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure must also be dissipated or restrained by methods such as grounding, repositioning, blocking, or bleeding down.
  - Lock out energy isolating devices with an assigned individual lock. A second lock will be used if possible by the superintendent.
  - After ensuring that no personnel are exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to

make certain the equipment will not operate. CAUTION: Return operating controls to the neutral position after the test.

  - Attach a completed accident prevention tag and/or sign on the controls of the machine. The identification tag and/or sign will be coordinated with the electrical contractor and the prime contractor. An AGVIQ-CH2M HILL representative will then make known to the facility personnel affected by this operation the identification of these tags or signs, the procedures in which the contractors will be working, and the electrical supervisor point of contact.
  - The equipment is now locked out.

- To restore equipment to service, use the following items as a guide. If for any reason the following items are in question, contact your immediate supervisor before moving forward.
  - When the job is complete and equipment is ready for testing or normal service, check the equipment area to see that no one is exposed.
  - When equipment is clear, remove all locks. The energy isolating devices may be operated to restore energy to the equipment. There must be a supervisor from the electrical contractor and the prime contractor present.
- The included checklist for lock out training is a minimum requirement to provide to new employees. The supervisors must sign, date, and retain in their own records this information. The supervisor must also delivery a copy of this training to the Site Safety Officer.
  - Explain the significance of why a machine is locked or tagged out.
  - Explain what an employee is to do (and not do) when encountering a tag or lock on a switch or device they want to operate.
  - Explain the importance of notification of affected employees.
  - Show the employee the location of all locks, tags, and lock out devices.
  - Explain how to recognize the applicable hazardous energy sources.
  - Explain the type(s) and magnitude of energy to be isolated on the machinery and how to control that energy.
  - Explain the proper sequence of locking out.
- All utility outages will follow the contract specifications, EM 385-1-1, and OSHA standards. The contractors will follow the above information as well as the following:
  - The contractor will supply the required tags and/or locks for each utility outage.
  - PWC Utility outages will be conducted with PWC Utilities, the contractor, and subcontractor.

- Interior building/ facility utility outages will be coordinated with Facility Manager, the contractor, and the subcontractor.
- A preparatory meeting will be held prior to all electrical work and utility outages. This meeting will also cover any safety issues that may pertain to the scope of work. The Activity Hazard Analysis will be reviewed and any additional concerns will be annotated on this form.

In addition to the above, Hazardous Energy Control shall be in accordance with the information identified in Section 3.0 of the HSP, Project Hazards – Lock-Out/Tag-Out.

9.20 Critical Lift Plan

(Reserved)

9.21 Contingency for Severe Weather Plan

See HSP Section 3.1 "Adverse Weather"

9.22 Float Plan

(Reserved)

9.23 Site Specific Fall Protection and Prevention Plan

(Reserved)

9.24 Demolition Plan

(Reserved)

9.25 Excavation/Trenching Plan

(Reserved)

9.26 Emergency Rescue (Tunneling)

(Reserved)

9.27 Underground Construction Fire Prevention and Protection Plan

(Reserved)

9.28 Compressed Air Plan

(Reserved)

9.29 Formwork Shoring and Removal Plan

(Reserved)

9.30 Precast Concrete Plan

(Reserved)

9.31 Lift Slab Plans

(Reserved)

9.32 Steel Erection Plans

(Reserved)

9.33 Site Safety and Health Plan (Hazwoper)

A Site Specific HSP for Hazwoper operations is a comprehensive document contained in Sections 1.0-11.0 of the HSP and its attachments.

9.34 Blasting Safety Plan

(Reserved)

9.35 Diving Plan

(Reserved)

9.36 Confined Space Program

(Reserved)

10.0 Risk Management Process

Project specific hazards and hazard control measures are identified in Section 3.0 of the HSP. A detailed Activity Hazard Analysis for each major phase of work is included in **Attachment 7** of the HSP.

Attachment 2
Employee Signoff Form

EMPLOYEE SIGNOFF FORM

AGVIQ-CH2M HILL Joint Venture (SBRAC), Contract Task Order WE09
Health and Safety Plan

AGVIQ-CH2M HILL project employees and subcontractors listed below have been provided with a copy of this Health and Safety Plan, have read or been briefed on its contents and agree to abide by its provisions.

Project Name: **Task Order:**

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

Attachment 3
Subcontractor H&S Tracking Form

Subcontractor H&S Tracking Form

Project Name: **Task Number:** **Date:**

Subcontractor		Completed as Needed						Completed Within the Last 12 Months		
Name	Company	40-hour Training	8-hour Site Supervisor Training	Confined Space Entry Training	FA/CPR /BBP	Hazard Specific Training	Equipment Specific Training	Med Clearance	Fit Test	8-hour Refresher Training
		Enter "√" if Completed						Enter Date Last Completed		

Hazard Specific Training may include Hazcom, asbestos, lead, fall protection, electrical, lock-out tag-out, drilling, demolition, etc.
Equipment Specific Training may include Industrial (fork) truck, aerial lift, crane, portable extinguisher, respirator, scaffolding, etc.
Medical Clearance documents must **not** include actual medical reports. Only accept a signed physician's statement of fitness to work.

Attachment 4
Project H&S Forms/Permits

EQUIPMENT INSPECTION FORM

This form will be used to document AGVIQ-CH2MHILL earthmoving equipment inspections. Earthmoving equipment will be inspected each day and shift prior to use. All components will be inspected for damage and proper operation. Any component failing the inspection will be corrected prior to earthmoving equipment use. Check each box after passing inspection and initial bottom of form each day.

Equipment Name: _____ Identification #: _____ Week of: _____

INSPECTION ITEM	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sa**	**Sun**
Visual Checks							
Operating manual – present							
Controls - labeled as to their function, visible and legible, safety latches/guards present							
Tires/tracks – proper inflation/tension, not excessively worn or damaged							
Fluid levels/leaks - engine, transmission, hydraulic, radiator, swing motor and PTO oils.							
Lubrication - to the manufacturer's specifications							
Air filter gauge - gauge is not in the red zone.							
Hydraulics – no fluid leaks, connections tight, hoses, cylinders free of damage.							
Hoses/belts – held securely, not loose or rubbing, no excessive wear or crimping							
Fuel system - tank free of damage, all valves/hoses secure, no leaks							
Body & ground-engaging tools – no damage, cracks, bends, or excessive wear.							
Cylinders/articulation joints– no worn pins, loose connections or other damage.							
Roll-over protective structures (ROPS) - no damage, no cracks or bends							
Seat belt/bar – required unless operator stands or no ROPS							
Handrails, steps, platforms – clean, free from grease, oil, clear of obstructions.							
Cab glass – safety glass, clean, no cracks or visible distortion							
Mirrors – properly adjusted, no cracks or visible distortion							
Windshield wipers, fluid, and defroster - functioning							
Machine guards – present and in good condition							
1. Fire extinguisher – present and charged							
Operational Checks – check items through normal maneuvers							
Horn & back-up alarm – operating and distinguishable from surrounding noise							
Lights, directional signals, and brake lights - functioning							
Gauges/indicators – visible and working properly							
Operating controls - lift and tilt functioning properly							
Outriggers, if present – functioning properly							
Accelerator - even acceleration, does not stick							
Brakes (service & parking) - brings to complete stop, holds in fixed position							
Steering – responsive, minimal looseness							
Exhaust system – guarded if potential for contact, no signs of sparks/leaks							
Inspector's Initials							

AGVIQ-CH2MHILL Joint Venture (JV) employees who are required to operate earthmoving equipment will be evaluated and approved as qualified earthmoving equipment operators by an authorized JV Earthmoving Equipment Operator Evaluation Designated Persons (DP).

This form will be used by the DP to assess, approve, and document the qualifications of JV IIIA employees who are required to operate earthmoving equipment.

Employee (Operator) Name: _____ Employee #: _____

Company: _____ Business Group: _____ Region: _____

Type of equipment to be operated:_____

1. Background Review

Resume and other documentation (training certificates) will be reviewed and verified with previous employers. The individual will also possess a valid driver's license. This review should take place prior to hiring.

☐ Background Review found to be adequate. Date: ___/___/____ DP initials: _____

2. Classroom Evaluation

a. Employee will read and understand the manufacturer's Equipment Operation Manual for the specific piece of equipment to be operated.
b. Employee will read and understand the CH2M HILL *Earthmoving Equipment* (HSE-306) and *Excavations* (HSE-307) Standards of Practice.
c. DP will discuss safe operating practices with the employee.
d. Employee will pass CH2M HILL written earthmoving equipment operator exam. (See Attachment 4 for exam guidelines)

☐ Classroom Evaluation successfully completed. Date: ___/___/____ DP initials: _____

3. Field Evaluation

a. Equipment Awareness, Inspection and Maintenance

The DP will observe the employee perform a daily inspection using the Earthmoving Equipment Inspection Form. The employee will demonstrate the ability to recognize deficient conditions that could affect the safe operation of the equipment. In addition, the operator will demonstrate awareness of the following:

☐ Location of vital fluid reservoirs
☐ Location of all lubrication points
☐ Proper fueling procedures
☐ Location and function of safety disabling devices (if equipped)
☐ Location and function of safety devices (fire extinguisher, back-up alarm, seat belt/bar, guards)
☐ Location of manufacturer warning labels, weight of equipment, and lift capacities labels
☐ Location and function of all gauges, indicators and controls (horn, lights, mirrors, etc.)
☐ Acceptable conditions for passing items during daily inspections
☐ Periodic maintenance requirements

b. Equipment Operation

- The DP will observe the employee operating the equipment through normal maneuvers. The employee will demonstrate the ability to operate the equipment safely and in accordance with the manufacturer's guidelines.

☐ Demonstrates ability to safely start equipment in preparation for use (proper start-up sequence followed)
☐ Understands function and proper appearance of all gauges and indicators
☐ Understands location and use of all equipment controls
☐ Checks front, side, and rear of equipment for pedestrians, traffic and obstructions
☐ Demonstrates smooth and safe equipment travel
☐ Demonstrates smooth and safe control operations
☐ Demonstrates safe loading and binding of equipment for travel
☐ Demonstrates normal shut-down procedures
☐ Demonstrates emergency shut-down procedures
☐ Demonstrates safe parking and storage of equipment

☐ Field Evaluation successfully completed. Date: ___/___/____ DP initials: _____

Operator Acknowledgement

I have reviewed and understand all of the information listed above. I also understand that as an operator of this equipment, I am responsible for daily inspections and maintenance as well as the safe and efficient operation of the equipment listed above.

_____	_____	_____
Operator Name	Signature	Date

Qualification approval

The employee has completed the earthmoving equipment operator evaluation process and is qualified to operate the type of earthmoving equipment identified above.

_____	_____	_____
DP Name	Signature	Date
_____	_____	_____
HS&E Name	Signature	Date

A copy of this evaluation form will be maintained in the project file and the original sent to the HS&E department for retention.

AGVIQ-CH2MHILL SBRAC WE09, NAS Brunswick – Site Sign In Sheet

DATE	NAME	COMPANY	IN	OUT	IN	OUT

AGVIQ LLC
AGVIQ ENVIRONMENTAL SERVICES
CH2M HILL
JOINT VENTURE

SBRAC WE09, NAS Brunswick - AIR MONITORING LOG

Date	Time	Activity	Location	PID	Benzene	LEL	02	CO	H2S

AGVIQ-CH2MHILL SBRAC WE09, NAS Brunswick – Exclusion Zone Log

DATE	NAME	COMPANY	IN	OUT	IN	OUT

EXCAVATION ENTRY PERMIT

This permit will only be used by AGVIQ-CH2M HILL Joint Venture staff when self-performing excavation activities and will be completed by a excavation competent person. A new permit will be completed each day authorizing excavation entry. Personnel entering excavations will verify that a current permit is completed, authorized, and posted at the excavation location prior to entry. Personnel will exit the excavation and notify the excavation competent person of any unsafe condition or violation of this permit.

Excavations are required to be inspected by an excavation competent person each day, as needed throughout the work shift, and after every rain or other event that could increase the potential for excavation cave-in. This permit will document that such an inspection has been conducted and that all precautions have been taken to ensure safe entry.

GENERAL INFORMATION

Project/Site Name: _____Task Order Number:_____

Name/Location of Excavation:
_____

Scope of Work Description:
_____

EXCAVATION ENTRY PRECAUTIONS

- ☐ No tension cracks/fractures or evidence of caving, sloughing, or weak zones observed in soil
- ☐ Precautions taken to prevent surface water from entering excavation
- ☐ Water is not accumulating in excavation
- ☐ When water removal equipment used, it is monitored for proper operation
- ☐ Air monitoring conducted for excavations with hazardous atmospheres potential
- ☐ If hazardous atmosphere, ventilation used to bring conditions to safe level and tested frequently
- ☐ If ventilation unable to bring conditions to safe level, appropriate respiratory protection used
- ☐ Rescue equipment provided where potential for hazardous atmospheres exists
- ☐ Protective systems provided to prevent excavation cave-in
- ☐ Protective systems used: ☐ Benching ☐ Sloping ☐ shoring ☐ Trench Box ☐ Combination
  Describe: _____
- ☐ Protective systems inspected and are free from damage and in stable condition
- ☐ Sloping cut to appropriate angle of incline for soil classification
- ☐ shoring installed according to design and secured from movement
- ☐ Hydraulic shores maintained at designed pressure
- ☐ Trench boxes not subjected to loads exceeding design limits
- ☐ Vehicular traffic diverted an adequate distance from excavation
- ☐ Spoil piles, equipment, and materials restrained or kept at least 2’ (61 cm) from excavation edge
- ☐ Protection provided from material falling/rolling into excavation
- ☐ Safe means of egress provided every 25’ (7.6 m) inside excavation
- ☐ Personnel entering excavation briefed and understand planned work and safety precautions
- ☐ Additional precautions taken when entering to repair damaged or unstable protective systems

ENTRY APPROVAL

Competent Person Name: _____

Excavation Competent Person Signature: _____

Date/Time Entry Authorized: ____/____/_____ ____:____

Stop Work Order Form

REPORT PREPARED BY:

Name:	Title:	Signature:	Date:

ISSUE OF NONPERFORMANCE

Description:_____	Date of Nonperformance:
_____ _____ _____ _____ _____	_____

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	Title:	Signature:	Date:

** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.*

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:_____	Date of Corrective Actions:
_____ _____ _____ _____ _____	_____

SUBCONTRACTOR SIGNATURE OF CORRECTION:

Name:	Title:	Signature:	Date:

Safety and Occupational Health Deficiency Tracking Log						
Item	Date Identified	Identified By	Deficiency Description	Resolution Date	Corrected By	Actual Correction Date
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Attachment 5
Material Safety Data Sheets
(provided onsite as materials are delivered)

Attachment 6
Chemical Specific Training Form and Project-Specific Chemical Product Hazard Communication Form

CHEMICAL-SPECIFIC TRAINING FORM

Location:	Task Order:
SSHO:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The SSC will use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

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

Copies of MSDSs, chemical inventories, and the written hazard communication program will be made available for employee review in the facility/project hazard communication file.

Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSHO will verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to AGVIQ-CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: **Task Order:**

MSDSs will be maintained at the following location(s):

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard

Refer to SOP HS-107 *Hazard Communication* for more detailed information.

Attachment 7
Activity Hazard Analyses (AHAs)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities)	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with the NAS Brunswick security office if severe weather systems appear to be developing to the east. NAS Brunswick may be able to provide an update local forecast. If not check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	Standard Level D PPE * * Work clothes, reflective vests/ high visibility clothing, hard hat, safety glasses and sturdy hard toed work boots that provide sufficient ankle support, hand, hearing and face protection, as dictated by task.
	Biological	• Observe ground surfaces, enclosed structures, ground water well heads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, stinging centipedes etc. • Where exposure to poisonous plants that have oils, berries or needle-like projects could cause skin irritations, infections or allergic reactions use disposable coveralls for protection. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes or other stinging/biting insects. • If there is potential for tick or chigger infestation at the site, personnel shall wear "bug-out" suits or disposable Tyvek suits to minimize potential exposures to ticks or other biting insects (i.e., chiggers) in combination with permethrin applied to outer clothing layer (only) or dedicated permethrin impregnated clothing. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs. • Avoid exposure to blood borne pathogens. Use universal precautions against exposure.	Standard Level D PPE *
	Cuts/Abrasions	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp/cut edges or hand tools. • Avoid use of razor knives. When cutting with knives, cut away from the body and never towards another worker.	Standard Level D PPE *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities) (cont.)	Fire Prevention	• Use only metal safety cans for storage and transfer of fuel. • Use funnels and nozzles during fueling operations. • Appropriately sized, easily accessible ABC fire extinguisher in work area. • Fire extinguishers must be inspected monthly (inspection tag) and have an annual maintenance/inspection certification (tag) attached to the extinguisher. • Fire extinguishers shall be approved by a nationally recognized testing laboratory and labeled to identify the listing and labeling organization and the fire test and performance standard that the fire extinguisher meets or exceeds. • Secure any applicable NAS Brunswick Hot Work permit from NAS Brunswick Fire Department representatives as necessary. • Only smoke in designated areas. Designated area must be free of combustible/flammable materials. • ASTs for heavy equipment fuel storage should have secondary containment capabilities.	Standard Level D PPE
	Electric Safety	• Ensure that electric connections to temporary construction facilities are performed by qualified/licensed electricians. • Verify electric power sources have been have undergone LOTO process before being worked on. • Use double insulated or properly grounded electric power-operated hand tools • Inspect all extension cords daily for structural integrity, ground continuity, and damaged insulation • Keep all plugs and receptacles out of water/liquids. • Inspect all electrical power circuits prior to commencing work. • If/when electrical extension cords are required to complete work, extension cords must be: • - Equipped with third-wire grounding. • - Covered, elevated, or protected from damage when passing through work areas. • - Protected from pinching if routed through doorways. • - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. - Rated to handle the voltage/amperage of equipment.	Standard Level D PPE
	Hand & Power Tools	• Perform daily or more frequent inspections on power tools, as may be needed • Power tools shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable, level, dry work surface is available for the operation of power tools. • All required guards are in place, functioning and utilized. • Hand held power tools equipped with constant pressure switch. Tools inspected before use. Maintain all tools in a safe condition. • Select and use the proper tool for the task. • Do not use tools that have been damaged or repaired in a manner which is not consistent with manufacturer's requirements.	Standard Level D PPE

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities) (cont.)	Haul Trucks	• Haul truck operators should ensure all persons are clear before operating trucks or equipment. Before moving, operators should sound horn/back-up alarm. All equipment should be equipped with an operational backing alarm. • Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots or a spotter must be provided. • Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator. • All haul trucks must following the designated Haul Route established for the NASB project site.	Standard Level D PPE *
	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70˚F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Standard Level D PPE (light colored clothing)
	Heavy Equipment	• Seat belts or other restraint system shall be used by heavy equipment operators. • Perform daily maintenance and inspections on operating equipment. Keep documentation on site. • Use caution around pressurized lines/hoses. Inspect hoses daily for cuts, abrasions and wear. • Equipment shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable ground surface is available for the operation of heavy equipment. • Equipment operators shall not leave the cab of the equipment while they are lifting/controlling a load unless the load has been delivered to its intended transport location or the load has been fully secured (no potential for rolling onto or crushing ground personnel) and the equipment and controls are fully secured/disengaged and equipment is "de-energized".	Standard Level D PPE *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities) (cont.)	Manual Lifting	• AGVIQ-CH2MHILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. Avoid carrying heavy objects above shoulder level.	Standard Level D PPE *
	Noise	• Personnel exposed to loud working environments shall wear hearing protection.	Standard Level D PPE *
	Overhead Utilities	• Maintain proper separation between Power Transmission Lines and over overhead utilities during the operation of heavy equipment. See Electric Safety section in HSP for references to proper separation between operating equipment and power transmission lines/overhead utilities. • Do not swing operate or swing heavy equipment booms or other components of operating heavy equipment toward overhead utilities. Be cognizant of utility pole guy wire positions.	Standard Level D PPE *
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions (well casings). Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. • Three points of contact when enter/exiting equipment or when using stairways/ladders.	Standard Level D PPE *
	Pinched/Struck-by/ Caught-in-between	• Sufficient separation between ground support personnel and any operating heavy equipment must be maintained. • Wear reflective vests or high visibility clothing to promote visibility of ground personnel by equipment operators. • Isolate equipment swing areas from workers, fixed objects or other equipment. Ground personnel shall avoid positioning themselves between fixed objects, operating equipment. Make/maintain eye contact with operators before approaching equipment. Do not approach equipment from rear or from blind spot of operator. Stay out of the swing radius of operating heavy equipment. • Understand and review hand signals. Designate one person to provide hand signals to equipment operators performing lifting/hoisting operations. • Ensure equipment has operable back-up alarms. Ensure heavy equipment operator has spotter for obstructed views and backing up. • Step away from heavy equipment when adjustments (positioning) are made.	Standard Level D PPE *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities) (cont.)	Spill Prevention	• Ensure that spill control and spill clean-up and materials are on hand prior to initiating any heavy equipment or fueling operations to prevent entry into sensitive receptors. • **Understand notification processes in the event a spill occurs. If a spill should occur on the project implement the following:** – Ensure all unnecessary persons are removed from the hazard area. Determine the major components in the waste at the time of the spill. – Put on protective clothing and equipment. (Modified Level D or C). – Only properly trained personnel should respond to/mitigate a spill or release – If a flammable/combustible material is involved, remove all ignition sources, and use spark- and explosion-proof equipment for recovery of material. – Remove all surrounding materials that could be especially reactive with materials in the waste. – If wastes reach a storm or sewer drain, dam the outfall by using sand, earth, sandbags, etc. Pump this material out into a temporary holding tank or drums as soon as possible. – Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site. – Apply appropriate spill control media (e.g. clay, sand, lime, etc.) to absorb discharged liquids. – For large spills, establish diking around leading edge of spill using booms, sand, clay or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank.	Standard Level D PPE * with upgrade to higher level of protection such as Level D modified or Level C (see HSP) for spill control response
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Standard Level D PPE
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	Standard Level D PPE
	Overhead Utilities	• Maintain proper separation between Power Transmission Lines and over overhead utilities during the operation of heavy equipment. See Electric Safety section in HSP for references to proper separation between operating equipment and power transmission lines/overhead utilities. • Do not swing operate or swing heavy equipment booms or other components of operating heavy equipment toward overhead utilities. Be cognizant of utility pole guy wire positions.	Standard Level D PPE

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Mobilization/Demobilization Activities (set-up/breakdown of work area & construction facilities)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Mobilization & Demobilization (set-up/break down of work area & construction facilities) (cont.)	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	Standard Level D PPE

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • Miscellaneous power and manual hand tools. • First Aid/BbPK/CPR shield • Extension chords • Spill Kit • Haul trucks (delivered heavy equipment or materials) • Heavy Equipment (earth moving) • Communication devices	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.) • Inspections of hand tools (power) and extension cords if used.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SCC (10hr Construction Safety) or equivalent • Power tool and heavy equipment operators qualified by previous training or experience. • Qualified equipment operators – Previous training or experience

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
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AHA Prepared By: Mark Orman

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Land and Utility Surveys			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Land and Utility Surveys	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with the NAS Brunswick security office if severe weather systems appear to be developing to the east. NAS Brunswick may be able to provide an update local forecast. If not check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may be developing. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	Standard Level D PPE * * Work clothes, reflective vests/ high visibility clothing, hard hat, safety glasses and sturdy hard toed work boots that provide sufficient ankle support, hand, hearing and face protection, as dictated by task.
	Biological	• Observe ground surfaces, enclosed structures, ground water well heads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, stinging centipedes etc. • Where venomous snakes are known to inhabit or may be present, the use of snake guards must be evaluated • Do not approach fresh or brackish water bodies that could contain alligators. • Where exposure to poisonous plants that have oils, berries or needle-like projects could cause skin irritations, infections or allergic reactions use disposable coveralls for protection. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes or other stinging/biting insects. • If there is potential for tick or chigger infestation at the site, personnel shall wear "bug-out" suits or disposable Tyvek suits to minimize potential exposures to ticks or other biting insects (i.e., chiggers) in combination with permethrin applied to outer clothing layer (only) or dedicated permethrin impregnated clothing. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs. • Avoid exposure to blood borne pathogens. Use universal precautions against exposure.	Standard Level D PPE *
	Fire Prevention	• Only smoke in designated areas. Designated area must be free of combustible/flammable materials.	Standard Level D PPE *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Land and Utility Surveys			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Land and Utility Surveys (cont.)	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Standard Level D PPE (light colored clothing)
	Manual Lifting	• AGVIQ-CH2MHILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level.	Standard Level D PPE *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Land and Utility Surveys			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Land and Utility Surveys (cont.)	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions (well casings). Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. • Three points of contact when enter/exiting equipment or when using stairways/ladders.	Standard Level D PPE *
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Standard Level D PPE
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	Standard Level D PPE

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick
ACTIVITY HAZARD ANALYSIS – Land and Utility Surveys

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment
Land and Utility Surveys (cont.)	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Personnel using survey equipment containing lasers shall be trained to utilize that equipment properly. Personnel operating laser equipped survey equipment must avoid exposing their eyes to direct or indirect laser light energy sources. • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	Standard Level D PPE

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Eye wash (small portable type) • Miscellaneous power and manual hand tools. • First Aid/BbPK/CPR shield • Communication devices • Land Survey or EM/GPR utility locating equipment (as applicable to task)	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.)	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SCC (10hr Construction Safety) or equivalent

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
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	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

AHA Prepared By: Mark Orman

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling	Chemical Exposure	• All personnel performing this task shall be trained in accordance with 29CFR1910.120 and been rolled in a medical monitoring program. • Pregnant or potentially pregnant AGVIG/CH2M HILL personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Do not allow on-site haul truck operators to climb into dump bodies without proper PPE. • Adhere to PPE and action monitoring level requirements identified in the sections 5.0 and 6.0 of the site specific HSP.	Level D_1 or D_2 Modified PPE or as required by HSP* D: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task. D_1 : D + hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Buried Objects	• For in-situ soil pre-characterization sampling activities verify Dig Safe dig excavation clearance notifications remain valid. Update notifications as may be required by Dig Safe requirements. • Where unknown or unanticipated buried objects are encountered AGVIQ/CH2M HILL or subcontractor personnel shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area and 3) immediately notify the site manager, SHSO and PM of the encountered condition. Work may only resume with appropriate documentation/notification that exposure hazards (physical or chemical) do not exist. Consult with AGVIQ/CH2M HILL PM and HSM prior to resuming activities.	Level D_1 or D_2 Modified PPE or as required by HSP *
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions. Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. • Use a sufficient amount of personnel (3) to cover waste stockpiles, use more as necessary in windy conditions. • Avoid walking on top of waste stockpiles that are covered in polyethylene sheeting or similar materials.	Level D_1 or D_2 Modified PPE or as required by HSP *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling (Cont.)	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Level D_1 or D_2 Modified PPE or as required by HSP *
	Cave Ins/ Engulfment	– Each employee in an excavation must be protected from cave-ins by adequate protective systems designed in accordance with applicable OSHA standards (i.e. Design of Sloping and Benching Systems and Design of Support Systems, Shield Systems and other Protective Systems) except when; – 1)Excavations are made entirely in rock; – 2) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides there is no indication of cave-in. – Sloping and benching configurations shall be in accordance with 29 CFR 1926.652(b) or EM 385 1-1, section 25.C, whichever is more stringent. – Where the use of support systems, shields or other protective systems is determined to be necessary, the design of said systems shall be in accordance with 29CFR1926.652(c) or shall be in EM 385 1-1, section 25.C, whichever is more stringent. – Special Excavation Requirements defined by 29CFR1926.651 shall also be evaluated prior to the start of site excavation activities. – AGVIQ/CH2M HILL personnel must notify and be granted authorization from the excavation-competent person prior to entering any excavation. AGVIQ/CH2M HILL personnel must follow all excavation requirements established by the competent person. A competent person is an individual who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and, who has authority to take prompt corrective measures to eliminate them. The competent person must be a person designated by the AGVIQ/CH2M HILL. • The competent person must inspect the excavation every day and after everyday hazard increasing event. Documentation of this inspection must be maintained on site at all times. • AGVIQ/CH2M HILL personnel must not enter any excavation where protective systems are deficient at any time, for any reason. The competent person must be notified of such conditions • Provide Excavation Perimeter Protection and Warning signs as necessary to be in compliance with EM 385 11-1, Section 25B Safe Access and Appendix Q, "Perimeter Protection".	Level D_1 or D_2 Modified PPE or as required by HSP *
	Noise	• Personnel exposed to loud working environments shall wear hearing protection. • Wear hearing protection in open cabs of heavy equipment or when working adjacent to operating heavy equipment.	Level D_1 or D_2 Modified PPE or as required by HSP *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling (Cont.)	Fire Prevention	▪ Use only metal safety cans for storage and transfer of fuel. ▪ Use funnels and nozzles during fueling operations. ▪ Appropriately sized, easily accessible ABC fire extinguisher in work area. ▪ Review and be cognizant of applicable NAS Brunswick Fire Prevention Procedures and Requirements. Secure any applicable NWIRP Calverton Hot Work permit from NAS Brunswick Fire Department representatives and institute fire watch provisions.	Level D_1 or D_2 Modified PPE or as required by HSP *
	Heavy Equipment	• Seat belts or other restraint system shall be used by heavy equipment operators. • Perform daily maintenance and inspections on operating equipment. Keep documentation on site. • Use caution around pressurized lines/hoses. Inspect hoses daily for cuts, abrasions and wear. • Equipment shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable ground surface is available for the operation of heavy equipment. • Do not swing overhead loads over ground personnel.	Level D_1 or D_2 Modified PPE or as required by HSP *
	Biological	• Observe ground surfaces, building structure, surrounding vegetation other site features for presence of spiders, bee/wasp hives etc. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant or permethrin (clothes). Tape pant legs to boots and ensure there are no open seams between boots and pant legs. Frequently check body and clothing for ticks, spiders. Where tick exposure is moderate or high exposure, the use of disposable coveralls shall be considered. f there is potential for tick or chigger infestation at the site, personnel shall wear "bug-out" suits or disposable Tyvek suits to minimize potential exposures to ticks or other biting insects (i.e., chiggers) in combination with permethrin applied to outer clothing layer (only) or dedicated permethrin impregnated clothing. Avoid exposure to blood borne pathogens. Use universal precautions against exposure.	Level D_1 or D_2 Modified PPE or as required by HSP *

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling (Cont.)	Vehicular traffic & Haul trucks	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests. • **All haul trucks must following the designated Haul Route established for the NAS Brunswick project.** • Haul truck operators should be familiar with their equipment and inspect all equipment before use. • Haul truck operators should ensure all persons are clear before operating trucks or equipment. Before moving, operators should sound horn or alarm. All equipment should be equipped with an operational backing alarm. • Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots. • Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator. • Where grades are steep, provide signs indicating the actual grade as well as measures for a runaway truck.. • Haul roads should be well lit, sufficiently wide (at least 50% of the width of the equipment on both sides of road) and equipped with reflectors to indicate access points. • Haul roads should have adequate right-of-way signs indicating haul directions, where appropriate	Level D_1 or D_2 Modified PPE or as required by HSP *
	Manual Lifting	• AGVIQ/CH2M HILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. ▪ Avoid carrying heavy objects above shoulder level.	Level D_1 or D_2 Modified PPE or as required by HSP

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling (Cont.)	Dewatering	• Use chemical/liquid resistant gloves and face shield (as necessary) when handling contaminated liquids. See section 5.0 of site specific HSP. • All pressured lines and fittings should be 'tethered' or otherwise secured to minimize whipping or 'launching' of lines in the event of a failure. Any 'quick connect' type fittings should be secured with appropriate pins, clips or covering to prevent accidental disengagement of the fitting. • Ensure all pressure is removed from discharge hoses before disconnecting hose sections. • Inspect all equipment, hoses, pressure lines and fittings daily and prior to pressurizing. • If a flammable/combustible material is involved, remove all ignition sources, and use spark- and explosion-proof equipment for recovery of material. • Dewatering operations are to be reviewed/monitored by the Excavation Competent Person.	Level D_1 or D_2 Modified PPE or as required by HSP *
	Manual Lifting	• AGVIQ/CH2M HILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 50lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. ▪ Avoid carrying heavy objects above shoulder level.	Level D_1 or D_2 Modified PPE or as required by HSP

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Management of Contaminated Soil & Confirmation Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Management of Contaminated Soil & Confirmation Sampling (Cont.)	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Level D_1 or D_2 Modified PPE or as required by HSP *
	Low Ambient Temperature	• Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather. • Frequent intake of non-caffeinated fluids to maintain body core temperature. • Frequent intake of non- caffeinated to prevent dehydration. • Obtain and review weather forecast— be aware of predicted weather systems. • Observe one (buddy system) another for initial signs of cold-related disorders. • Frequent observance of Wind Chill Chart (HSP) to assist with work warming regiment determination and frostbite avoidance	Level D_1 or D_2 Modified PPE or as required by HSP *

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment
Management of Contaminated Soil & Confirmation Sampling (Cont.)	Stuck by/Pinched Caught in Between	• Sufficient separation between ground support personnel and the operating heavy equipment must be maintained. • Wear reflective vests or high visibility clothing to promote visibility of ground personnel by equipment operators. • Isolate equipment swing areas from workers, fixed objects or other equipment. Ground personnel shall avoid positioning themselves between fixed objects, operating equipment. Make/maintain eye contact with operators before approaching equipment. Do not approach equipment from rear or from blind spot of operator. Stay out of the swing radius of operating heavy equipment. • Understand and review hand signals. Designate one person to provide hand signals to equipment operators performing lifting/hoisting operations. • Ensure equipment has operable back-up alarms. • Step away from heavy equipment when adjustments (positioning) are made. • Ensure heavy equipment operator has spotter for obstructed views and backing up.	Level D_1 or D_2 Modified PPE or as required by HSP *
	Other	▪ Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. ▪ Shut down operations in heavy rain and lightning. Seek safe haven in a grounded structure or vehicle. Implement 30 – 30 rule. ▪ Buddy System maintained for all phases of work. ▪ Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. ▪ Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • Miscellaneous power and manual hand tools. • First Aid/BbPK/CPR shield • Excavator, Loader, Haul trucks	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Inspections of hand tools (power) and extension cords if used.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SC-HW (29CFR1910.120(e)(4) or equivalent, SCC (10 hr Construction Safety) • All - Training and medical surveillance in accordance 29CFR1910.120 (HAZWOPER) or 29CFR1910.134 (respiratory, as necessary) • Power tool and heavy equipment operators qualified by previous training or experience. • Competent Person - Excavation

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
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AHA Prepared By: Josh Painter

AGVIQ-CH2M HILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Equipment Cleaning (Non CSE) & Management of Generated Waste (As Required)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Equipment Cleaning (Non CSE) & Management of Generated Waste	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If on-site internet or radio monitoring are not available, check with the NAS Brunswick security office if severe weather systems appear to be developing to the east. NAS Brunswick may be able to provide an update local forecast. If not check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	Modified Level D PPE (D_1 or D_2) per HSP* D_1: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard toed work boots, hearing and hand protection as necessary for task, Hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Biological	• Observe ground surfaces, enclosed structures, ground water well heads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, etc. • Where venomous snakes are known to inhabit or may be present, the use of snake guards must be evaluated. • Do not approach fresh or brackish water bodies that could contain alligators. • Where exposure to poisonous plants that have oils, berries or needle-like projects could cause skin irritations, infections or allergic reactions use disposable coveralls for protection. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes or other stinging/biting insects. Frequently check body and clothing for ticks, spiders. If there is potential for tick or chigger infestation at the site, personnel shall wear "bug-out" suits or disposable Tyvek suits to minimize potential exposures to ticks or other biting insects (i.e., chiggers) in combination with permethrin applied to outer clothing layer (only) or dedicated permethrin impregnated clothing. • Use permethrin on clothing only to deter tick bites. If this is in effective, use light weight, white disposable clothing. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs. • Avoid exposure to blood borne pathogens. Use universal precautions against exposure.	Modified Level D PPE (D_1 or D_2) per HSP*
	Cuts & Abrasions	• Wear cut resistant work gloves, when the possibility of lacerations or other injury may be caused by sharp edges of hand tools.	Modified Level D PPE (D_1 or D_2) per HSP*

AGVIQ-CH2M HILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Equipment Cleaning (Non CSE) & Management of Generated Waste (As Required)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Equipment Cleaning (Non CSE) & Management of Generated Waste (cont.)	Chemical Exposure	• All personnel performing this task shall be trained in accordance with 29CFR1910.120 and be rolled in a medical monitoring program. • **Where any work involves a Confined Space Entry (CSE) a separate AHA, PPE, Air Monitoring Equipment and engineering control measures shall be put in place prior to executing this work.** • Pregnant or potentially pregnant AGVIQ-CH2M HILL personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Do not allow on-site haul truck operators to climb into dump bodies without proper PPE. • Adhere to PPE and action monitoring level requirements identified in the Sections 5.0 and 6.0 of the site specific HSP.	Modified Level D PPE (D_1 or D_2) per HSP*
	Electrical Safety	• Do not connect car batteries direct to sampling devices for power. Use a generator, GCFI or other protected circuit. • If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. – Inspected all extension cords daily for structural integrity, ground continuity, and damaged insulation. – Kept out of water/liquids. – Electrical power circuits should be inspected before plugging in extension cords.	Modified Level D PPE (D_1 or D_2) per HSP*
	Hand Tools	• Select and use the proper tool for the task. • Do not use tools that have been damaged or repaired in a manner which is not consistent with manufacturer's requirements.	Modified Level D PPE (D_1 or D_2) per HSP*

AGVIQ-CH2M HILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Equipment Cleaning (Non CSE) & Management of Generated Waste (As Required)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Equipment Cleaning (Non CSE) & Management of Generated Waste (cont.)	Fire Prevention	• Only smoke in designated areas. Designated area must be free of combustible/flammable materials. • Use only metal safety cans for storage and transfer of fuel. • Use funnels and nozzles during fueling operations. • Appropriately sized, easily accessible ABC fire extinguisher in work area. Fire extinguishers must be inspected monthly (inspection tag) and have an annual maintenance/inspection certification (tag) attached to the extinguisher. • Fire extinguishers shall be approved by a nationally recognized testing laboratory and labeled to identify the listing and labeling organization and the fire test and performance standard that the fire extinguisher meets or exceeds.	Modified Level D PPE (D_1 or D_2) per HSP*
	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Modified Level D PPE (D_1 or D_2) per HSP* (light weight cotton/breathable clothing underneath)

AGVIQ-CH2M HILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Equipment Cleaning (Non CSE) & Management of Generated Waste (As Required)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Equipment Cleaning (Non CSE) & Management of Generated Waste (cont.)	Manual Lifting	• AGVIQ-CH2M HILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level. • Use drum dollies for the movement of drums used for the storage of wastes generated on the project.	Modified Level D PPE (D_1 or D_2) per HSP*
	Sample Handling	• Skin contact with contaminated water shall be avoided at all times. • Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents before labeling and placing them in the cooler for shipment to the laboratory. • **Sample or open only labeled drums or drums known to contain generated waste materials. Unknown drums or drums that show evidence of excessive buckling/bulging, corrosion, vapors, crystallization, unusual discoloration or other abnormalities may not be sampled without the evaluation of engineering controls, proper PPE air monitoring equipment and the use properly trained personnel familiar with the sampling of unknown drum contents. If there is any question to the proper handling or opening of drums.** • Minimize transportation of drums or other containers with waste materials. • Follow proper decontamination procedures for sample equipment. Properly containerize, label, store and dispose of any decontamination wastes.	Modified Level D PPE (D_1 or D_2) per HSP*
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions (well casings). Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. .	Modified Level D PPE (D_1 or D_2) per HSP*

AGVIQ-CH2M HILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – Equipment Cleaning (Non CSE) & Management of Generated Waste (As Required)			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Equipment Cleaning (Non CSE) & Management of Generated Waste (cont.)	Pressure Washing	• Inspect pressure washer before use and confirm dead man switch fully operational. • The wand must always be pointed at the work area. • The Wand trigger should never be tied down in the open position. • Never point the wand at yourself or another worker. • The wand must be at least 42 inches from the trigger to the tip. • The operator must maintain good footing. • Non-operators must remain a safe distance from the operator. • No unauthorized attachment may be made to the unit. • Do not modify the wand. • All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service. • Rain gear (disposal coated chemical suits for Hazwoper operations), 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves should be worn, at a minimum during pressure washing operations.	Modified Level D PPE (D_1 or D_2) per HSP*
	Visible Lighting	• Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Modified Level D PPE (D_1 or D_2) per HSP*
	Vehicular Traffic	• Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle. • Exercise caution when exiting traveled way or parking along street— avoid sudden stops, use flashers, etc. • Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. • All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.	Modified Level D PPE (D_1 or D_2) per HSP*
	Other	• **Verify that EMS services are available and can respond in a prompt manner prior to the start of work.** • Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. • Buddy System maintained for all phases of work. • Base or Local Emergency medical Service and Fire Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. • Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	Modified Level D PPE (D_1 or D_2) per HSP*

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • Miscellaneous hand tools. • Pressure Washer • Drum Dolly • Sample coolers, containers and equipment • First Aid/BbPK/CPR shield • Communication devices	• Visual Inspections of designated work areas identify and address hazardous conditions. • Emergency Response equipment Inspections (Fire Extinguishers, Eye wash First Aid/CPR etc.) • Inspections of hand tools, generator and power cords, if used.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SC-HW (29CFR1910.120(e)(4) or equivalent, SCC (10 hr Construction Safety) • All - Training and medical surveillance in accordance 29CFR1910.120 (HAZWOPER) or 29CFR1910.134 (respiratory, as necessary) • Power tool operators qualified by previous training or experience.

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Supervisor Name:	_____	_____	**Date/Time:** _____
Safety Officer Name:	_____	_____	**Date/Time** _____
Site Personnel:	_____	_____	**Date/Time:** _____
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AHA Prepared By: Mark Orman

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on site to monitoring local weather or marine forecasts. If onsite internet or radio monitoring are not available, check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	Modified Level D PPE (D_1 or D_2 per HSP) * * Level D Modified D_1: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard-toed work boots, hearing and hand protection as necessary for task, Hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)
	Biological	• Observe ground surfaces, enclosed structures, groundwater, wellheads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, stinging centipedes, etc. • Where exposure to poisonous plants that have oils, berries or needle-like projects could cause skin irritations, infections or allergic reactions use disposable coveralls for protection. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes, ticks, or other stinging/biting insects. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs, consider the use of "bug repellent" suits/clothing. •	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling **(CONT)**	Buried Utilities or Unknown Objects	• Contact **Dig Safe** to secure a utility owner verification request number at 888-344-7233 for utility clearance verification. Keep copies of any written documentation (faxes, email printouts) regarding utility location verification provided by utilities owners in the office project file and in a working field file on-site. • Photo document owner provided field utility mark-outs as related to proposed limits of ground disturbing activities prior to the start of work. • Conduct "third" party utility clearance when the locations of utilities may be in question and document results of third party utility location. • Determine if an NAS Brunswick/NAVFAC "Excavator Permit" is required prior to performing any ground disturbing activities. • Hand dig around identified utilities (within 5′) or as otherwise required by NAS Brunswick issued excavation permit. • Review base engineering records or drawings against utility owner or third party utility mark-out to verify any potential differences. • Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, utilities must be relocated/marked. • Where unknown or unanticipated buried objects are encountered (i.e. drums, tanks, cylinders, munitions of explosive concern, soil with unusual staining or odor) AGVIQ-CH2M HILL JV or subcontractor personnel shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area and 3) immediately notify the site manager, SSHO or PM of the encountered condition. Work may only resume with appropriate documentation/notification that exposure hazards (physical or chemical) do not exist. Notify AGVIQ-CH2M HILL JV PM and program officials and applicable NAVFAC POCs and do not resume work until authorized to do so.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling **(CONT)**	Chemical Exposure	• All personnel performing this task shall be trained in accordance with 29CFR1910.120 and be rolled in a medical monitoring program. • Pregnant or potentially pregnant AGVIQ-CH2M HILL personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Do not perform decontamination of equipment without proper PPE. • Adhere to PPE and action monitoring level requirements identified in the Sections 5.0 and 6.0 of the site specific HSP.	Modified Level D PPE (D_1 or D_2) per HSP*
	Cuts and Abrasions	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Avoid use of razor knives. • Cut away from the body and never towards another worker. Provide sufficient work space between workers.	Modified Level D PPE (D_1 or D_2 per HSP)
	Electric Hazards	• If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. • - Rated to handle the voltage/amperage of equipment.	Modified Level D PPE (D_1 or D_2 per HSP)
	Fire/Explosion Prevention	▪ Use only metal safety cans for storage and transfer of fuel. ▪ Use funnels and nozzles during fueling operations. ▪ Appropriately sized, easily accessible ABC fire extinguisher in work area. • Review and be cognizant of NAS Brunswick Fire Prevention Procedures and Requirements. Secure a Hot Work permit from NAS Brunswick Fire Department representatives and institute fire watch provisions and conditions of Hot Work permit before performing Hot Work related work.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling (cont)	Hand & Power Tools	• Perform daily or more frequent inspections on power tools, as may be needed • Power tools shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable, level, dry work surface is available for the operation of power tools. • All required guards are in place, functioning and utilized. • Hand held power tools equipped with constant pressure switch. Tools inspected before use. Maintain all tools in a safe condition. • Select and use the proper tool for the task. • Do not use tools that have been damaged or repaired in a manner which is not consistent with manufacturer's requirements.	Modified Level D PPE (D_1 or D_2 per HSP)
	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. • *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling (cont)	Low Ambient Temperature	• Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather. • Frequent intake of non-caffeinated fluids to maintain body core temperature. • Frequent intake of non- caffeinated to prevent dehydration. • Obtain and review weather forecast— be aware of predicted weather systems. • Observe one (buddy system) another for initial signs of cold-related disorders. • Frequent observance of Wind Chill Chart (HSP) to assist with work warming regiment determination and frostbite avoidance	Modified Level D PPE (D_1 or D_2 per HSP)
	Manual Lifting	• AGVIQ-CH2M HILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level. • Use drum dollies for the movement of drums used for the storage of wastes generated on the project.	Modified Level D PPE (D_1 or D_2) per HSP*
	Noise	• Personnel exposed to loud working environments shall wear hearing protection. • Personnel working near the drilling/DPT equipment shall wear hearing protection.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Drilling/DPT (Direct Push Technology) Well Installation and Sampling (cont)	Pressure washing	• Only trained, authorized personnel may operate the pressure washer. • Follow manufacturer's safety and operating instructions. • Inspect pressure washer before use and confirm a power shut-off or emergency stop switch is fully operational. • The wand must always be pointed at the work area only. • The trigger should never be tied down in the open position. • Never point the wand at yourself or another worker. • The wand must be at least 42 inches from the trigger to the tip. • The operator must maintain good footing. • Non-operators must remain a safe distance from the operator. • No unauthorized attachment may be made to the unit. • Do not modify the wand. • All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.	Modified Level D PPE (D_1 or D_2 per HSP)
	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions. Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. ▪ Evaluate disposable/re-usable footwear to provide footwear that gives workers the best traction/slip resistance capabilities.	Modified Level D PPE (D_1 or D_2 per HSP)
	Stairways & ladders	• A Stairway or ladder is generally required when a break in elevation of 19 inches or greater exists. • Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions. Do not work out-side of the rails a ladder. • Ladders must be inspected for visible defects prior to each day's use. Defective ladders must be tagged and removed from service. • Ladders must be used only for the purpose for which they were designed and will not be loaded beyond their rated capacity. Only one person at a time will climb on or work from an individual ladder. • Ladders shall be extended to 3' above its landing surface and be secured from movement.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick
ACTIVITY HAZARD ANALYSIS – – Drilling/DPT Well Installation and Sampling

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment
	Struck/pinched	• Wear reflective warning vests or high visibility clothing. • Isolate any equipment operating envelop from workers, fixed objects. • Make/maintain eye contact with operators before approaching equipment. Do not approach operating equipment from the rear or from blind spot of operator. • Understand and review hand signals. Designate one person to provide hand signals to equipment operators. • Ensure equipment has operable back-up alarms and that Drill/DPT rig emergency kill switches are working. • Avoid positioning between fixed objects and operating equipment.	Modified Level D PPE (D_1 or D_2 per HSP)
	Visible Lighting	Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Modified Level D PPE (D_1 or D_2 per HSP)
	Other	▪ Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. ▪ Shut down operations in heavy rain and lightning. Seek safe haven in a grounded structure or vehicle. Implement 30 – 30 rule. ▪ Buddy System maintained for all phases of work. ▪ Base Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. ▪ Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher (with fuel and electrical sources) • Eye wash (small portable type) • Miscellaneous power and manual hand tools. • First Aid/BbPK/CPR shield • extension chords • Drilling/DPT rig • Air Monitoring Equipment (section 6.0 of HSP) • Pressure washer. • Generators	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Inspections of hand tools (power) and extension cords if used. • Drill/DTP rig Inspection	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan for new site personnel. • Review operations/safety manuals for all equipment utilized. • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SC-HW (29CFR1910.120(e)(4) or equivalent, SCC (10 hr Construction Safety) • All - Training and medical surveillance in accordance 29CFR1910.120 (HAZWOPER) or 29CFR1910.134 (respiratory, as necessary) • Drill/DPT operators qualified by previous training or experience. • 29CFR1910.146

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AHA Prepared By: Josh Painter

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling	Adverse Weather	• Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on site to monitoring local weather or marine forecasts. If onsite internet or radio monitoring are not available, check with home office support personnel who may be able to verify pending regional severe weather conditions. • Frequently observe the eastern skyline for developing rain squalls and thunder storms systems that may develop. • Bring clothing suitable for anticipated daily weather conditions. • Shut down operations during heavy rain/lightning events or high wind conditions. For storms producing lightning, seek safe haven in a grounded structure or rubber vehicle. Implement 30 – 30 rule. Do not seek refuge under trees during electrical or high wind storm events. • Stay away from ravines and gullies during heavy rain events, because of the possibility of flash flood events. • Do not use telephones during electrical storms, except in the case of emergency.	Modified Level D PPE (D_1 or D_2 per HSP) * * Level D Modified D_1: Work clothes, reflective vests, hard hat, safety glasses and sturdy hard-toed work boots, hearing and hand protection as necessary for task, Hand protection (inner and outer chemical resistant gloves) D_2: D_1+ chemical resistant suits and boot covers, face protection (as needed)

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment
	Biological	• Observe ground surfaces, enclosed structures, groundwater, wellheads, surrounding vegetation other site features for presence of spiders, bee/wasp hives, stinging centipedes, etc. • Where exposure to poisonous plants that have oils, berries or needle-like projects could cause skin irritations, infections or allergic reactions use disposable coveralls for protection. • Observe areas for presence of stinging insects. Prior to starting field activities, **notify supervisors of known allergies to stinging insects and location of antidotes.** • Use insect repellant with DEET or other insect repellent to deter being bit by mosquitoes, ticks, or other stinging/biting insects. • Tape pant legs to boots and ensure there are no open seams between boots and pant legs, consider the use of "bug repellent" suits/clothing. •	Modified Level D PPE (D_1 or D_2 per HSP)
Groundwater, Surface Water, and Sediment Sampling **(CONT)**	Buried Utilities or Unknown Objects	• Contact **Dig Safe** to secure a utility owner verification request number at 888-344-7233 for utility clearance verification. Keep copies of any written documentation (faxes, email printouts) regarding utility location verification provided by utilities owners in the office project file and in a working field file on-site. • Photo document owner provided field utility mark-outs as related to proposed limits of ground disturbing activities prior to the start of work. • Conduct "third" party utility clearance when the locations of utilities may be in question and document results of third party utility location. • Determine if an NAS Brunswick/NAVFAC "Excavator Permit" is required prior to performing any ground disturbing activities. • Hand dig around identified utilities (within 5′) or as otherwise required by NAS Brunswick issued excavation permit. • Review base engineering records or drawings against utility owner or third party utility mark-out to verify any potential differences. • Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, utilities must be relocated/marked. • Where unknown or unanticipated buried objects are encountered (i.e. drums, tanks, cylinders, munitions of explosive concern, soil with unusual staining or odor) AGVIQ-CH2M HILL JV or subcontractor personnel shall 1) secure equipment to the extent possible, without causing bodily injury, 2) evacuate the work area and 3) immediately notify the site manager, SSHO or PM of the encountered condition. Work may only resume with appropriate documentation/notification that exposure hazards (physical or chemical) do not exist. Notify AGVIQ-CH2M HILL JV PM and program officials and applicable NAVFAC POCs and do not resume work until authorized to do so.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling **(CONT)**	Chemical Exposure	• All personnel performing this task shall be trained in accordance with 29CFR1910.120 and be rolled in a medical monitoring program. • Pregnant or potentially pregnant AGVIQ-CH2M HILL personnel to review Standard of Practice HSE-120, Reproductive Protection before performing any hazardous or potentially hazardous duty. • Do not allow dermal contact or incidental ingestion of impacted soil or groundwater. Skin contact with contaminated water, soils, debris, or equipment shall be avoided at all times. Do not kneel or step in potentially contaminated media (soil or ground water) without first donning proper PPE. • Open GW Well heads and plugs from the upwind side, remove yourself from the location and allow the well to vent prior to working over the open well head. • Exercise good hygiene practices. Always wash hands before eating, drinking, smoking and leaving site. Only eat, drink, smoke or chew tobacco in designated areas. • Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Adhere to PPE and action monitoring level requirements identified in the Sections 5.0 and 6.0 of the site specific HSP.	Modified Level D PPE (D_1 or D_2) per HSP*
	Cuts and Abrasions	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Avoid use of razor knives. • Cut away from the body and never towards another worker. Provide sufficient work space between workers.	Modified Level D PPE (D_1 or D_2 per HSP)
	Electric Hazards	• If/when electrical extension cords are required to complete work, extension cords must be: - Equipped with third-wire grounding. - Covered, elevated, or protected from damage when passing through work areas. - Protected from pinching if routed through doorways. - Not fastened with staples, hung from nails, or suspended with wire. - Extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed. • - Rated to handle the voltage/amperage of equipment.	Modified Level D PPE (D_1 or D_2 per HSP)
	Fire/Explosion Prevention	▪ Use only metal safety cans for storage and transfer of fuel. ▪ Use funnels and nozzles during fueling operations. ▪ Appropriately sized, easily accessible ABC fire extinguisher in work area. • Review and be cognizant of NAS Brunswick Fire Prevention Procedures and Requirements. Secure a Hot Work permit from NAS Brunswick Fire Department representatives and institute fire watch provisions and conditions of Hot Work permit before performing Hot Work related work.	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling (cont)	Hand & Power Tools	• Perform daily or more frequent inspections on power tools, as may be needed • Power tools shall only be operated by personnel qualified by prior training or experience. • Ensure that a stable, level, dry work surface is available for the operation of power tools. • All required guards are in place, functioning and utilized. • Hand held power tools equipped with constant pressure switch. Tools inspected before use. Maintain all tools in a safe condition. • Select and use the proper tool for the task. • Do not use tools that have been damaged or repaired in a manner which is not consistent with manufacturer's requirements.	Modified Level D PPE (D_1 or D_2 per HSP)
	High Ambient Temperature	• Provide and drink fluids to prevent worker dehydration. • Minimize intake of caffeinated fluids. ▪ Institute a proper work-break regiment in a cool area to avoid heat stress symptoms and overexertion. ▪ Monitor for signs and symptoms of heat stress (maintain use of buddy system) when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress and especially when wearing disposable or other types of coveralls. 1) Heat Syncope = Sluggishness or fainting while standing erect or immobile in heat. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.* 2) Heat Rash = Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. *Treatment = Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.* 3) Heat Cramps = Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. *Treatment = Remove to cooler area. Rest lying down. Increase fluid intake.* 4) Heat exhaustion = Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid steady pulse and low blood pressure; oral temperature normal or low. *Treatment = Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.* 5) Heat Stroke = Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. • *Treatment = Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!*	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling (cont)	Low Ambient Temperature	• Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather. • Frequent intake of non-caffeinated fluids to maintain body core temperature. • Frequent intake of non- caffeinated to prevent dehydration. • Obtain and review weather forecast— be aware of predicted weather systems. • Observe one (buddy system) another for initial signs of cold-related disorders. • Frequent observance of Wind Chill Chart (HSP) to assist with work warming regiment determination and frostbite avoidance	Modified Level D PPE (D_1 or D_2 per HSP)
	Manual Lifting	• AGVIQ-CH2M HILL or subcontract personnel must notify supervisors or safety representatives of preexisting medical conditions that may be aggravated or re-injured by lifting activities, especially lifting operation involving repetitive motions. • When lifting objects, lift using knees not back. For repetitive lifting tasks, the use of lifting braces/supports may be considered. Use heavy equipment to transfer heavy or awkward loads wherever possible. Have someone assist with the lift— especially for heavy (> 40lbs.) or awkward loads. Do not attempt to manually lift objects that should otherwise be lifted with heavy equipment. • Plan storage and staging to minimize lifting or carrying distances. Make sure the path of travel is clear prior to the lift. • Avoid carrying heavy objects above shoulder level. • Use drum dollies for the movement of drums used for the storage of wastes generated on the project.	Modified Level D PPE (D_1 or D_2) per HSP*
	Noise	• Personnel exposed to loud working environments shall wear hearing protection. • Personnel working near the generators shall wear hearing protection.	Modified Level D PPE (D_1 or D_2 per HSP)
	Sample Handling	• Skin contact with contaminated water shall be avoided at all times. • Follow procedures listed in the SAP. • Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns. • Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents before labeling and placing them in the cooler for shipment to the laboratory. • Minimize transportation of coolers or other containers with sample materials. • Follow proper decontamination procedures for sample equipment. Properly containerize, label, store and dispose of any decontamination wastes.	Modified Level D PPE (D_1 or D_2) per HSP*

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling (cont)	Slips, Trips, Falls	• Be aware of poor footing, potential slipping/tripping hazards in the work area, such as wet/steep slopes, stumps/roots, unprotected holes, ditches, rip rap, utilities, ground protrusions. Observe and avoid areas of unprotected holes, ramps and ground penetrations or protrusions (stumps, roots, holes curbs, utility structures etc). Use sturdy hard toe work boots with sufficient ankle support. • Institute and maintain good housekeeping practices. Clean Work Areas as activities proceed. Clear/removed materials and debris from pathways and commonly traveled areas as soon as possible. ▪ Evaluate disposable/re-usable footwear to provide footwear that gives workers the best traction/slip resistance capabilities. ▪ When sampling along streams, soft soled felt, leather, or rubber footwear should be used.	Modified Level D PPE (D_1 or D_2 per HSP)
	Stairways & ladders	• A Stairway or ladder is generally required when a break in elevation of 19 inches or greater exists. • Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions. Do not work out-side of the rails a ladder. • Ladders must be inspected for visible defects prior to each day's use. Defective ladders must be tagged and removed from service. • Ladders must be used only for the purpose for which they were designed and will not be loaded beyond their rated capacity. Only one person at a time will climb on or work from an individual ladder. • Ladders shall be extended to 3' above its landing surface and be secured from movement.	Modified Level D PPE (D_1 or D_2 per HSP)
	Struck/pinched	• Wear reflective warning vests or high visibility clothing. • Isolate any equipment operating envelop from workers, fixed objects. • Make/maintain eye contact with operators before approaching equipment. Do not approach operating equipment from the rear or from blind spot of operator. • Understand and review hand signals. Designate one person to provide hand signals to equipment operators. • Ensure equipment has operable back-up alarms. • Avoid positioning between fixed objects and operating equipment.	Modified Level D PPE (D_1 or D_2 per HSP)
	Visible Lighting	Perform tasks in daylight hours whenever possible. If dawn, dusk or dark work is to be performed portable lightly must be provided to sufficient illuminate work area(s).	Modified Level D PPE (D_1 or D_2 per HSP)

AGVIQ-CH2MHILL Joint Venture (SBRAC) Task Order WE09, NAS Brunswick ACTIVITY HAZARD ANALYSIS – – Groundwater, Surface Water, and Sediment Sampling			
Task Breakdown	**Potential Hazards**	**Critical Safety Practices**	**Personal Protective Clothing and Equipment**
Groundwater, Surface Water, and Sediment Sampling (cont)	Other	▪ Always using a seat belt while driving on military/government facilities. Always observe posted speed limits, traffic signs and signals. Never using a cell phone or two way radio while driving on military/government facilities. Violating these rules may result in loss of military/government facility driving privileges. ▪ Shut down operations in heavy rain and lightning. Seek safe haven in a grounded structure or vehicle. Implement 30 – 30 rule. ▪ Buddy System maintained for all phases of work. ▪ Base Emergency Dispatch numbers programmed into cellular phones. Have hospital route maps readily available. ▪ Report all unsafe conditions and acts, injury/illness or property damage to supervisors immediately.	NA

EQUIPMENT REQUIRED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Fire extinguisher Eye wash (small portable type) • Miscellaneous power and manual hand tools. • First Aid/BbPK/CPR shield • extension chords • Sample coolers, containers and equipment • Air Monitoring Equipment (section 6.0 of HSP)	• Visual Inspections of designated work areas identify and address hazardous conditions. • Equipment inspections and maintenance. • Inspections of hand tools (power) and extension cords if used.	• Review AHA with all task personnel • Review Site Specific Health and Safety Plan • 1st Aid/CPR (two people on-site) • Supervisors, SSHO - BBLPS, SC-HW (29CFR1910.120(e)(4) • All - Training and medical surveillance in accordance 29CFR1910.120 (HAZWOPER)

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Site Personnel:	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

AHA Prepared By: Josh Painter

Attachment 8
Pre-Task Safety Plan (Example Only)

AGVIQ ENVIRONMENTAL SERVICES
CH2M HILL JOINT VENTURE

EXAMPLE ONLY

DAILY PRE-TASK SAFETY PLAN (PTSP)

Project:_____Location: NAS Brunswick Site 26_____ Date:_____

Site Safety and Health Officer: _____ Job Activity: _____Site #:_____

Task Personnel:

List Tasks:
Well gauging and sampling

Tools/Equipment/Materials required (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools, cords, generators, compressed gases, regulated chemical products, etc.):
Generators, sampling equipment, coolers/glass ware

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (Check all that apply):

_X_ Chemical burns/contact Dermal protection (hands), eye protection. See HSP for PPE requirements per task.	__ Trench, excavations, cave-ins	__Ergonomics
__ Pressurized lines/equipment	X_ Overexertion Work/break regiment as dictated by task. Maintain fluid intake for hydration	_X_ Chemical splash Use PPE in accordance with HSP. Protect hands from splash during decon. activities.
_X_Thermal burns Watch for warm engine/muffler components on generators.	__ Pinch points	X Poisonous plants/insects Review HSP for identification of poisonous snakes in the geographic area. Long sleeves in areas where poison ivy, sumac or oak may exist. Use insect repellent. Tape pant legs to boots (ticks).
X_ Electrical GCF Is for generators, Inspect and protect extension cords, Cords rated for use and have 3rd wire grounding	X_Cuts/abrasions Do not use razor knives. Cut away from body. Identify and avoid rusty/jagged or sharp surfaces from aboveground features (brush, pipe chases/supports, utility structures, doors)	X Eye hazards/flying projectile Use eye protection at all times. Ensure head protection is used in areas where heavy brush, trees, thorns, vines exist when accessing well heads.
X_ Weather conditions Foul and cold weather clothing as dictated by expected conditions	X Spills Use funnels and nozzles during fueling of generators.	__ Inhalation hazard
__Heights/fall> 6'	__ Overhead Electrical hazards	X **Heat**/cold stress Work/break regiment as dictated by heat exposure Provide sufficient fluids for employee intake. Recommended employees begin with 16 oz. of water before initiating field work.
X_Noise Use hearing protection in loud work environments	__ Elevated loads	__ Water/drowning hazard
X_Explosion/fire Metal safety cans for fuel storage, No open flame, sparks ignition in hazardous/flammable/ combustible storage areas. Let engine surfaces cool before fueling.	X_ Slips, trip and falls Exercise good general housekeeping practices Identify/remove slip/trip falls hazards in work area. Watch for and avoid holes, ground protrusions. Watch for entanglement of feet around vines and brush.	__ Heavy equipment
X_ Radiation Solar. UV protection on skin and UV eye protection. ANSI rated safety eye protection only.	X_Manual lifting >50 lbs or awkward loads, get assistance. If employee not capable of lifting 40 lbs. seek assistance.	__ Aerial lifts/platforms
__ Confined space entry	__Welding/cutting	__ Demolition

Continue on page 3 of 3 (if necessary)

Hazard Control Measures (Check all that apply):

PPE	Protective Systems	Fire Protection	Electrical
X_ Head protection	__ Locate buried utilities	__ Fire extinguishers	__ Lockout/tagout
__ Face protection	__ Competent person	__ Fire watch	__ Grounded
X_Hard toe work boots	__ Daily inspections	__ Non-spark tools	__ Panels covered
__ Thermal/lined	__ Sloping	__ Grounding/bonding	X_GFCI/extension cords
X_ Eye	__ Shoring	__ Intrinsically safe equipment	__ Power tools/cord inspected
X_Dermal/hand	__ Trench box	__Combustible materials storage	__Insulated tools/gloves
__ Hearing	__ Barricades	__Chemical Storage	
__ Respiratory			
X__Reflective vests			
Fall Protection	**Air Monitoring**	**Proper Equipment**	**Welding and Cutting**
__ Harness/lanyards	__ PID/FID	__ Aerial lift/ladders/scaffolds	__ Cylinders secured/capped
__ Adequate anchorage	__ Detector tubes	__ Forklift/ heavy equipment	__ Cylinders separated/upright
__ Guardrail system	__ Radiation	__ Backup alarms	__ Flash-back arrestors
__ Covered opening	__ Personnel sampling	__ Hand/power tools	__ No cylinders in CSE
__ Fixed barricades	__ LEL/O2	__ Crane w/current inspection	__ Flame retardant clothing
__ Warning system	__ Other	__ Proper rigging	__ Appropriate goggles
		__ Operator qualified	
Confined Space Entry	**Medical/Emerg. Response**	**Heat/Cold Stress**	**Vehicle/Traffic**
__ Isolation	X_ First-aid and BBP kit	X_Work/rest regime	__ Traffic Awareness
__ Air monitoring	X_Eye wash	X_ Rest area	__Traffic control
__ Trained personnel	X_FA-CPR training	X_Liquids available	__ Barricades
__ Permit completed	X_Route to hospital	X_Monitoring	__ Flags
__ Rescue provisions		__ Training	__ Signs
Permits	**Demolition**	**Inspections**	**Training**
__ Hot work	__ Pre-demolition survey	__ Ladders/aerial lifts	X_ Hazwaste
__ Confined space	__ Structure condition	__ Lanyards/harness	__ Construction
__ Lockout/tagout	__ Isolate area/utilities	__ Scaffolds	__ Equipment
__ Excavation	__ Competent person	__ Heavy equipment	__ Competent person
__ Demolition	__ Hazmat present	__ Cranes and rigging	X_Task-specific (AHA)
__ Energized work		__ Other per Field Safety Plan	X_ Hazcom
__Local/Environmental			

FieldNotes:_____

Additional Space for Project Specific Hazard Awareness (if necessary):

1) Observe government/vehicles while on government/military facilities
2) Do not use cell phones or two-way radios while driving or actively operating equipment on government/military facilities. Failure to do so may result in loss of driving privileges on government/military facilities.
3) Report all accidents/injuries and property damage to the Project Manager and HSPA immediately.
4) Maintain hospital route maps in site vehicles. Know facility EMS, Fire and Security dispatch #s.
5) Secure any loads to hauling vehicle (pick-up truck) with appropriate rated tie down straps.
6) Use reflective vests/ high visibility clothing in high traffic areas or in areas were material handling operations are occurring.

Attendees:

Name (Printed):	Signature:

Meeting Conducted By:

Name Printed Signature

Attachment 9
Loss Prevention Observation (LPO) Form

Loss Prevention Observation Form		
Project:	Observer:	
Position/Title of worker observed:	Background Information/comments:	
Task/Observation Observed:		Date:

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM/Site Manager support facilitates eliminating/reducing hazards (material/personnel resources)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	**Consistent w/ H&S Program**	**Not Consistent w/ H&S Program**	**Observations/Comments**
Current & accurate Pre-Task Planning/Briefing (Project safety plan, AHA, PTSP, tailgate briefing, c., as needed)			**Positive Work Practices Observed:**
Personnel properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Actions/Comments:**
Pace			
Uncomfortable position			
Inconvenient location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

Attachment 10
Loss/Near Loss Incident Report Form

Incident Report Form

Type of Incident (Select at least one)

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

General Information (Complete for all incident types)

Preparer's Name: _____ Preparer's Employee Number: _____

Date of Report: _____ Date of Incident: _____ Time of Incident: _____ am/pm

Type of Activity (Provide activity being performed that resulted in the incident)

- ☐ Asbestos Work
- ☐ Confined Space Entry
- ☐ Construction Mgmt- Haz Waste
- ☐ Construction Mgmt - Non-Haz Waste
- ☐ Demolition
- ☐ Drilling-Haz Waste
- ☐ Drilling-Non Haz Waste
- ☐ Drum Handling
- ☐ Electrical Work
- ☐ Excavation Trench-Haz Waste
- ☐ Excavation Trench-Non Haz
- ☐ Facility Walk Through
- ☐ General Office Work
- ☐ Keyboard Work
- ☐ Laboratory
- ☐ Lead Abatement
- ☐ Motor Vehicle Operation
- ☐ Moving Heavy Object
- ☐ Other (Specify) _____
- ☐ Process Safety Management
- ☐ Tunneling
- ☐ Welding
- ☐ Wetlands Survey
- ☐ Working from Heights
- ☐ Working in Roadways
- ☐ WWTP Operation

Location of Incident (Select one)

- ☐ Company Premises (identify location): _____
- ☐ Field (Project #: _____ Project/Site Name: _____ Client: _____)
- ☐ In Transit (Traveling from: _____ Traveling to: _____)
- ☐ At Home

Geographic Location of Incident (Select region where the incident occurred)

- ☐ Northeast
- ☐ Southeast
- ☐ Northwest
- ☐ Southwest
- ☐ Corporate
- ☐ Canadian
- ☐ Asia Pacific
- ☐ Europe Middle East
- ☐ Latin America

If an AGVIQ-CH2M HILL subcontractor was involved in the incident, provide their company name and phone number: _____

Describe the Incident (Provide a brief description of the incident): _____

_____

_____

•

Injured Employee Data (Complete for Injury/Illness incidents only)

If AGVIQ-CH2M HILL employee injured

Employee Name: _____ Employee Number: _____

If AGVIQ-CH2M HILL Subcontractor employee injured

Employee Name: _____ Company: _____

Injury Type

- ☐ Allergic Reaction
- ☐ Amputation
- ☐ Asphyxia
- ☐ Bruise/Contusion/Abrasion
- ☐ Burn (Chemical)
- ☐ Burn/Scald (Heat)
- ☐ Cancer
- ☐ Carpal Tunnel
- ☐ Concussion
- ☐ Cut/Laceration
- ☐ Dermatitis
- ☐ Dislocation
- ☐ Electric Shock
- ☐ Foreign Body in eye
- ☐ Fracture
- ☐ Freezing/Frost Bite
- ☐ Headache
- ☐ Hearing Loss
- ☐ Heat Exhaustion
- ☐ Hernia
- ☐ Infection
- ☐ Irritation to eye
- ☐ Ligament Damage
- ☐ Multiple (Specify) _____
- ☐ Muscle Spasms
- ☐ Other (Specify) _____
- ☐ Poisoning (Systemic)
- ☐ Puncture
- ☐ Radiation Effects
- ☐ Strain/Sprain
- ☐ Tendonitis
- ☐ Wrist Pain

Part of Body Injured

- ☐ Abdomen
- ☐ Ankle(s)
- ☐ Arms (Multiple)
- ☐ Back
- ☐ Blood
- ☐ Body System
- ☐ Buttocks
- ☐ Chest/Ribs
- ☐ Ear(s)
- ☐ Elbow(s)
- ☐ Eye(s)
- ☐ Face
- ☐ Finger(s)
- ☐ Foot/Feet
- ☐ Hand(s)
- ☐ Head
- ☐ Hip(s)
- ☐ Kidney
- ☐ Knee(s)
- ☐ Leg(s)
- ☐ Liver
- ☐ Lower (arms)
- ☐ Lower (legs)
- ☐ Lung
- ☐ Mind
- ☐ Multiple (Specify)
- ☐ Neck
- ☐ Nervous System
- ☐ Nose
- ☐ Other (Specify) _____
- ☐ Reproductive System
- ☐ Shoulder(s)
- ☐ Throat
- ☐ Toe(s)
- ☐ Upper Arm(s)
- ☐ Upper Leg(s)
- ☐ Wrist(s)

Nature of Injury

- ☐ Absorption
- ☐ Bite/Sting/Scratch
- ☐ Cardio-Vascular/Respiratory System Failure
- ☐ Caught In or Between
- ☐ Fall (From Elevation)
- ☐ Fall (Same Level)
- ☐ Ingestion
- ☐ Inhalation
- ☐ Lifting
- ☐ Mental Stress
- ☐ Motor Vehicle Accident
- ☐ Multiple (Specify) _____
- ☐ Other (Specify) _____
- ☐ Overexertion
- ☐ Repeated Motion/Pressure
- ☐ Rubbed/Abraded
- ☐ Shock
- ☐ Struck Against
- ☐ Struck By
- ☐ Workplace Violence

- Initial Diagnosis/Treatment Date: _____

Type of Treatment

- ☐ Admission to hospital/medical facility
- ☐ Application of bandages
- ☐ Cold/Heat Compression/Multiple Treatment
- ☐ Cold/Heat Compression/One Treatment
- ☐ First Degree Burn Treatment
- ☐ Heat Therapy/Multiple treatment
- ☐ Multiple (Specify) _____
- ☐ Heat Therapy/One Treatment
- ☐ Non-Prescriptive medicine
- ☐ None
- ☐ Observation
- ☐ Other (Specify) _____
- ☐ Prescription- Multiple dose
- ☐ Prescription- Single dose
- ☐ Removal of foreign bodies
- ☐ Skin Removal
- ☐ Soaking therapy- Multiple Treatment
- ☐ Soaking Therapy- One Treatment
- ☐ Stitches/Sutures
- ☐ Tetanus
- ☐ Treatment for infection
- ☐ Treatment of 2nd /3rd degree burns
- ☐ Use of Antiseptics – multiple treatment
- ☐ Use of Antiseptics – single treatment
- ☐ Whirlpool bath therapy/multiple treatment
- ☐ Whirlpool therapy/single treatment
- ☐ X-rays negative
- ☐ X-rays positive/treatment of fracture

Number of days doctor required employee to be off work: _____
Number of days doctor restricted employee's work activity: _____
Equipment Malfunction: Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐
Describe how you may have prevented this injury:
_____
_____
_____

Physician Information	Hospital Information
Name: _____	Name: _____
Address: _____	Address: _____
City: _____	City: _____
Zip Code: _____	Zip Code: _____
Phone: _____	Phone: _____

Property Damage (Complete for Property Damage incidents only)

Property Damaged: _____ Property Owner: _____
Damage Description: _____
Estimated Amount: $ _____

Spill or Release (Complete for Spill/Release incidents only)

Substance (attach MSDS): _____ Estimated Quantity: _____
Facility Name, Address, Phone No.:
_____
Did the spill/release move off the property where work was performed?: _____
Spill/Release From: _____ Spill/Release To: _____

Environmental/Permit Issue (Complete for Environmental/Permit Issue incidents only)

Describe Environmental or Permit Issue:
_____
Permit Type:
_____
Permitted Level or Criteria (e.g., discharge limit):
_____
Permit Name and Number (e.g., NPDES No. ST1234):
_____
Substance and Estimated Quantity:
_____
Duration of Permit Exceedance:
_____

Verbal Notification (Complete for all incident types)(Provide names, dates and times)

AGVIQ-CH2M HILL Personnel Notified:
_____
Client Notified:
_____

Root Cause Investigation

This attachment is provided to assist in accessing, completing, and reviewing an incident investigation. It is important to remember the following when conducting an investigation:

Gather relevant facts, focusing on fact-finding, not fault-finding.
Draw conclusions, pitting facts together into a probable scenario.
Determine incident root cause(s), the basic causes why an unsafe act/condition existed.
Develop and implement solutions, matching all identified root causes with solutions.

Documentation
The following should be included in the IRF to document the incident.

Description

Provide a description of the event and the sequence of events and actions that took place prior to the incident. Start with the incident event and work backwards in time through all the preceding events that directly contributed to the incident. The information should identify why the event took place, who was involved, when and where the event took place, and what actions were taken.

Cause Analysis

Using the form and flowchart in this attachment, the root cause of the incident will be determined. This form must be retained in the project and/or regional HS&E files.

Immediate Causes—List the substandard actions or conditions that directly affected the incident. The following are examples of immediate causes:

> ***Substandard Actions*:** Operating equipment without authority; failure to warn; failure to secure; operating at improper speed; making safety device inoperable; using defective equipment; failing to use PPE; improper loading; improper lifting; improper position for task; under influence of alcohol or drugs; horseplay.
>
> ***Substandard Conditions:*** Exposure to hazardous materials; exposure to extreme temperatures; improper lighting; improper ventilation; congestion; exposure to fire and explosive hazard; defective tools, equipment or materials; exposure to extreme noise; poor ventilation; poor visibility; poor housekeeping.

Basic Causes—List the personal and job factors that caused the incident. The following are examples of basic causes:

> ***Personal Factors:*** Capability; knowledge; skill; stress; motivation.
>
> ***Job Factors:*** Abuse or misuse; engineering; maintenance; purchasing; supervision; tools and equipment; wear and tear; work standards.

Corrective Action Plan

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a time frame for completion. Be sure the corrective actions address the causes. For example, training may prevent recurrence of an incident caused by a lack of knowledge, but it may not help an incident caused by improper motivation.

The following are examples of management programs that may be used to control future incidents. These programs should be considered when determining specific corrective actions.

Management Programs: Accident/incident analysis; emergency preparedness; engineering controls; general promotion; group meetings; health control; hiring and placement; leadership and administration; management training; organizational rules; personal protective equipment; planned inspections; program audits; program controls; purchasing controls; task analysis and procedures; task observation.

Loss/Near-Loss Investigation Report Form

Employer Information

Company Name: _____

Project Name: _____ Task Order: _____

Project Location: _____

Task Location: _____

Job Assignment: _____

Preparer's Name: _____ Preparer's Employee Number: _____

Incident Specific Information

Date of Incident: _____ Time of Incident: _____ a.m./p.m.

Location of incident:
☐Company premises ☐Field ☐In Transit ☐Other:_____

Address where the incident occurred: _____

Equipment Malfunction: Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐

Describe any property damage: _____

Specific activity the employee was engaged in when the incident occurred:

_____

_____

All equipment, materials, or chemicals the employee was using when the incident occurred:

_____

_____

Describe the specific incident and how it occurred:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Describe how this incident may have been prevented:

_____
_____
_____
_____
_____
_____
_____
_____

Contributing Factors (Describe in detail why incident occurred):

_____
_____
_____
_____
_____

Date employer notified of incident: _____ To whom reported: _____

Witness Information (First Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code: _____
Phone: _____

Witness Information (Second Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code: _____
Phone: _____

Additional information or comments:_____
_____
_____

A ROOT CAUSE ANALYSIS FORM MUST BE COMPLETED FOR ALL INJURIES AND ILLNESSES OR ACTUAL LOSSES.

COMPLETION OF THE ROOT CAUSE ANALYSIS FORM FOR NEAR LOSSES IS OPTIONAL, AT THE DISCRETION OF THE HEALTH AND SAFETY MANAGER.

Determination of Root Cause(s)

For losses or near losses, the information may be gathered by the supervisor or other personnel immediately following the loss or near loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, to determine the root cause, and to develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must use the Root Cause Analysis Flow Chart to assist in identifying the root cause(s) of a loss. Any loss may have one or more “root causes” and “contributing factors”. The root cause is the primary or immediate cause of the incident, while a contributing factor is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the *person* involved in the loss, his or her peers, or the supervisor should be referred to as “personal factors”. Causes that pertain to the *system* within which the loss or injury occurred should be referred to as “job factors”.

<u>Personal Factors</u>

1. Lack of skill or knowledge, lack of motivation
2. Correct way takes more time and/or requires more effort
3. Short-cutting standard procedures is positively reinforced or tolerated
4. Person thinks there is no personal benefit to always doing the job according to standards

<u>Job Factors</u>

5. Lack of or inadequate operational procedures or work standards.
6. Inadequate communication of expectations regarding procedures or standards
7. Inadequate tools or equipment

<u>Other</u>

8. Uncontrollable Factors *****

The root cause(s) could be any one or a combination of these seven possibilities or some other “uncontrollable factor”. In the vast majority of losses, the root cause is very much related to one or more of these seven factors. * **Uncontrollable factors should be used rarely and only after a thorough review eliminates all seven other factors.**

Root Cause Analysis Form

Root Cause Analysis (RCA)

Root Cause Categories (RCC): Select the RCC numbered below that applies for the root cause (RC) and/or contributing factor (CF) in the first column, then describe the specific root cause and corrective actions in each column.

1. **Lack of skill or knowledge**
2. **Lack of or inadequate operational procedures or work standards**
3. **Inadequate communication of expectations regarding procedures or work standards**
4. **Inadequate tools or equipment**
5. **Correct way takes more time and/or requires more effort**
6. **Short-cutting standard procedures is positively reinforced or tolerated**
7. **Person thinks there is no personal benefit to always doing the job according to standards**
8. **Uncontrollable Factor (Note: Uncontrollable factors should be used rarely and only after a thorough review eliminates all seven other factors.)**

RCC #	Root Cause(s)	Corrective Actions	RC[1]	CF[2]	Due Date	Completion Date	Date Verified

[1] RC = Root Cause; [2] CF = Contributing Factors (check which applies)

Investigation Team Members

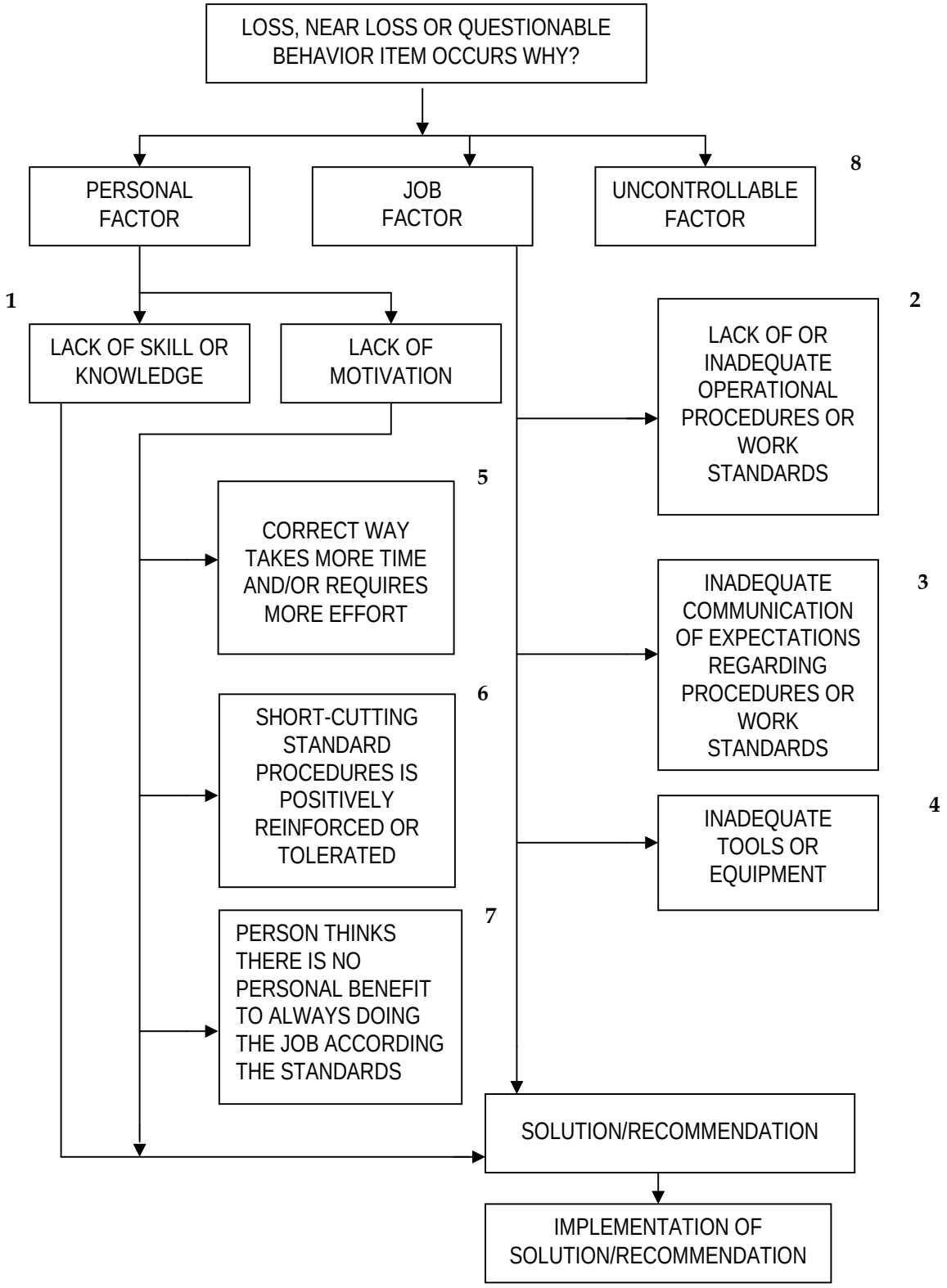
Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date

Root Cause Analysis Flow Chart



Attachment 11
Emergency Contact List

Emergency Contact List

24-hour CH2M HILL Serious Incident Reporting Contact/Pager: 720-286-4911
CH2M HILL 24-hour Nurse Number: 866-893-2514
(See attached instructions *)

Local Brunswick Medical/Fire/Police Emergency **911**	**CH2M HIL- Medical Consultant** WorkCare Dr. Peter Greaney M.D. 300 S. Harbor Blvd, Suite 600 Anaheim , CA 92805 800-455-6155 714-978-7488 (After hours calls will be returned within 20 minutes) **AGVIQ Medical Consultant(s)** Refer to AQVIQ VBO office for a detailed list of Medical Facilities/contacts.
AGVIQ-CH2M HILL Program Manager Name: Sidney Allison AGVIQ Phone 843-242-8018 (o); 843-813-2672 (cell)	**AGVIQ-CH2M HILL Deputy Program Manager** Name: Michael Halil CH2M HILL – (JXO) Phone: 904-777-4812 x 233/904-219-6277 (cell)) **AGVIQ-CH2M HILL Project Manager** Name: Venky Venkatesh – CH2MHILL (DAY) Phone: 215-640-9391 / 216-235-8613 (cell)
AGVIQ Corporate Human Resources Department Name: Nichola Ruedy TIKIGAQ Corp. Anchorage, AK Phone: (907) 365-6129 / (907) 230-1567 cell	**CH2M HILL Corporate Human Resources Department** Name: Pete Hannon, DEN Phone: 303-771-0900
AGVIQ-CH2M HILL Site Supervisor/Alternate SSHO **AGVIQ-CH2M HILL Site Supervisor** Name: Mike Niebauer – CH2M HILL Phone: (414) 847-0254 **AGVIQ-CH2M HILL HSPA/ SHSO (alternate)** Name: Glen Jackson - AGVIQ Cell Phone: (757) 644 8293 (cell) /(757) 318 9420 X 12	**AGVIQ-CH2M HILL CIH** Name: Angelo Liberatore, CH2M HILL Constructors, Inc. (ATL) Phone: (770) 604 9182/(770) 331-3127 (cell) **AGVIQ-CH2M HILL HSPA** Name: Mark Orman, CH2M HILL Constructors, Inc. (MKE) Phone: (414) 847-0597 / (414) 712-4138 (Cell) **AGVIQ-CH2M HILL SHSO (primary)** Name: Will Knox CH2M HILL Constructors, Inc. (ATL) Phone: 757-671-6280 / 336-457-3094 (cell) **AGVIQ-CH2M HILL SHSO** Name: **Kyle Block – CH2M HILL** Phone: (617) 626-7013
AGVIQ Worker's Compensation & Auto Claims Name: Nichola Ruedy TIKIGAQ Corp. Anchorage, AK Phone: (907) 365-6129 / (907) 230-1567 cell AGVIQ personnel to report all accidents or injuries to AGVIQ Corporate HSM or HSO immediately but no later than 24 hrs. Fatalities and hospitalizations shall require immediate notification to AGVIQ Corporate HSM.	**CH2M HILL Worker's Compensation & Auto Claims** Sterling Administration Services Phone: 800/420-8926 After hours: 800/497-4566 Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars. Fatalities and hospitalizations shall require immediate notification to JV CIH/HSPA.
AGVIQ Corporate HSM Name: Troy Izatt – Office phone # (907) 365-6182 Cell phone # (907) 947-6851	**Federal Express Dangerous Goods Shipping** Phone: 800/238-5355 **Emergency Number for Shipping Dangerous Goods** Phone: 800/255-3924

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms: Sound vehicle horn three times	**Evacuation Assembly Area(s):** Outside of club house, or local hotel where field team is staying

Facility/Site Evacuation Route(s): Developed site specific on-site prior to start of work

Hospital Name/Address: See site Specific Hospital Route Maps for emergency contact information.

* Emergency Nurse Assistance Instructions
(CH2M HILL personnel only)

- After informing their supervisor (AGVIQ-CH2M HILL Project Manager and/or AGVIQ-CH2M HILL Deputy Program Manager), the injured employee calls CH2M HILL's contracted Occupational Nurse.

24-hour CH2M HILL Emergency Nurse Assistance

1-866-893-2514

- The Occupational Injury Nurse listens to the injured employee to understand the injury/illness.
- Employee is provided guidance on appropriate treatment options (triage).
- If instructed to visit a medical facility by the Occupational Injury Nurse, the Supervisor is responsible for instructing the injured employee to take a copy of the **CH2M HILL Initial Medical Treatment Form (Attachment # 11– For Use by CH2M HILL Personnel Only)** with them to the physician, clinic or hospital.
- Appropriate treatment details are handled by the Occupational Injury Nurse, and Workers Compensation Groups.
- Nurse communicates and troubleshoots with and for employee through full recovery
- Upon any project incident (fire, spill, injury, near miss, death, etc.), immediately notify the AGVIQ-CH2M HILL PM (overall) and AGVIQ-CH2M HILL HSPA. Call emergency beeper number if HSM is unavailable.
- For work-related injuries or illnesses to CH2M HILL personnel, contact and help Human Resources administrator complete a HITS (Hours and Incident Tracking System) Form. HITS must be completed within 24 hours of incident.
- For AGVIQ-CH2M HILL subcontractor incidents, complete the Incident Report Form (IRF), Near Loss Investigation Report and Root Cause Analysis and submit to the AGVIQ-CH2M HILL PM and HSM.

To be completed by CH2M HILL Supervisor – Send with employee visiting medical facility or forward within 24 hours.

Employee name: _____Date of Injury:_____
Supervisor: _____ HS Representative:_____
Visit Authorized by: _____Phone #;_____

CH2M HILL Workers Compensation Administrator: Cambridge
Send Bills to: CH2M HILL
Attn: Jennifer Rindahl
P.O. Box 22508
Denver, Colorado 80222-0508

To be completed by medical provider:

Physician's name: _____ Phone #: _____
Address:
_____
CH2M HILL employee: _____ has been treated for:_____

It is the policy of CH2M HILL to provide temporary modified duty whenever possible for employees with physical restrictions resulting from an occupational injury or illness.

☐ Released to full duty

☐ Released to restricted duty only (list restrictions below)

☐ Out of work until _____(date)

Please list any physical restrictions:
_____
_____

Expected duration of restricted duty?
_____

CH2M HILL would like the best and most efficient care extended to all our employees. Please recommend over-the-counter (OTC) medication as a suitable alternative when medically feasible.

☐ Prescribed medication:_____

☐ Recommended OTC alternative:_____

Date of follow-up
appointment:_____

Physician's signature: _____ Date: _____

Please return this form to the injured employee and FAX to Health Resources at 1-800-853-2641. If you want to discuss the employee's work restrictions, please call the person listed in the "Visit Authorized by" field.

Attachment 12
Hurricane Preparedness Plan

(Reserved)

ATTACHMENT B

Field Standard Operating Procedures

STANDARD OPERATING PROCEDURE 01

Note Taking and Field Logbook

Purpose

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording field and sampling information in a field logbook.

Scope

Data generated from the use of this SOP may be used to support the following activities: site characterization, risk assessment, and future long-term monitoring.

Equipment and Materials

- Field logbook
- Indelible black ink pen
- Write-in-the-rain pen (for extreme weather conditions—cold/rain)

Procedures and Guidelines

All information pertinent to a field or sampling effort will be recorded in a bound field logbook that will be initiated at the start of the first onsite activity. The field logbook will consist of a bound notebook with consecutively numbered pages that cannot be removed. The outside front cover of the logbook will contain the project (site) name and the specific activity (e.g., groundwater-surface water interface sampling). The inside front cover will include the following:

- Project name
- Project number
- Project manager's name and mailing address
- Sequential logbook number
- Start date and end date of logbook

Each page will be consecutively numbered, dated, and initialed. All entries will be made in indelible black ink, and all corrections will consist of line-out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include the following:

- Time of arrival and departure of site personnel, site visitors, and equipment
- Instrument calibration information, including make, model, and serial number of the equipment calibrated
- Description of significant activities for the day

- Documentation of photographs taken during field activities (e.g., date, time, and description of photograph)
- Field observations (e.g., sample description, weather, unusual site conditions or observations, sources of potential contamination, etc.)
- Detailed description of the sampling location, including a sketch when necessary
- Details of the sample site (e.g., coordinates [x, y], water elevation [z], casing diameter and depth, integrity of the casing, etc.)
- Sampling methodology and matrix, including distinction between grab and composite samples
- Names of field team members and subcontractors
- Start or completion time of sample collection activities
- Field measurements (e.g., water depths, sediment probe depths)
- Type of sample (e.g., pore water, groundwater, surface water, sediment)
- Number, depth, and volume of sample collected
- Field sample number
- Requested analytical determinations
- Sample preservation
- Quality control samples associated with the sample
- Sample shipment information including chain-of-custody (CoC) form number and laboratory, carrier, date, and time
- Health and safety issues (including level of personal protective equipment [PPE])
- Signature and date by personnel responsible for observations

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The field team leader will keep a master list of all field logbooks assigned to the sampling crew.

Attachments

None.

Key Checks and Items

None.

STANDARD OPERATING PROCEDURE 02

Utility Clearance for Intrusive Operations

Purpose

This document describes the utility mark-out/clearance process to be followed prior to completing any intrusive subsurface activities.

Scope and Applicability

This document describes the utility mark-out/clearance process to be followed by AGVIQ-CH2M HILL prior to any intrusive activities. The document discusses steps that must occur prior to mobilizing and steps that must occur during intrusive work.

This document should be reviewed by the field project team prior to working in the field. In addition, this document should be used to develop scopes of work (SOW) for utility clearance subcontractors.

Procedures / Guidelines

Prior to Mobilizing to the Field

Prior to mobilizing to perform intrusive work, Maine One Call, Dig Safe, must be called and utility companies must mark out their utility lines.

Public Utilities

Maine Dig Safe System Inc. (1-888-344-7233) **must** be notified and a locate ticket issued and completed prior to intrusive activities. The **Attachment** to this SOP provides the instructions for submitting an online quick-ticket through Dig Safe System, Inc.

The proposed areas where intrusive work will be performed should be pre-marked by AGVIQ-CH2M HILL. All public utilities in the area where intrusive work is to be performed should be marked out on the ground by the utility locator using the American Public Works Association (APWA) Uniform Color Code (Attachment 2).

Utility locates are good for 60 calendar days, including the day the call was made. The person(s) or company performing the intrusive activities (i.e. drilling subcontractor) is responsible for completing the public utility locates. For more information, visit the website at http://www.digsafe.com/.

Private Utility Clearance

Private utilities must be cleared as follows:

1. The location(s) where intrusive work will occur should be pre-marked by CH2M HILL and identified during a site visit with the designated third-party utility locator. It is important to take access issues into consideration while pre-marking.
   - The utility locator should clear an area for intrusive work. Additional area (if possible) to be cleared by the utility locator is based on the work to be performed. At locations where utilities are congested, the boring location only will be cleared. (i.e., only an "X" will be cleared). At other locations that are less congested with utilities, a 3-foot radius around the boring location may be cleared. This will be communicated on the utility clearance signoff sheet by the private utility locator.
2. The area that is cleared by the utility locator for intrusive work should include the marking of all utilities in the immediate area (at least a 10-foot buffer around the cleared area). If it is not possible to mark utilities, then a figure should be provided that will show the field team exactly where these utilities are located.
3. A utility clearance signoff sheet will be provided to AGVIQ-CH2M HILL after all areas, where intrusive work will be completed, have been cleared. The sign-off sheet will document the location of all underground utilities and obstructions in the immediate area of the intrusive work. If the utilities could not be marked out on the ground, then a figure showing their location(s) should be provided with the signoff sheet.
4. The utility clearance is applicable for a 60-day period. Any intrusive work conducted after this 60-day period requires a new utility clearance.

Prior to Intrusive Work

The following should be completed before commencing intrusive work:

1. Verify that all public utility companies have identified the presence of utilities with marking paint or have provided a response back indicating the absence of utilities in the area. To verify what the utility markings on the ground indicate, use the color code in Attachment 1 (for public utilities). **If utilities have not been marked or a negative response has not been confirmed, do not perform intrusive work in that area. Contact the appropriate companies to come out to mark their utility line or verify that they have no utility lines in that area. The following website has a list of contacts: http://www.digsafe.com/memberinfo_members.php**
2. Review the utility clearance signoff sheet to verify that the location has been cleared for intrusive work if private utilities are present. Also, review the markings on the ground and compare this against the document provided by the utility locator that indicates the utilities in the area. **If markings are missing or the signoff sheet or figure provided indicates that cleared areas contain utilities, do not perform any intrusive work until the utility locator has been contacted and has marked the missing utility line(s) or evaluated whether the cleared area contains utilities.**
3. Review the utility clearance documentation with the subcontractor during the tailgate meeting.
4. Use other methods to identify utilities if there are numerous utility lines around the area and/or lines that cannot be clearly located where intrusive work is to be performed. If

possible, hand digging or hand augering will be performed down to 5 feet below ground surface (bgs). Another method would involve the use of an air knife to bore 5 feet bgs with the use of high pressure air that would not damage any utilities encountered.

5. Intrusive work can only be performed in the cleared area. If intrusive work needs to be performed outside of the cleared area, the appropriate utility locator(s) must clear the new location. If the new area cleared involves private utilities, an addendum to the initial utility clearance signoff sheet should be provided.

6. While performing intrusive work, monitor for signs of an encounter with a utility line. These signs include encountering fill material such as gravel, sand, or other fill material; warning tape; plastic; or metal. If it is believed that a utility was struck stop work, call the appropriate personnel, and document in the field book.

7. If refusal occurs while boring and it is believed **not** to be related to a utility, then advancement will be tried up to two more times within cleared area (only applies to locations where the boring and a 3-foot radius was cleared). If the same refusal is observed, then the location will be abandoned.

Attachment 1 – Quick-Ticket Guidelines

Dig Safe System, Inc.

Quick-Ticket Guidelines

Welcome to Online Ticket Entry!

Quick-Ticket is a free program allows you the convenience of applying for Dig Safe tickets online, without the aid of a Customer Service Representative. Quick-Ticket offers

- Immediate processing from your own PC.
- Available 24/7.
- Ideal for multiple tickets. Information from your first ticket is carried over to the next, saving time.
- Print a confirmation for easy record keeping.

Important:

As with any new program, you must understand the system before becoming proficient at Quick-Ticket entry.

Please read these guidelines before attempting to enter your first Dig Safe permit online.

These step-by-step instructions guide you through each data field, saving you time and hassles later on.

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Things to Know Before Starting

1. Quick-Ticket Does Not accept

- **Work that extends beyond 1320' (one quarter mile) from the street address, intersection or lat/long coordinates given.** If the work is beyond 1320', you must apply for the ticket by phone at 888-DIG-SAFE, so a Customer Service Representative can draw out the parameters of your work accordingly. See "Buffer" on page 15.
- **New Streets, Developments, Sub-divisions and Condo Complexes** – Contact us at **888-DIG-SAFE or 811** for locations that are not reflected on our digital map. Our Customer Service Representative must draw out these types of locations to notify the appropriate utilities.
- **Emergency Tickets –** Quick-Ticket only accepts scheduled excavation notices. You must call **888-DIG-SAFE or 811** to request an Emergency Dig Safe permit.
- **Blasting and 'State Permit Only' tickets-** Quick-Ticket can only process standard excavation permits.

2. New Google Map Feature

Quick-Ticket now includes a new map feature that allows you to see the area that you enter into the system.

After you enter the location information, a pink highlighted area appears on the map. This pink area represents where our system will search for member utility companies to notify for your markout.

Please understand that these highlighted areas are for Dig Safe's purposes only. It is a tool that enables us to identify the utility companies that need to be notified.

.

Your dig location must be located within the pink area. However, you must still describe the scope of your job with your written description on the ticket, and with your premarks at the job site.

3. Incorrect Address or Location

- If you process a ticket with the wrong location, please contact the center at **888-DIG-SAFE or 811** right away. The ticket must be cancelled before you process a new one.
- Dig Safe reserves the right to revoke a Quick-Ticket password if a user repeatedly enters tickets with missing or inaccurate information.

4. Live Support

- If you're having trouble, we're here to help. For live support, call 877-DIG-SAFE Monday through Friday between 6:00 am and 6:00 pm.

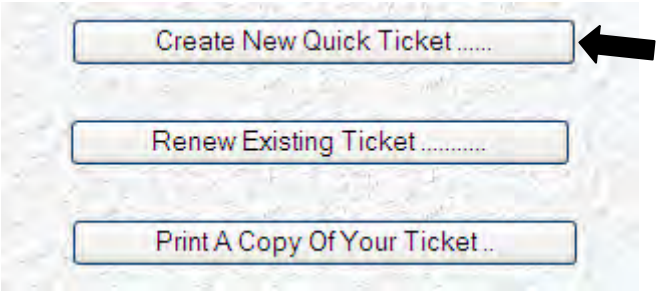
Step by Step Instructions for Quick-Ticket Entry

1. **Log On:**

   - Go to digsafe.com, click on Quick-Ticket, and then click on Quick-Ticket Options.
   - Bookmark this page if you plan to use this program often.

2. **Choose Function:**

   - On the Online Options Menu, choose Create New Quick-Ticket.

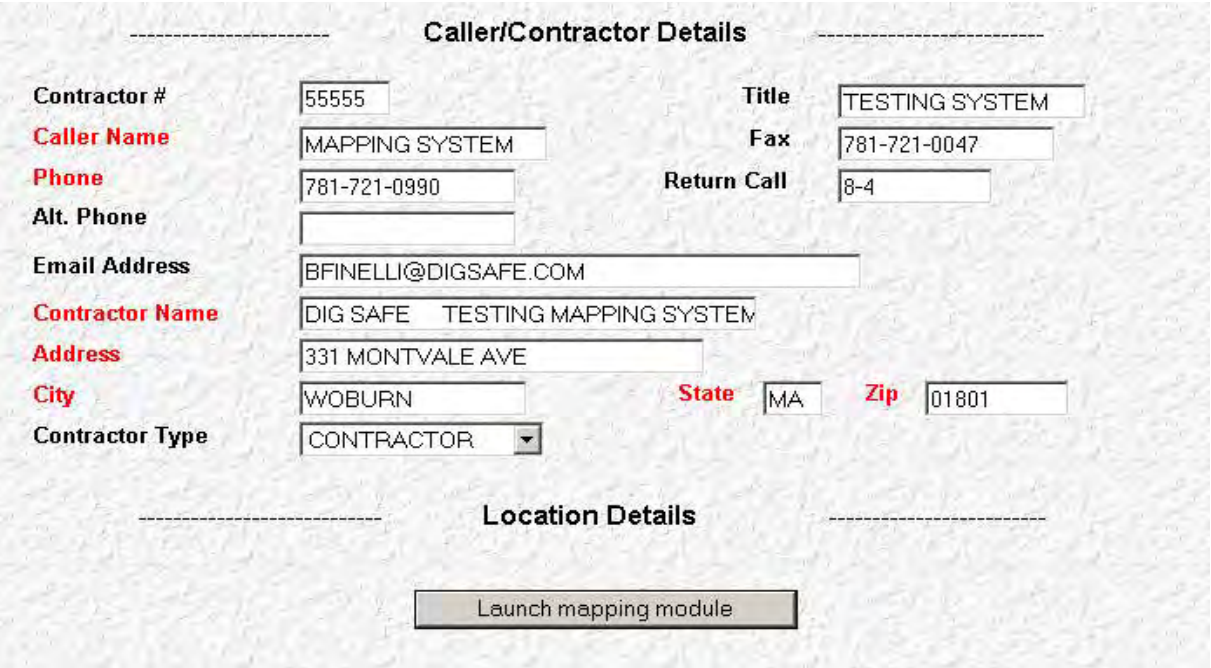


3. Enter Password:

- If you don't have a Quick-Ticket password, go to digsafe.com and click on Quick-Ticket Password to apply.
- Enter your Quick-Ticket password, and click Verify.
- Your password is upper and lower case sensitive.
- After you verify your password, the Quick-Ticket entry screen appears.

4. Caller/Contractor Details:

- Getting tickets is easier when you use your contractor ID number. If you don't have one, apply by going to digsafe.com, and click on Contractor ID Number. Or, apply by phone at 888-DIG-SAFE or 811.
- If you don't have a Dig Safe contractor ID number, manually fill in the fields under the heading Caller/Contractor Details.
- Enter your contractor ID number in the appropriate field, then tab to the next field.
- Your ID number should occupy the fields for your company name, mailing address, phone number, fax number, alternate number and email address.
- Manually enter in the information for any blank fields.



5. Click **Launch mapping module.** This will initiate the **Location Details** screen.

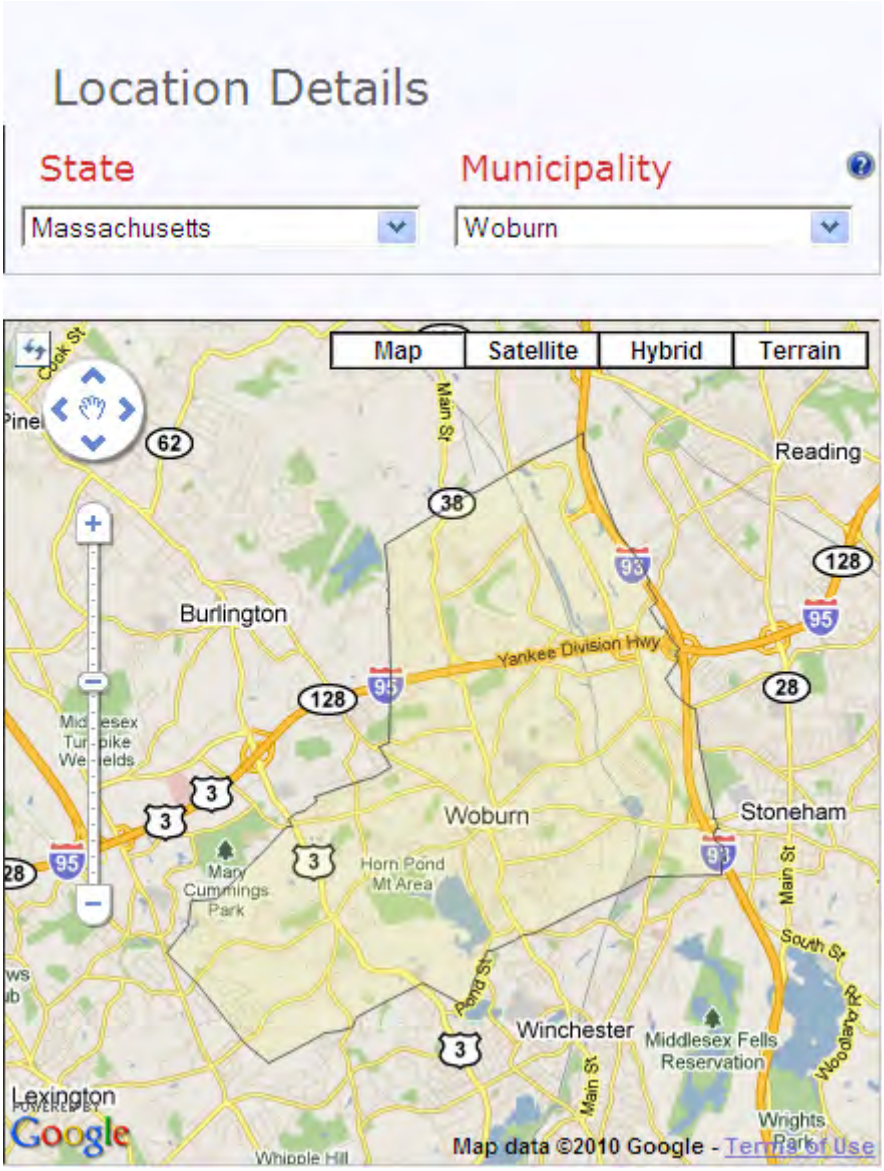
- Mouse click to advance to each field.
- All items in red are required fields.

6. State/Municipality:

- Click on the scroll arrow to choose the **state** where the work will take place.

- Click on the scroll arrow to choose the **municipality** where the work will take place.

- The city or town or city you entered is now displayed on the digital map.
- Example here is Woburn, MA.



7. Latitude/Longitude (optional)

It is easy to apply for Dig Safe permits using latitude and longitude coordinates. You may capture this information by using one of the many free online map programs now available (i.e. Google maps, Yahoo maps).

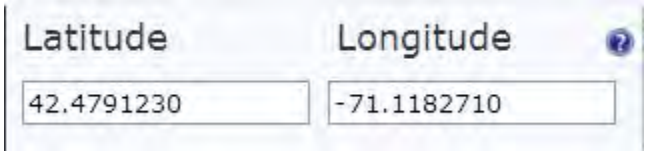
And, many modern devices also provide coordinates, such as mobile phones, digital watches, vehicle navigation systems, and hunting and fishing equipment.

- If you do not have lat/long coordinates, leave these fields blank and advance to the **Address/Intersection field**.
- When using lat/long coordinates to describe a dig location, you are covered for that one specific location only. If you plan to work beyond this point, you must expand this location using the buffer tool. See "Buffer" on page 15.
- If your work extends beyond one quarter mile (or 1320') of the coordinates you entered, you must apply for your ticket by phone at 888-DIG-SAFE or 811 so that a Customer Service Representative may draw out your excavation parameters accordingly. See "Buffer" on page 15.
- Lat/Long coordinates are used to determine the member utilities that should be notified. You must also provide a description of the job location in the **Additional Information** field to help the locators in the field to find your job site.

Occupy both latitude and longitude fields using **<u>one of the two acceptable</u>** formats:

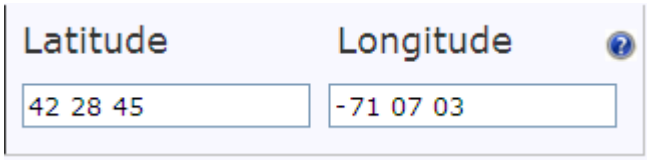
a. True Decimal Degrees:

- For Latitude and Longitude: Enter the first two digits, then a decimal point, then enter up to seven digits.



b. Degrees, Minutes, Seconds (DMS):

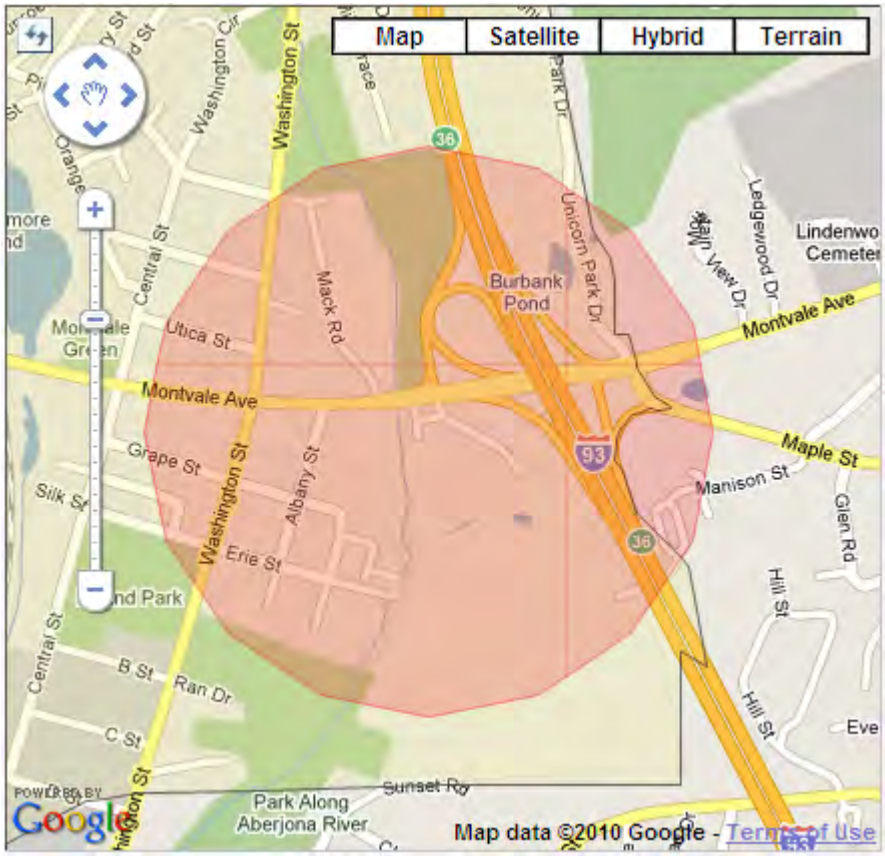
- For Latitude and Longitude: Enter two digits, then hit the space bar. Enter another two digits, followed by another space. Enter the last two digits.



- Click to the next field. The area of the X/Y coordinates now appears on the digital map.

- The pink highlighted area you see on the map represents the area on the ground where our system searches for member utility companies to notify, plus Dig Safe's inherent 500' buffer.

- This pink highlighted area DOES NOT define the parameters of your excavation location. The work location must still be defined in words in the **Address/Intersection** field, the **Additional Information** field, and with your pre-marks on the jobsite.



- After entering lat/long coordinates in appropriate fields, click to the Address/Intersection field.

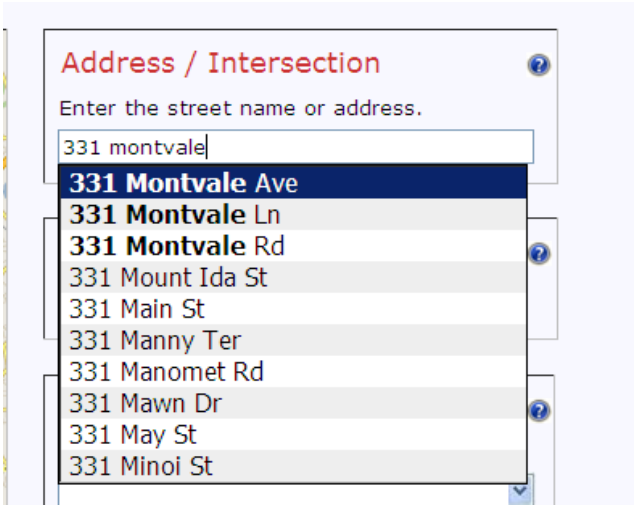
7. Address / Intersection:

- This field must be occupied. Quick-Ticket will not process the ticket if left blank.
- Interstate route numbers should be entered as: **I 95, I 495**
- Remember that Quick-Ticket may not recognize new streets and subdivisions. You must call 888-DIG-SAFE or 811for locations that are not reflected on our digital map. A Customer Service Representative must draw out these types of locations on the digital map to notify the appropriate utilities.

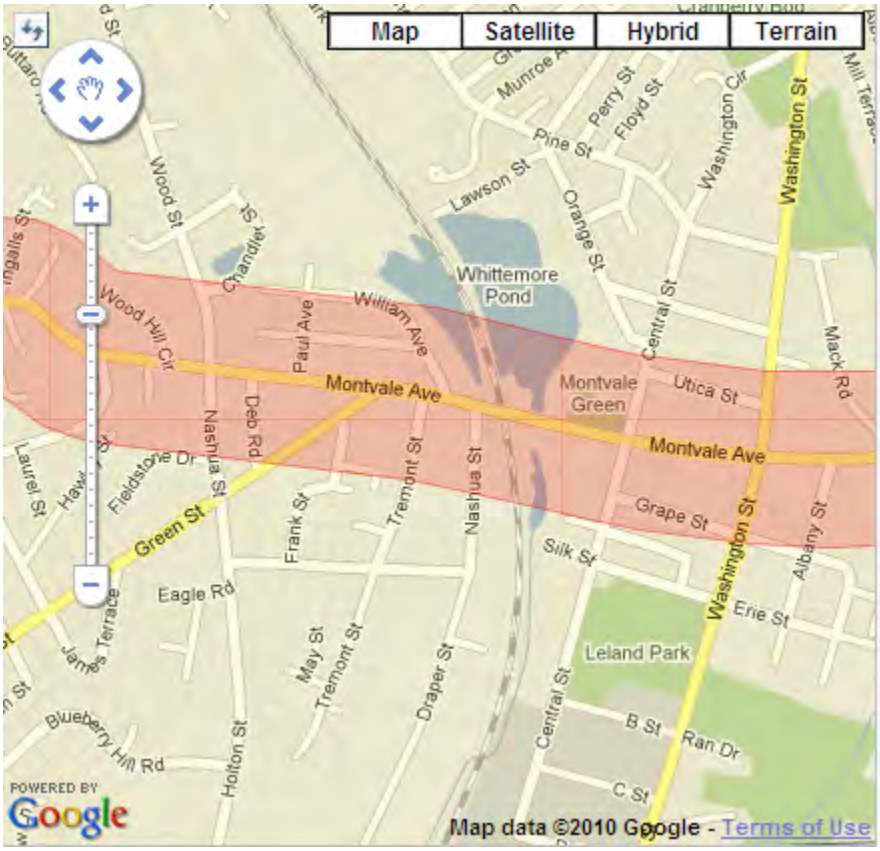
Recommended Methods to Describe a Dig Location:

a. **Address:** (i.e. 331 Montvale Ave)

- As you type the address, a drop-down box will appear. Point and click to the correct address, or type it in manually.



- Click to the next field. The area of the address you entered now appears on the digital map.

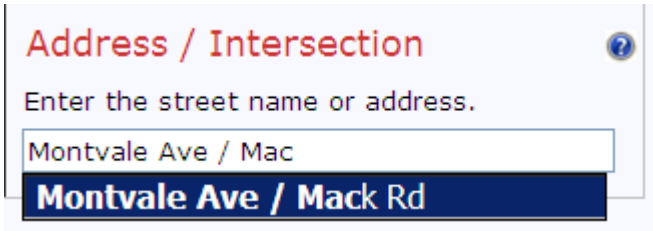


- The pink highlighted area you see on the map represents the area where our system searches for member utility companies to notify, plus Dig Safe's inherent 500' buffer.

- This pink highlighted area DOES NOT define the parameters of your excavation location. The work location must still be defined in words in the Address/Intersection field, the Additional Information field, and with your pre-marks on the jobsite.

b. Intersection

- When entering an intersection in the Address/Intersection field, the two street names must be separated with a forward slash (/).

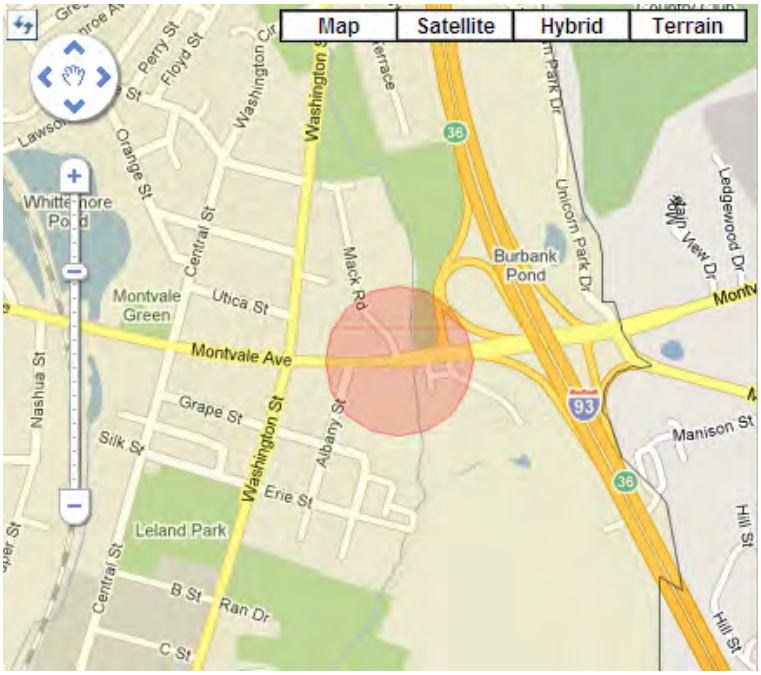


- As you type the intersection, a drop-down box will appear. Point and click to the correct intersection, or type it in manually.

- Do not enter more than two streets when describing an intersection.

- If you enter two streets separated with a forward slash (/) in the **Address/Intersection** field, you are covered only for the area where the two streets meet.

- The intersection you entered now appears on the digital map



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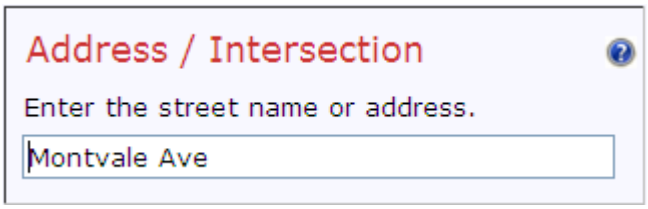
- The pink highlighted area you see on the map represents the area where our system searches for member utility companies to notify, plus Dig Safe's inherent 500' buffer.

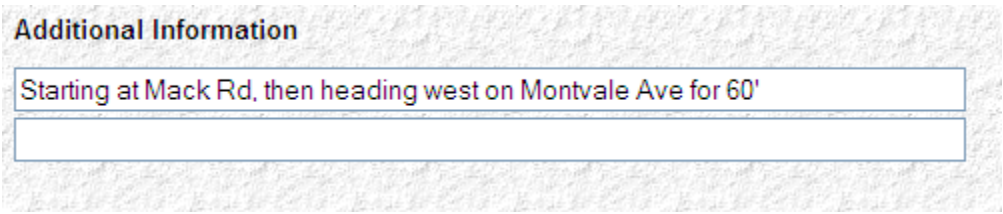
- This pink highlighted area DOES NOT define the parameters of your excavation location. The work location must still be defined in words in the **Address/Intersection** field, the **Additional Information** field, and with your pre-marks on the jobsite.

c. Starting at an intersection and proceeding down either street:

- First enter the name of the street you will proceed down in the **Address/Intersection** field.



- Then, use the **Location Description** field to establish the limits of the excavation area:



- If you plan to work more than 100' down either street from the intersection, you must apply for two separate tickets- one for each street.

The Address/Intersection field <u>DOES NOT RECOGNIZE:</u>

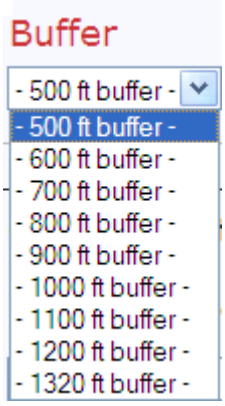
- Place names (i.e. McDonald's, Chevrolet Dealership, Public Library)
- Numbers for poles, mile markers, pedestals, transformers, manholes
- Exit numbers and lot numbers

Although this information is helpful for the utility locators to find your excavation area, this type of descriptive information must be entered in the **Additional Information** field.

If you can't provide a physical address, intersection, or latitude longitude, type in the name of the street in the Address/Intersection field, and then tab to the **Additional Location Information field** to enter the parameters of your excavation job.

8. Buffer:

- Select the furthest point, in feet, you will be digging from the center line of the street(s) entered in the address field, or the GPS coordinates entered in the Latitude/Longitude fields.



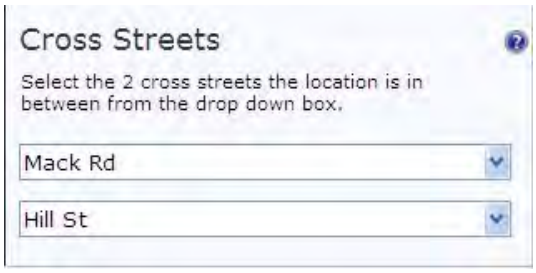
- If no buffer distance is selected, the system will automatically default to 500’t, and it will notify the member utilities companies who have underground facilities within 500’.

9. Cross Streets:

Our goal is to filter out unnecessary notifications to member companies who don't have underground facilities where you plan to dig. We want to notify only those who need to respond and mark out.

Providing the two cross streets allows our system to alert only the companies who have underground lines in that segment of the road, rather than the entire length of the road.

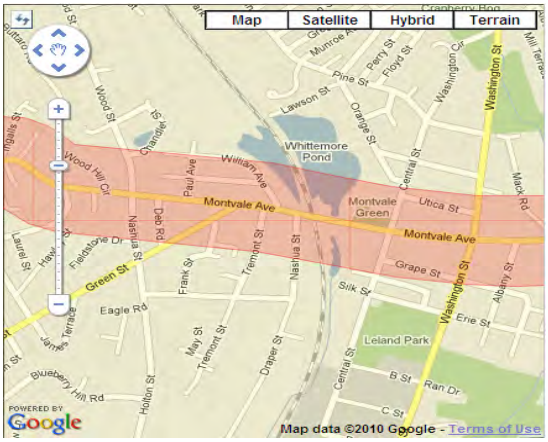
- Choose from the drop down menu to select the two street names that the jobsite is located between.



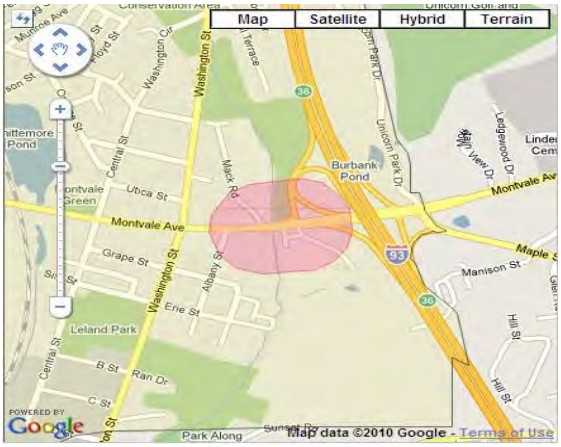
- If two cross streets are chosen, the system will notify the member utilities that have underground facilities between these two streets.
- If no cross streets are chosen, or if only one cross street is chosen, the system will notify the utilities that have underground facilities anywhere for the entire length of the street.

Example: 331 Montvale Ave in Woburn, MA

Without two cross streets



With two cross streets



10. Additional Information:

Examples:

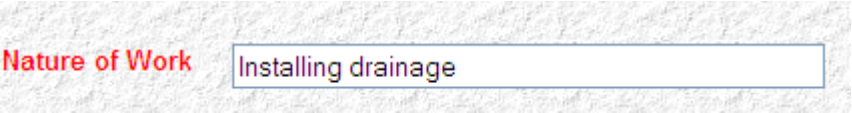
- Place names
- Exit and mile marker numbers on highways
- Manholes, poles, pedestals, or transformer numbers
- Lot numbers
- Distance and direction from a landmark

11. Nature of Work:

Please be specific. Do not enter Trenching, Excavating, or Drilling. Why are you trenching, excavating or drilling? To do what?

Examples:

- **Install** new pole (not 'pole')
- **Replace** water main (not 'water main')
- Foundation **for house addition** (not 'foundation')

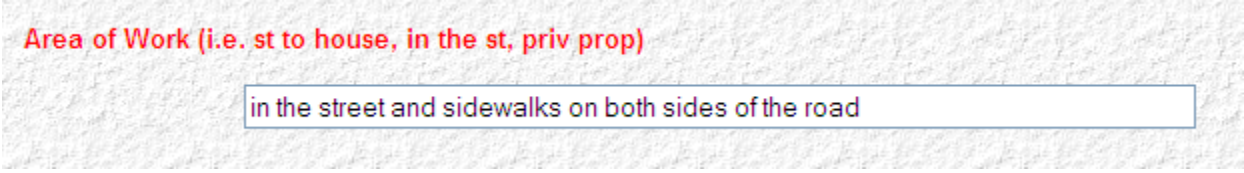


12. Area of Work:

Describe the specific area at the jobsite.

Examples:

- From street to house
- The center of the street
- Sidewalk area
- Entire width of street
- In the back yard on private property



13. Area Premarked:

Premarking is required in Massachusetts, Maine, New Hampshire, Rhode Island and Vermont. Please enter Y for “yes” or N for “no.”

14. Start Date and Time:

Start Date:

- For tickets in Vermont, enter legal start date for 48 business hours in advance.
- For tickets in Massachusetts, Maine, New Hampshire, and Rhode Island, enter legal start date for 72 business hours in advance.
- Enter the start date in the fields using the format shown here:

Weekends and holidays do not count toward your legal start date.

Observed Holidays:

- NEW YEAR’S DAY
- MARTIN LUTHER KING DAY
- PRESIDENT’S DAY
- PATRIOT’S DAY (MA & ME ONLY)
- MEMORIAL DAY
- INDEPENDENCE DAY
- VICTORY DAY (RI ONLY)
- LABOR DAY
- COLUMBUS DAY
- ELECTION DAY (NH ONLY)
- VETERAN’S DAY
- THANKSGIVING DAY
- CHRISTMAS DAY

Start Time:

- Quick-Ticket recognizes only **military time**.
- Time must be entered as **FOUR** digits; two digits for the hour, two for the minutes.

  For Example:

  - 8:00 am = 08:00
  - 1:30 pm = 13:30
  - 3:45 pm = 15:45

- Quick-Ticket uses an internal, real-time clock. Keep in mind that if the actual time is 14:06 (2:06 pm), it will reject an entered start time of 14:00 (2:00 pm) Advance to the next 15-minute increment of the actual time for the ticket to be processed - 14:15 (2:15 pm)

Start Date & Time Examples:

<u>When applying during Dig Safe's operational hours- 6:00 am to 6:00 pm Monday-Friday:</u>

Enter a start date that is 72 business hours in advance from the time you apply.

For Example:

- The location is in Vermont, and it is 4:00 pm. The legal start date is the following Tuesday at 4:00 pm (48 business hours)
- The location is in Massachusetts, and it is 7:00 am. The legal start date is the following Wednesday at 7:00 am (72 business hours)

<u>When applying during off hours- Weekdays from 6:00 pm to 6:00 am; weekends; holidays:</u>

Calculate the start date and time as if you were applying first thing the next business day.

For Example:

- The location is in Rhode Island, and it's after 6:00 pm. Calculate the start date as if you are applying first thing Monday morning at 6:00 am. (72 business hours)
- The location is Vermont, and it is Saturday. Calculate the start date as if you are applying first thing Monday morning at 6:00 am (48 business hours)

15. Excavator Doing Work:

- Enter the name of the company doing the excavation, or “Same” if your company is doing the work.

16. Process Request:

- Click on the **Process Request** button.
- To reset the form, click on the **Reset Form** button.
- For additional help, click on the **Help** button.

17. Confirmation

If the information is entered properly, you receive a confirmation that you should print and leave at the jobsite.

Request Number: 20103206047 **Date** 08/04/2010 **Time** 11:04

Latitude: **Longitude:**

State: MASSACHUSETTS **Municipality:** WOBURN

Address / Intersection: 331 MONTVALE AVE

Nearest Cross Street 1: MACK RD **Nearest Cross Street 2:** HILL ST

Additional Information: THIS IS A TEST TICKET. TESTING THE NEW ONLINE SYSTEM. DO NOT RESPOND TO THIS JOBSITE TO MARK! TEST TICKET!

Nature Of Work: TEST TICKET / DO NOT RESPOND TO MARK

Area Of Work: SEE CANCELLATION NOTICE FOR THIS TICKET

Area Is Premarked: Y **Start Date:** 08/09/2010 **Start Time:** 11:15

Caller: MAPPING SYSTEM **Title:** TESTING SYSTEM **Return Call:** 8-4

Phone#: 781-721-0990 **Fax#:** 781-721-0047 **Alt. Phone#:**

Email Address: BFINELLI@DIGSAFE.COM

Contractor: DIG SAFE TESTING MAPPING SYSTEM

Address: 331 MONTVALE AVE **City:** WOBURN **State:** MA **Zip:** 01801

Excavator Doing Work: SAME

Member Utility List

Code	Abbreviation	Name
NJ	VERIZN	VERIZON
SB	NSTREL	NSTAR ELECTRIC
SC	NGRDGS	NATIONAL GRID GAS-BOSTON
TV	COMCAS	COMCAST
ON	ONTARG	ON TARGET LOCATING
RJ	IDM	INNOVATIVE DATA MANAGEMENT

- **There may be non-member utilities in the area that you need to notify.**
- **Electric and other companies may not mark lines they don't own or maintain. You may want to contact them for more information.**
- **The excavator is responsible to maintain markings placed by member utilities...**

DIG SAFE ENCOURAGES A COPY OF THIS ELECTRONIC TICKET ON SITE AT ALL TIMES.

Create New | Create From Existing | Print Ticket | Return To Menu | Return To Home

Dig Safe Ticket # _____**Date** ____/____/____ **Time** _____

Contr I.D. _____ **Caller's Name**_____**Title**_____

Phone #_____ **Fax #**_____ **Alt #** _____

Email address _____ **Business Hours** _____ **to** _____

Company _____

Address_____

City_____ **State** _____ **Zip** _____

State _____**Municipality** _____

(optional) **Latitude** _____ **Longitude** _____

Address/Intersection_____

Buffer Distance (Please circle): **500' 600' 700' 800' 900' 1000' 1100' 1200' 1320'**

Nearest Cross St 1_____

Nearest Cross St 2_____

Additional Information _____

Type of Work_____

Area of Work _____

Area Premarked? **Y** _____ **N** _____

Start Date _____/_____ **Time** _____ **:** _____

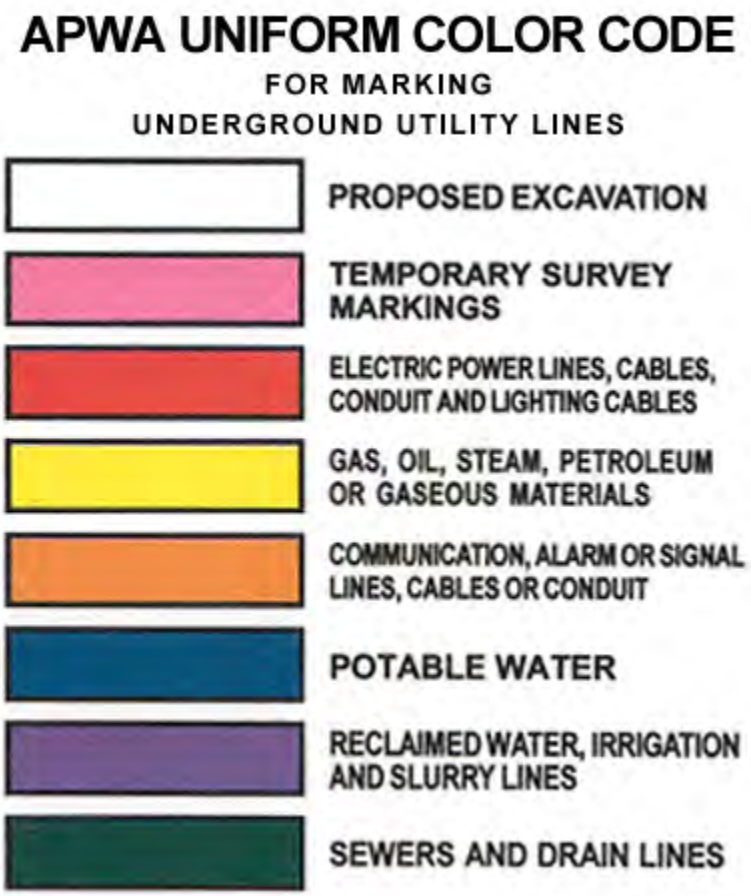
Excavator Doing Work _____

Member Companies Notified:

- **There may be non-member utilities in the area that you need to notify.**
- **Electric and other companies may not mark lines they don't own or maintain. You may want to contact them for more information.**
- **The excavator is responsible to maintain marking placed by member utilities.**
- **This ticket will expire in exactly 30 days (from today) for tickets in ME, NH and VT; 60 days in RI.**

Date of Last Revision: 08/05/2010

Attachment 2



STANDARD OPERATING PROCEDURE 03

Soil Boring Logging

Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations. The logging of soil samples will be conducted in general accordance with ASTM Designation D 2488-93: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), a copy of which is affixed to this SOP.

Equipment and Materials

- Soil boring log forms
- Soil logging guide
- Field logbook and water proof pen
- Clean plastic sheeting
- Clean DOT-approved 55-gallon steel drum and label
- Tape measure
- Pocket pentrometer (optional)
- Photoionization detector (PID)
- Clean latex or nitrile gloves
- 12-inch ruler
- Hand lens
- Color Chart for Soil and Rock

Procedures and Guidelines

This section covers several aspects of the soil characterization: instructions for completing the AGVIQ-CH2M HILL soil boring log, field classification of soil, and standard penetration test procedures.

Instructions for Completing Soil Boring Logs

Soil boring logs will be completed on the AGVIQ-CH2M HILL soil boring log. The information collected in the field to perform the soil characterization is described below. Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Analytical samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets. Print all information on the field log form—do not write in cursive.

Heading Information

Boring Number. Enter the boring number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each location.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities.

Contractor. Enter name of the company and the city and state where it is based.

Drilling/Excavation Method and Equipment. Identify the bit size and type and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted. For excavations enter type of equipment used (e.g., make/model of equipment).

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole/excavation. If free water is not encountered during drilling/excavation or cannot be detected because of the drilling method, this information should be noted. Record date and time of day of each water level measurement.

Date of Start and Finish. Enter the date(s) and time(s) the boring/excavation was begun and completed.

Logger. Enter the first initial and full last name of the person completing the form and describing the materials from the borehole.

Technical Data

Depth Below Ground Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

For Soil Borings:

- **Sample Type and Number.** Enter the sample type and number. DP-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.
- **Sample Recovery.** Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material (e.g., slough) in the measurement. Record recovery in feet.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (e.g., rod drops, rod bounce as in driving on a cobble, and equipment malfunctions). In addition, note if casing was used, the sizes, and depths installed. You should instruct the driller to alert you to any significant changes in

drilling (changes in material, occurrence of boulders). Such information should be attributed to the driller and recorded in this column.

Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example “Sandy CLAY”
2. Group symbol, in parentheses, for example, “(CL)”
3. Color, using Munsell color designation if appropriate
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order generally follows the format described in ASTM D 2488.

Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is Silty SAND with gravel, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is Sandy SILT. The gravel portion is not included in

the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML). However, the description of this sample should include the term…"with some gravel" after the descriptive terminology of the primary soil group.

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated.

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group.

Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

Moisture Content

The relative degree of moisture present in a soil sample should be defined as dry, moist, or wet.

Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586). If an auto-hammer is not used to collect samples, this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly determined by the use of a pocket penetrometer. For purposes of environmental sampling, the 'rule of thumb' can be used, for example, very soft means the soil can be easily penetrated several inches by fist, soft is easily

penetrated several inches by thumb, firm can be penetrated several inches by thumb with moderate effort, stiff is readily indented by thumb, but penetrated only with great effort, very stiff is readily indented by thumbnail, and hard is indented with difficulty by thumbnail.

Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described. Man-made debris encountered in drilling, such as slag from mineral smelting activities, should be identified as such on the log, and otherwise described similar to soils, considering grain size, angularity, moisture content, etc.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

Equipment and Calibration

No equipment needs to be calibrated if not sampling with the auto hammer.

Attachments

1. Soil Boring Log Template

Key Checks

- Check entries to the soil boring log and field logbook in the field for accuracy
- Check that drilling and sampling equipment is decontaminated prior to use at each location using the procedures defined in the SOP, Personnel and Equipment Decontamination Procedures.

STANDARD OPERATING PROCEDURE 04

Temporary Piezometer and Monitoring Well Installation

Purpose and Scope

To provide site personnel with a review of the temporary piezometer and well installation procedures that will be performed.

Equipment and Materials

1. Drilling rig (direct-push technology [DPT])
2. Temporary piezometer construction materials (i.e. 1-inch PVC and typically with 5-foot screens, depending on groundwater and subsurface conditions)
3. Drilling rig (HSA, sonic, air hammer, air rotary, or mud rotary)
4. Well-construction materials (i.e., surface casing, screens, riser, casing, end caps, vented well caps, sand, bentonite grout, and surface-finish materials)

Procedures and Guidelines

1. Monitoring well or piezometer locations, depths, and construction details must be determined by a Maine Certified Geologist *(C.G.)*, based on interpretation of the geology and hydrogeologic regime at a project site, in order to provide valid groundwater monitoring data.
2. The threaded connections on casing and screen sections will be water-tight.
3. Well screens will be constructed of nominal 2-inch diameter, 10-slot Schedule 40 PVC and will typically be 5 feet in length, depending on groundwater and subsurface conditions.
4. Permanent well completions will be stick up completions on a concrete pad with bollard to protect the well.
5. A record of the finished well construction details, including types of materials used, depths of top and bottom of screen and casing, depth of top and bottom of any materials added to the annular space between the screen and casing and the well borehole, etc., will be documented. The records requirements are described in detail in the Maine Monitoring Well/Piezometer Installation Details.
6. All soils and liquids generated during well installations will be drummed for proper disposal. Soils and liquids will be segregated into separate drums and may be consolidated with materials from multiple borings or wells.

7. Wells will be installed in accordance with the Maine Monitoring Well/Piezometer Installation Details for a well screened over a single interval. Piezometers will be temporary and therefore will not be grouted in place as specified for permanent monitoring wells and piezometers by the State of Maine.

Temporary Piezometer/Micro Point Installation

- A DPT drilling rig will advance a continuous core lined with disposable plastic tubes in 4-foot intervals to the target depth of the bottom of the temporary piezometer which is approximately 12 feet below ground surface.
- Each soil core obtained from advancing the plastic disposal tubes will be logged following SOP, Soil Boring Logging.
- A 1-inch PVC pipe with typically a 5-foot screen (depending on groundwater and subsurface conditions) will be installed to serve as the temporary piezometer point. The micro point well will be dropped into the open borehole and dropped to the desired depth.
- Carefully pour filter sand into the annulus around the casing to ensure that the well screen is surrounded by the filter sand. The level of filter sand should rise above the top of the screen by a minimum of 1 foot.
- Place bentonite into the annulus to approximately the ground surface.
- Development of the micro point should be conducted to ensure that there is sufficient connection between the aquifer and the well screen. All fines should be removed from the well, it may be necessary to purge the well several times to fully remove all of the fines and settled material.
- After the temporary piezometer is sampled, the PVC pipe and screen will be removed and the borehole will be backfilled with hydrated bentonite pellets and the surface will be repaired with like material (i.e. topsoil), as required.
- The installation of micropurge wells should follow the MEDEP SOP Identification #: RWM-DR 009.

Monitoring Well Installation

- Monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations. Boreholes will be logged continuously following SOP, Soil Boring Logging. Generally, 2-inch diameter well materials, i.e., screen and casing, set into a 6-inch-diameter boring will leave a nominal 2-inch annulus into which well seal materials and sand packs will be placed.
- Monitoring wells will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC or stainless steel screen and solid casing, fitted with a threaded end cap.
- Screens will have 0.010-inch slots and will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, siliceous sand. When using hollow-stem

augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.

- The primary filter silica sand pack (grain size No. 01) will extend from the bottom of the boring to between 6-inches and 1 foot above the top of the screen; filter pack will be allowed to settle before final measurement is taken. The filter pack will be placed as a slurry, using a tremie pipe and flowing water.
- Annular well seals will consist of 1 foot of puddled clay or bentonite placed above the filter pack. If bentonite pellets are used, and if necessary, the pellets will be hydrated using potable water in one foot lifts. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 1 hour before work in the well continues.
- The annular space above the bentonite seal will be backfilled sand (which is preferable) or native soil (but not silt or clay) to between 6-inches and 1 foot below the ground surface.
- The remaining 6-inches to 1 foot will consist of mounded puddle clay, bentonite, or cement grout to seal the well at the ground surface.
- After allowing the grout to settle and set up overnight, additional grout may be added to maintain grade. The minimum grout settling time prior to well development will be based on manufacturer's requirements. The grout to be used should have manufacturer's requirements for settling time of 24 hours or less.
- A protective steel casing equipped with keyed locking well protectors will be cemented in place for each new well. Wells will be above grade completions. The casing will extend at least 2 to 3 feet above the ground surface.
- A label will be attached inside the casing indicating the well identification number, installation date, well depth and top of casing elevation.

Attachments

- None.

Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.

- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

	PROJECT NUMBER	BORING NUMBER SHEET 1 OF 2
AGVIQ ENVIRONMENTAL SERVICES CH2M HILL JOINT VENTURE	**SOIL BORING LOG**	

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	PID READING (ppm)	CORE DESCRIPTION SOIL TYPE, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF SURFACE CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND START/STOP TIMES OF DAILY DRILLING RUNS.
5						
10						
15						
20						
25						
30						
35						
40						
45						

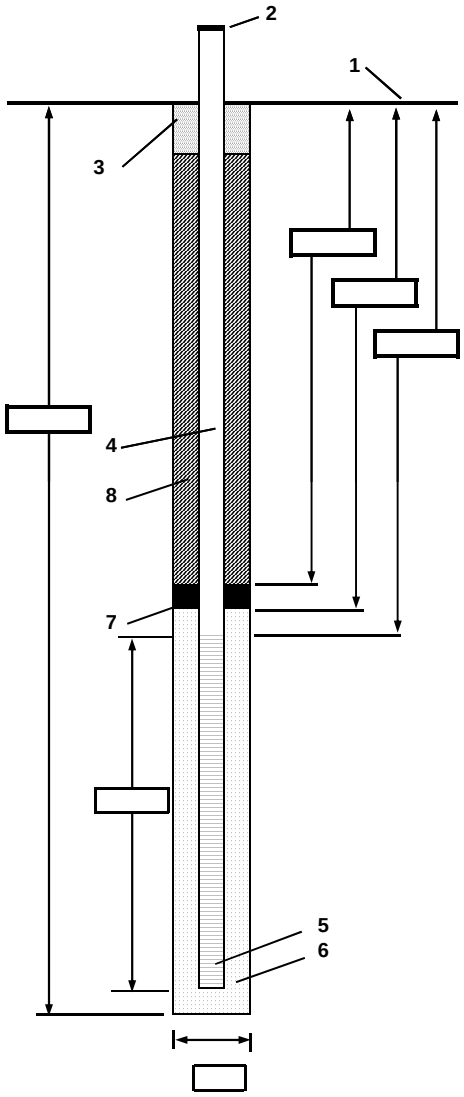
	PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1
AGVIQ ENVIRONMENTAL SERVICES CH2M HILL JOINT VENTURE	**MONITORING WELL COMPLETION DIAGRAM**	

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
   a) drain tube?
   b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Primary Sand Pack _____
   a) Quantity used _____

7- Bentonite Seal _____
   a) Quantity used _____

8- Annular Seal _____
   a) Grout mix used _____

   b) Method of placement _____
   c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated Purge volume _____

Comments _____

STANDARD OPERATING PROCEDURE 05

Monitoring Well Development

Purpose and Scope

The purpose of this SOP is to provide site personnel with a review of the well development procedures that will be performed.

Equipment and Materials

1. Pump capable of removing at least 3 gallons per minute from the well, or bailer for low recharge wells
2. Tubing for pump
3. Water level indicator
4. Surge block
5. Well development form
6. Decontamination supplies; see the SOP, Personnel and Equipment Decontamination Procedures
7. Container for water removed from the well

Procedures and Guidelines

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened. The minimum grout settling time prior to well development will be based on manufacturer's requirements. The grout to be used should have manufacturer's requirements for settling time of 24 hours or less (See the SOP, Monitoring Well Installation).
- The well will be developed by surging and pumping, or bailing for low recharge wells where pumping is not appropriate.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least contaminated well first.
- Well is to be surged with a surge block for 10 minutes before pumping begins. The surge block should be relatively close fitting within the well, and should preferably be connected to a solid rod during surging.

- Development will include surging the well by rapidly moving the surge block up and down several feet at a time inside the well screen interval of the well, abruptly stopping flow and allowing water in the well column to fall back into the well.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well if the water table is relatively close to the land surface or the well diameter and volume of air available are sufficient to lift water and sediment all the way to the top of the well, and the produced water can be captured and contained. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- A YSI water quality meter or equivalent will be used to collect water quality data from the produced groundwater, including temperature, PH, specific conductivity, and turbidity. A Hach Turbidity Meter should be used to collect more accurate turbidity readings. The water quality meter is to be calibrated in accordance with manufacturer's instructions.
- Well development will continue until the water produced is visibly free of turbidity, sand, and silt. Monitor purge water until turbidity is below 50 nephelometric turbidity units (NTU), and the other parameters are within 10 percent over three readings, or until 10 boring volumes have been purged, whichever is first.
- Development water will be handled as if it is hazardous and placed in sealed 55-gallon U.S. DOT-approved steel drums. AGVIQ-CH2M HILL will label and date the drums, and arrange transport of the drums to a designated site for storage. An "on hold pending analysis" label will be used until laboratory results return, at which time the appropriate label will be applied.

Attachments

1. Well development form

Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Ensure all drums are properly labeled and stored.
- Check that all information has been recorded on the well development form.

	PROJECT NUMBER 395101	WELL NUMBER SHEET OF
AGVIQ ENVIRONMENTAL SERVICES CH2M HILL JOINT VENTURE	**WELL DEVELOPMENT FORM**	

PROJECT : Hegeler Zinc OU1 Supplemental Remedial Investigation

PERSONNEL:

EQUIPMENT:

START :

END :

START WATER LEVELS :

WELL DEPTH:

WELL VOLUME:

MAXIMUM DRAWDOWN DURING DEVELOPMENT:

TOTAL QUANTITY OF WATER DISCHARGED:

Make attempt to remove at least three well volumes during development (Calculate well volume before starting development!)
Development will be continued until pH, temperature, and specific conductance, and turbidity stabilize within 10% over 3 readings or until 10 well volumes have been purged.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	pH	Temperature (°C)	Specific Conductivity (mS/cm)	Turbidity (NTU)	Remarks (color, odor, sheen, sediment, etc.)
		Stabilization Criteria:	±10%	±10%	±10%	< 50 NTU	

STANDARD OPERATING PROCEDURE 06

Water Level and Total Depth Measurements

Purpose and Scope

This SOP provides guidelines for measuring depths to groundwater and total depth in piezometers and monitoring wells. It includes only guidelines for discrete measurements of static water levels.

Equipment and Materials

- Field logbook and water proof pen
- Equipment/instrument decontamination materials (see SOP, Personnel and Equipment Decontamination Procedures)
- Well keys and wrenches/T-bar
- Clean latex or nitrile gloves
- Electronic water level meter or oil/water interface probe (Solinst® or equivalent) with a minimum 100-foot tape with graduations in increments of 0.01 foot or less

Procedures and Guidelines

- Set up instrument in accordance with manufacturer's instructions.
- Decontaminate equipment/instruments in accordance with the SOP, Personnel and Equipment Decontamination Procedures.
- Open the protective cover on well.
- Unlock and remove all piezometer and monitoring well caps. A minimum time of 30 minutes shall be allotted between the removal of a well cap and measuring the depth to groundwater in the same monitoring well unless the well casing has a hole in it to allow barometric pressures to constantly equilibrate. This will allow the groundwater surface within the riser to stabilize with atmospheric pressure prior to taking a depth to water measurement.
- Lower the probe slowly into the piezometer or monitoring well until the probe just contacts the groundwater surface; the unit will respond with a tone or light signal. Make sure that the top of the riser pipe does not have a sharp edge that may damage the protective coating around the wires in the tape.
- Note the depth to groundwater relative to a reference point indicated on the piezometer monitoring well riser pipe. If no reference is clearly visible, reference the northern edge

of the riser pipe. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the field logbook.

- Measure water levels to the nearest 0.01 foot.
- Record the condition of the concrete pad, padlock, well cap, protective cover, and bollards (if present) in the field logbook, along with the depth to the groundwater surface.
- Compare the newly measured depth to water in each piezometer and well to the historical depth to water in that and adjacent wells and re-measure if the new data are outside the historic range for an individual well or if the new data are inconsistent with general patterns of water table rise and fall, considering all wells being monitored. [For example, if most wells measured are generally a few feet higher than the past monitoring event but one well is measured as being several feet lower than past data indicate, re-measure and verify the depth.]
- The total depth of the piezometer or monitoring well should be measured and recorded in the field logbook every time it is monitored. The total depth shall be measured in the same general manner as the depth to groundwater except that no indication [light or buzzer] will be produced by the instrument when bottom is reached. Instead, the field personnel will have to monitor the relative weight of the tape and probe as it is lowered into the well and use feel to determine when bottom is reached. The feel of the bottom of the well should also be recorded, this would be soft if the bottom appears to be covered in silt, or firm if the bottom feels clean.
- Decontaminate the probe and tape as it is removed from the piezometer or well in accordance with the SOP, Personnel and Equipment Decontamination Procedures.

Key Checks

- Verify that the battery of the water level meter or oil/water interface probe is charged before each use by pressing the test button on the side of the unit.
- Verify that the unit is operating correctly by testing the probe in tap water (not distilled or deionized water) and verifying that the light and buzzer are activated at the same depth. If one measures higher or lower than the other, continue testing in tap water and determine which indicator is more accurate, and use that indicator for the field measurements.
- Inspect the tape for abrasions that may have been exposed to the wires. The unit will not function properly if there is a short in the wiring.
- It is recommended that a map of all piezometers and wells to be monitored be carried into the field when monitoring occurs.
- Prior to mobilizing to the site, use historical data to determine which wells to be monitored are cleanest and which are dirtiest/most contaminated and start monitoring with the clean wells first and moving to more contaminated wells last.

Attachments

None.

STANDARD OPERATING PROCEDURE 07

EPA Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling

objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

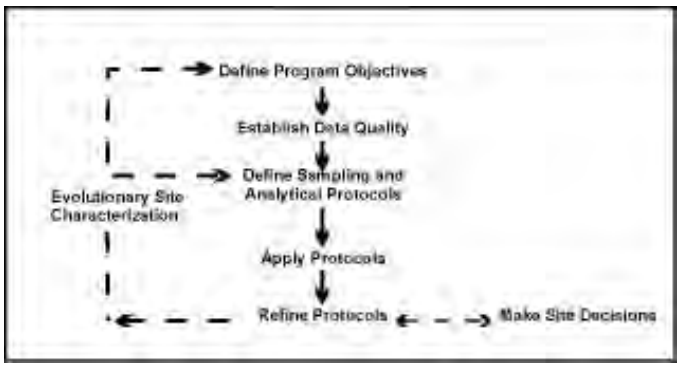

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-

flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality

indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of

the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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VIII. References

Backhus, D,A., J.N. Ryan, D.M. Groher, J.K. McFarlane, and P.M. Gschwend. 1993. Sampling Colloids and Colloid-Associated Contaminants in Ground Water. *Ground Water*, 31(3):466-479.

Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb. 1984. A laboratory evaluation of groundwater sampling mechanisms. *Ground Water Monitoring Review*, 4(2):32-41.

Barcelona, M.J. and J.A. Helfrich. 1986. Well construction and purging effects on ground-water samples. *Environ. Sci. Technol.,* 20(11):1179-1184.

Barcelona, M.J., H.A. Wehrmann, and M.D. Varljen. 1994. Reproducible well purging procedures and VOC stabilization criteria for ground-water sampling. *Ground Water*, 32(1):12-22.

Buddemeier, R.W. and J.R. Hunt. 1988. Transport of Colloidal Contaminants in Ground Water: Radionuclide Migration at the Nevada Test Site. *Applied Geochemistry*, 3: 535-548.

Danielsson, L.G. 1982. On the Use of Filters for Distinguishing Between Dissolved and Particulate Fractions in Natural Waters. *Water Research*, 16:179.

Enfield, C.G. and G. Bengtsson. 1988. Macromolecular Transport of Hydrophobic Contaminants in Aqueous Environments. *Ground Water,* 26(1): 64-70.

Gschwend, P.M. and M.D. Reynolds. 1987. Monodisperse Ferrous Phosphate Colloids in an Anoxic Groundwater Plume, *J. of Contaminant Hydrol.,* 1: 309-327.

Herzog, B., J. Pennino, and G. Nielsen. 1991. Ground-Water Sampling. In **Practical Handbook of Ground-Water Monitoring** (D.M. Nielsen, ed.). Lewis Publ., Chelsea, MI, pp. 449-499.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The effect of membrane filtration artifacts on dissolved trace element concentrations. *Water Res.,* 26(6):753-763.

Laxen, D.P.H. and I.M. Chandler. 1982. Comparison of Filtration Techniques for Size Distribution in Freshwaters. *Analytical Chemistry*, 54(8):1350.

McCarthy, J.F. and J.M. Zachara. 1989. Subsurface Transport of Contaminants, *Environ. Sci. Technol.*, 5(23):496-502.

McCarthy, J.F. and C. Degueldre. 1993. Sampling and Characterization of Colloids and Ground Water for Studying Their Role in Contaminant Transport. In: Environmental Particles (J. Buffle and H.P. van Leeuwen, eds.), Lewis Publ., Chelsea, MI, pp. 247-315.

Parker, L.V. 1994. The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review. *Ground Water Monitoring and Remediation*, 14(2):130-141.

Penrose, W.R., W.L. Polzer, E.H. Essington, D.M. Nelson, and K.A. Orlandini. 1990. Mobility of Plutonium and Americium through a Shallow Aquifer in a Semiarid Region, *Environ. Sci. Technol.*, 24:228-234.

Puls, R.W. and M.J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analyses. *Hazardous Waste and Hazardous Materials,* 6(4):385-393.

Puls, R.W., J.H. Eychaner, and R.M. Powell. 1990. Colloidal-Facilitated Transport of Inorganic Contaminants in Ground Water: Part I. Sampling Considerations. EPA/600/M-90/023, NTIS PB 91-168419.

Puls, R.W. 1990. Colloidal Considerations in Groundwater Sampling and Contaminant Transport Predictions. *Nuclear Safety*, 31(1):58-65.

Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. *Ground Water Monitoring Review,* 12(3):167-176.

Puls, R.W., D.A. Clark, B.Bledsoe, R.M. Powell, and C.J. Paul. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials*, 9(2): 149-162.

Puls, R.W. and C.J. Paul. 1995. Low-Flow Purging and Sampling of Ground-Water Monitoring Wells with Dedicated Systems. *Ground Water Monitoring and Remediation,* 15(1):116-123.

Ryan, J.N. and P.M. Gschwend. 1990. Colloid Mobilization in Two Atlantic Coastal Plain Aquifers. *Water Resour. Res.*, 26: 307-322.

Thurnblad, T. 1994. Ground Water Sampling Guidance: Development of Sampling Plans, Sampling Protocols, and Sampling Reports. Minnesota Pollution Control Agency.

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350.

U. S. EPA. 1995. Ground Water Sampling Workshop -- A Workshop Summary, Dallas, TX, November 30 - December 2, 1993. EPA/600/R-94/205, NTIS PB 95-193249, 126 pp.

U. S. EPA. 1982. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.

Figure 2. **Ground Water Sampling Log**

Project _____ **Site** _____ **Well No.** _____ **Date** _____

Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____

Sampling Device _____ **Tubing type** _____ **Water Level** _____

Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project _____ **Site** _____ **Well No.** _____ **Date** _____

Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____

Sampling Device _____ **Tubing type** _____ **Water Level** _____

Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

STANDARD OPERATING PROCEDURE 08

Groundwater-Surface Water Investigation: Well Point Method Pore Water Sampling Procedures

Overview

Pore water samples will be collected at two to three sampling intervals (shallow, intermediate and deep) across the top approximately 26 inches of shallow subsurface sediment using a "well-point" method. Samples from target intervals of approximately 2 to 8 inches (shallow) and 8 to 14 inches (intermediate) will be collected at all locations. An additional pore water sample at a target interval of approximately 14 to 26 inches (deep) will also be collected at select sample locations.

The well point method incorporates an outer and inner screen and riser apparatus (**Figure 1**). Outer screens will be installed a specified depths and allowed to fill with site pore water. This water will be purged and an inner screen with a pre-pack sand filter will be inserted into the outer screen. Once inserted, pore water samples will be drawn from within the inner screen using low-flow, peristaltic pump sampling technigue.

Equipment Construction and Installation

Outer screens will be constructed using 15-inch segments of 2-inch diameter PVC piping. Each screen will have a 6 or 12-inch machine slotted screen (0.010 inch slot size) depending on the sampling interval. Both shallow (2 to 8 inches) and intermediate (8 to 14 inches) pore water samples will require 6-inch screens, while as 12-inch screen will be used for deep (14 to 26 inches) pore water samples. A pointed well cap will be attached to the bottom of the outer screened segment, and the top end of this segment will be threaded to accept a 2-inch- diameter PVC riser segment. The threaded area of each riser segment will be sealed with an internal O-ring to prevent surface water leakage at the threaded zones. The risers will be attached to the screen segment in 5-foot segments to achieve enough overall well point length so the top riser segment will extend above the surface water line when the top of the slotted screen area is driven to depth matching the top of the sample interval (2 inches, 8 inches or 14 inches). Once installed, the outer well point will be purged of one to two complete volumes of water using a peristaltic pump and tubing that extends to the bottom of the screening. Once purged, the well points will be covered (not sealed) with 2-inch-diameter lockable-style well plugs and left to stand for at least 2 hours to equilibrate and recharge before sampling.

After the equilibration period, an inner screen and riser apparatus will be inserted within the outer well point. The inner screen will be constructed using 15-inch segments of 1-inch diameter PVC piping and will be capped at the bottom. Each screen will have a 12-inch machine slotted area (0.010-inch slot size) and will be covered by a pre-pack

filter that consists of a metal mesh covering filled with coarse well-drillers sand. This filter reduces intake of colloidal particles and facilitates collection of a more representative pore water sample. The top end of the inner screen segment will be threaded to accept 1-inch-diameter PVC riser segments. The inner screen and riser will be inserted into the outer well point, and additional 1-inch-diameter risers will be attached in 5-foot segments to achieve enough overall length so the top inner riser segment will extend to within a couple of inches below the top of the outer riser segment (**Figure 2**). Once the inner screens are inserted, pore water samples will be collected from within the inner well point screen using peristaltic pumps and low-flow sampling methods that incorporate ¼-inch–outer- diameter polyethylene tubing connected to ¼-inch–inner- diameter silicone peristaltic tubing. The polyethylene sample tubing will be slowly lowered until the bottom end is near mid-height of the inner screen (**Figure 3**).

Pore water samples will be collected and placed directly into the appropriate sample bottle(s) according to the analyses requested. Water for dissolved metals analysis can be collected using double in-line filters (45 µm cellulose acetate disposable in-line filters), before the total metals sample is collected (unfiltered). New disposable PVC screens (outer and inner), PVC risers, sample tubing, and filters (when needed) will be used for each well. After the samples have been collected, the well point will be removed from the sediment and disposed of following investigation-derived waste procedures.

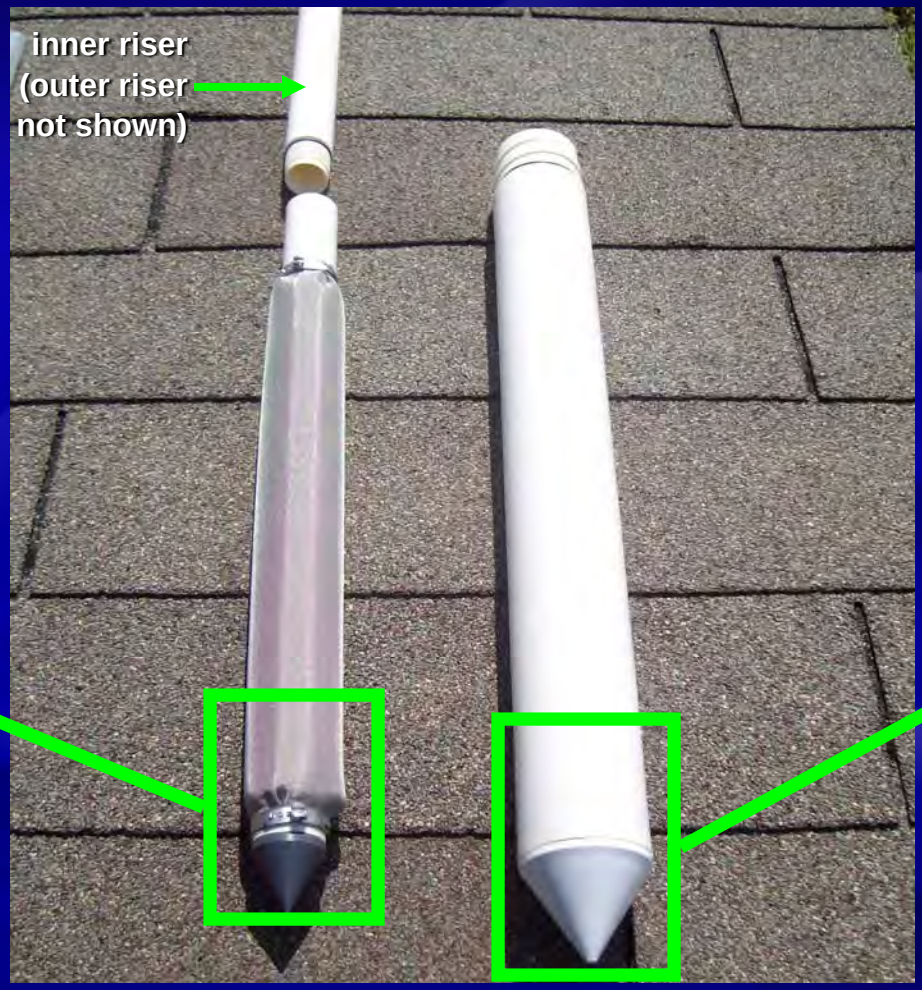
Water Quality Parameters

Water quality parameters, including pH, specific conductance, temperature, oxidation-reduction potential, turbidity, total dissolved solids, and dissolved oxygen, will be measured in both pore water and surface water directly adjacent to the well point using a handheld water quality meter. Because these water quality parameters are expected to differ in the pore water and the surface water environments, they will be compared onsite during sampling activities. This comparison also will be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping. The parameters will be measured and recorded before, during, and immediately after sample collection for the purposes of this verification.

Pore Water Sampling: Equipment

- Well point method (dual PVC piezometer construction)

Inner Screen
- 1” diameter
- 12” prepack (sand) screen



Outer Screen
- 2” diameter
- 12” screen
- 0.010” slot

Figure 1
Pore Water Sampling Apparatus

Pore Water Sampling: Equipment

- Installation of outer piezometer with sledge/post/slide hammer
- Inner piezometer inserted after purging

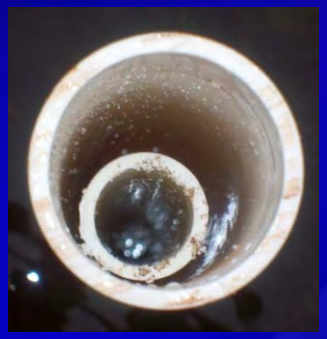


Figure 2
Pore Water Well-Point

Pore Water Sampling: Sampling

- Sample tubing equipped with in-line filter (45 μm) for dissolved metals

Figure 3
Pore Water Sampling Set-Up

STANDARD OPERATING PROCEDURE 09

MEDEP Protocol for Groundwater/Surface Water Interface Sampling Using a Pore Water Sampler

Department of Environmental Protection
Bureau of Remediation & Waste Management
RCRA Program

Standard Operating Procedure Change Record

Title: **PROTOCOL FOR GROUNDWATER/SURFACE WATER INTERFACE SAMPLING USING A PORE WATER SAMPLER**

Identification #: **RWM-DR 023**

SOP Originator: **Brian Beneski**

Author	Revision	Description of Change	Date
Erika Bonenfant	RCRA 01	Substitute MEDEP/RCRA in the place of MEDEP/DR, and Division of Oil and Hazardous Waste Facilities Regulation in the place of Division of Remediation. Section 2.0: Change first sentence to "MEDEP/RCRA is responsible for the investigation and subsequent corrective actions for RCRA facilities throughout Maine."	8/1/2009

Approved by:

Scott Whittier, RCRA Program Director Date:

COVER SHEET
STANDARD OPERATING PROCEDURE

OPERATION TITLE: **PROTOCOL FOR GROUNDWATER/SURFACE WATER INTERFACE SAMPLING USING A PORE WATER SAMPLER**

ORIGINATOR NAME: **Brian Beneski**
Quality Assurance Coordinator
Maine Department of Environmental Protection
Division of Site Remediation

Standard Operating Procedure: **RWM-DR-023**
Revision: 02
Date: **April 1, 2009**
Revised by: **Hank Andolsek; Troy Smith**
Reviewed by: **Brian Beneski**

Five Year Review No Changes Needed:

Print Name:_____ Signature:_____ Date:_____

Print Name:_____ Signature:_____ Date:_____

Print Name:_____ Signature:_____ Date:_____

Print Name:_____ Signature:_____ Date:_____

1.0 PURPOSE

The purpose of this document is to describe the Maine Department of Environmental Protection, Bureau of Remediation and Waste Management, Division of Site Remediation (MEDEP/DR) standard operating procedure (SOP) for collecting groundwater samples using a pore water sampler.

2.0 APPLICABILITY

MEDEP/DR is responsible for the investigation and remediation of uncontrolled hazardous substance sites throughout Maine. In the course of these investigations, samples are sometimes taken from groundwater discharge points beneath surface water bodies. This Standard Operating Procedure (SOP) is designed to be a guideline for MEDEP/DR staff for collecting such groundwater samples for chemical analysis. This procedure is based on current methodology guidelines and field experience of MEDEP personnel.

3.0 RESPONSIBILITIES

All MEDEP/DR staff must follow this procedure when using a pore water sampler to perform groundwater sampling activities. Typically, MEDEP/DR field staff (OHMS positions) conduct this type of sampling, although other staff may collect these types of samples in specific instances if accompanied by, or once appropriately trained in, this methodology. The respective managers and supervisors for MEDEP/DR are responsible for ensuring that their staff receive adequate training, are familiar with, and adhere to these procedures.

4.0 INTRODUCTION

It is often difficult to determine the extent and origin of contamination using solely surface water sampling techniques. In some cases, a surface water body may be clean but the groundwater beneath it may be contaminated. Thus, sampling the groundwater prior to its discharge to a surface water body may lead to a better understanding of the extent and origin of contamination. This can be accomplished by using a pore water sampler.

Underlying this procedure is the assumption that surface water bodies are common discharge points for groundwater. Thus, a sample of the water beneath a stream or riverbed would be characteristic of the groundwater in the area. This SOP identifies sampling protocols to be followed when collecting samples using a pore water sampler.

5.0 PLANNING

A well developed conceptual site model (CSM) is imperative for effective porewater sampling. Prior to conducting any sampling event, a sampling plan should be developed (see SOP DR#014 - Development of a Sampling and Analysis Plan). Included in the sampling plan should be specifics regarding the anticipated substances of concern, data quality objectives, the laboratory conducting analysis and Quality Assurance/Quality Control.

6.0 EQUIPMENT

The following is a list of equipment currently owned and available to MEDEP/DR staff for collecting groundwater samples using the pore water sampler method.

- Peristaltic Pump
- Tubing – Two types of tubing are needed for this sampling technique. Polyethylene tubing with an inside diameter (ID) of one-quarter (1/4) inch is the standard size tubing used in conjunction with peristaltic pumps. This size tubing should also be used to fit around the top opening of the pore water sampler. Additionally, one-quarter (1/4) inch outside diameter (OD) polyethylene tubing will be necessary to connect the pore water sampler to the peristaltic pump. A knife or other tool to cut tubing to desired lengths is recommended.
- Power Supply – A power supply will be necessary to operate the peristaltic pump.
- Hip Waders – This sampling method will likely require the sampler to wade into stream or river in order to insert pore water sampler in a suitable location.
- Boat – Depending on the depth and size of a water body, a boat may be required to access sample points. Even if sample points are accessible by wading, boats and canoes can also act as equipment barges to help transport equipment between sample locations.
- Pore Water Samplers – A pore water sampler comes in two parts, a strengthening rod and the pore water sampler itself, both made of stainless steel. The pore water sampler is basically a hollow tube with small holes in its tip that allow groundwater to percolate through. The strengthening rod slides into the pore water sampler, and while in place, blocks all water from entering pore water sampler. Both pieces are placed in a PVC sheath for protection. Although the pore water sampler is fairly sturdy, exercise caution during use, as once either piece becomes bent, the equipment is useless. Bring at least as many pore water samplers as there are sampling locations, as onsite decontamination is difficult and should be avoided.
- Permanent Porewater Samplers – A porewater sampler modified for long-term deployment. This may be necessary for silty organic rich sediments where low turbidity samples are required and traditional porewater samplers will not meet the DQOs for the site.
- Sample Collection Containers – These will be provided by the lab, and will vary depending on parameters to be sampled.

7.0 PROCEDURES FOR USE OF PORE WATER SAMPLER

6.1 MOBILIZATION/ RECONNAISSANCE

Prior to sampling suitable access points to porewater sampling locations should be identified, and reviewed to assure safe sampling. The Water body should not be in flood stage during sampling. If available, a water bodies' flow should be checked prior to sampling; porewater sampling should not be conducted during flood stage.

5.2 SAMPLING PORCEDURE

Once an appropriate sampling location has been determined, obtain pore water sampler and carefully insert into river/streambed to desired depth. Do not remove strengthening rod until

instrument has been securely placed in sediment. Pore water sampler should be inserted deep enough as to ensure the sample collected will contain only groundwater and no surface water. Typically, this depth is at least 8 inches. Once this has been accomplished, remove the strengthening rod from the pore water sampler and connect pore water sampler to peristaltic pump using appropriate tubing described in section 4.0 of this SOP. Turn pump on and purge water for several minutes until purge water is relatively clear. If sample is not visually free of sediment, it should be documented in field notes (see SOP DR#013: Documentation of Field Notes and Development of a Sampling Event Trip Report).

If sampling for metals, it is recommended that turbidity be measured. If turbidity is above 30 NTUs, it is recommended that an additional sample be collected that has been filtered through a 0.2-0.45 μm inline particulate filter.

After water has been sufficiently purged, decrease pumping rate if necessary (e.g., to fill 40ml VOA vials) and begin collecting sample. Pumping rate should be low enough to ensure that surface water is not drawn down into the sample. Low flow purging and sampling protocol is not required, but if desired, refer to SOP DR#003 - Groundwater Sampling Using Low Flow Purging and Sampling Protocol. Course sediment are the most transmissive; with experience, samplers can actually “feel” the type of sediment as the pore water sampler is advanced. If the formation intercepted by the screen is not transmissive enough for collection of sample, gently advance and/or pull back the sampler in an attempt to find a more transmissive zone. If the formation does not allow adequate transmission of water, it may require a change in sampling location. This change is made at the discretion of the sampler and should be documented in field notes (see SOP DR#013: Documentation of Field Notes and Development of a Sampling Event Trip Report).

Neither the tubing nor the pore water sampler should be reused at subsequent sampling locations without appropriate decontamination. Do not put strengthening rod back in pore water sampler once sample has been collected, as sediment in the sampler must be flushed out first. Rather, place both pieces separately into plastic sheath.

If porewater sampling is to be repeated, use of permanent porewater samplers should be considered. The sampling point should marked in a permanent manner. Additionally, all points should be located/ identified with global positioning.

7.0 DECONTAMINATION

Decontamination procedures generally follow SOP DR#017: Decontamination Procedures Protocol. However, specific decontamination procedures are as follows.

In the course of sampling, sediment will build up in sampler that must be carefully flushed out. For this reason, it is best if decontamination is conducted with a large amount of water available for continuous flushing. If possible, bring as many pore water samplers as there are sampling locations, as onsite decontamination can be difficult.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

Data quality objectives should be stated in the sampling plan. Quality Assurance/Quality Control (QA/QC) samples may be collected if needed to meet your data quality objectives. The

following typical types of QA/QC samples may be collected as part of the QA/QC program for porewater sample collection. For an additional discussion of QA/QC, please refer to the MEDEP/DR Quality Assurance Plan, Section 5.

8.1 EQUIPMENT BLANKS

If unable to used dedicated equipment, equipment blanks may be collected at a rate of 5%, one equipment blank every twenty samples collected.

8.2 DUPLICATE SAMPLES

It is recommended that duplicate samples be collected at a rate of 5% to assess sample location variability.

8.3 BACKGROUND SAMPLES

Background samples should be collected as part of the porewater evaluation. Background sample requirements should be outlined in the SAP.

8.4 TRIP BLANK

When collecting samples for volatile organic compound analysis, trip blanks are recommended.

9.0 DOCUMENTATION

Documentation is the most important aspect of any sampling event. Documentation should be completed with the idea that someone not present during the actual event may need to repeat the event exactly as it was conducted originally. During the sampling event or immediately upon the completion of the event, diagram a map of the area and locate sampling points (and corresponding sample container numbers) on the map. Also, record observational data concerning the groundwater, such as the approximate depth of the screen when the sample was collected, any detection of odor or contamination, color and turbidity. Make sure to record in your personal field book any and all information that is pertinent to the sample. All deviations from the procedures outlined in this or in any other SOP followed for groundwater sampling using a pore water sampler must be documented in field notes. Refer to the MEDEP/DR SOP DR#013 – Documentation of Field Notes and Development of a Sampling Event Trip Report. It is very important that all information regarding a sampling event (or any events/activities) be accurately recorded. Record all information obtained while sampling such as sample numbers, measurements taken, observations made and other comments. A trip report package should also be completed for the event, as outlined in MEDEP/DR SOP DR#013.

When checking in samples at the laboratory for analysis, a Chain of Custody (COC) form must be completed. Refer to MEDEP/DR SOP DR#012 – Chain of Custody Documentation for requirements for COC protocol.

10.0 HEALTH AND SAFETY

As part of the overall work plan at a hazardous substance site, a site specific health and safety plan (HASP) must be developed and adhered to by all personnel working at the site. Refer to MEDEP/DR SOP DR3014 – Development of a Sampling and Analysis Plan.

All personnel must understand that if a sample cannot be obtained safely, the sample should not be taken at all. If a sample cannot be obtained due to safety considerations it should be documented in the sampler's field book.

All personnel should be aware of the potential dangers associated with this particular sampling method. These dangers include, but are not limited to, strong water currents, slippery substrate, roots or sharp objects beneath the water's surface that may cause a fall or other personal injury. If sampling in water that is greater than three feet deep, all DEP personnel are required to wear life jackets. All necessary precautionary measures should be heeded when performing this sampling technique.

STANDARD OPERATING PROCEDURE 10

Manometer

EXCERPTS (Section 6.17.7.0) Taken from:

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for installing, measuring, and decommissioning hand-driven in-water piezometers

Version 1.1

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Date-

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Date -

QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date -

EAP061

APPROVED: August 2, 2010

Signatures on file

The Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows this SOP in most cases, there may be situations where an alternative methodology, procedure, or process is employed to meet specific project objectives. In such cases the project manager is responsible for documenting significant deviations from these procedures in the formal study report.

Revision History

Date	Revision number	Summary of change(s)	Revised section(s)	Reviser(s)
07/26/2010	1.1	Updated well construction fees and discussion of procedures, Appendix B.	Append B	K. Sinclair

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6.17.7.0 Using a Manometer Board to Measure Hydraulic Heads in Piezometers

6.17.7.1 In some situations a manometer board may be the only practical way to measure water level relationships (hydraulic head differences) between surface water and groundwater (Winter, et al, 1988). Manometer boards are particularly useful for measuring small head differences or when ripples or water surges make it difficult to accurately measure surface-water stage with a steel tape. A manometer board may also be required to measure tubing piezometers installed along losing reaches or where a piezometer no longer lies in direct contact with surface water.

6.17.7.2 (Note: Manometer boards should be tested and calibrated at the beginning of each field season (and periodically during use) to ensure they don't have air leaks and are otherwise working properly. The simplest way to perform this test is to position two "identical" 5-gallon buckets of clean water side-by-side on a level surface. One bucket should have more water than the other so that their water surfaces settle at different heights when stable. Set up the manometer board so that the lower "surface water" and "piezometer" tubes rest well below the water surface in their respective buckets. Charge the manometer board per the instructions below, turn off the pump, and disconnect the pump tubing from the upper manometer valve. Measure and record the distance from the top of each bucket to its corresponding water surface using a metric ruler. Proceed with the replicate manometer board measurements (5 sets) using the techniques described below, and then compare the average of these values to the initial water level difference measured for the buckets. If all is working correctly, the average head difference from the manometer should match the initial water level difference measured using the metric scale).

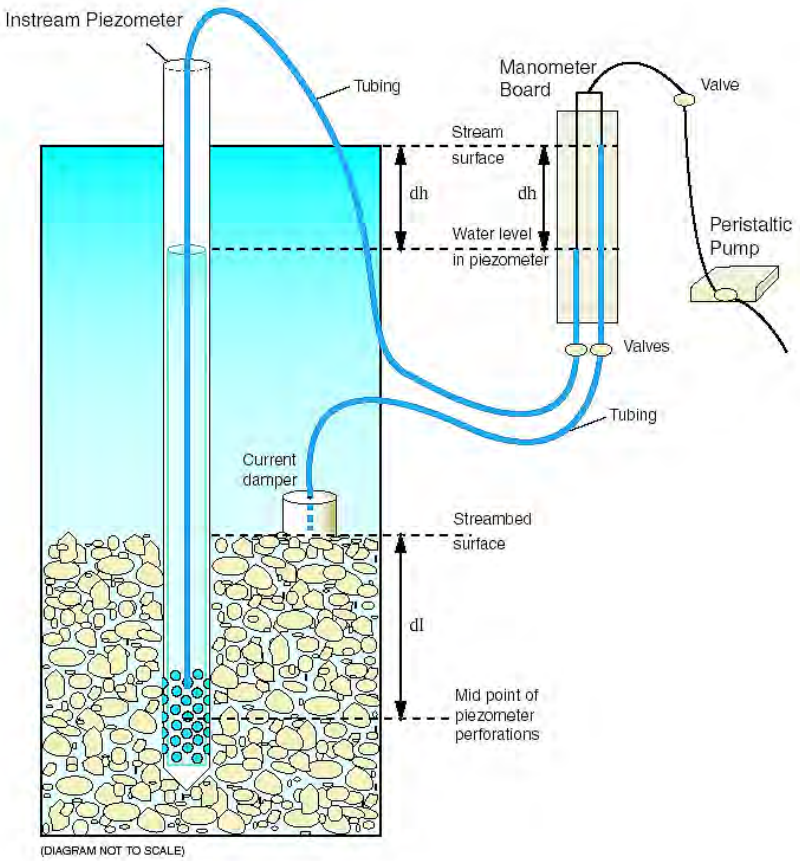


Figure 10 - Typical Manometer Board Setup (figure courtesy of F.W. Simonds, USGS, Tacoma, WA)

6.17.7.3 Manometer board use typically requires a battery, peristaltic pump, and a floating platform to hold the assembled equipment. Set up the floating platform, peristaltic pump, and battery adjacent to the piezometer casing and secure in place.

6.17.7.4 Attach one end of the silastic tubing from the peristaltic pump to the top barbed tubing-fitting on the manometer board (Figure 10).

6.17.7.5 For pipe piezometers place one of the lower manometer tubes (typically the right-hand tube) into the piezometer, so that it extends well below the piezometer water level. (Note: if the piezometer contains thermistors they will likely need to be removed before inserting the manometer tubing. If so, record the thermistor removal time on the field form).

6.17.7.6 For tubing piezometers secure the manometer tubing directly to the piezometer tube.

6.17.7.7 Insert the second manometer tube into a current damper and place the damper into the surface water so that the manometer tube remains under water but does not rest directly on the sediment surface (where it might clog with fine sediment).

6.17.7.8 Make sure all three manometer valves (one upper and two lower) are in their closed position.

6.17.7.9 Rest (or clamp) the manometer board on the piezometer casing or other stable surface. Open the top valve that leads to the pump and the lower valve that leads to the surface water tubing.

6.17.7.10 Start the pump and completely fill the surface-water side of the manometer with water from the stream or lake. The surface tubing should be *completely* full of water with no visible bubbles or sediment.

6.17.7.11 When the surface tubing is fully charged, slowly open the third valve and fill the remaining tube with water from the piezometer. As the piezometer tube fills, tap the board firmly with the flat of your hand to ensure both sides of the manometer are filled with water and to remove any air bubbles or sediment that may be trapped in the tube.

6.17.7.12 When both sides of the manometer are full with water, close the top valve that leads to the pump and shut the pump off. Disconnect the pump tubing from the top valve. (Note: leave the lower two valves open).

6.17.7.13 *Briefly* open the top valve and let just enough air into the manometer so that the water level drops to the point that you can see the location of the air/water interface for both tubes on the manometer scale.

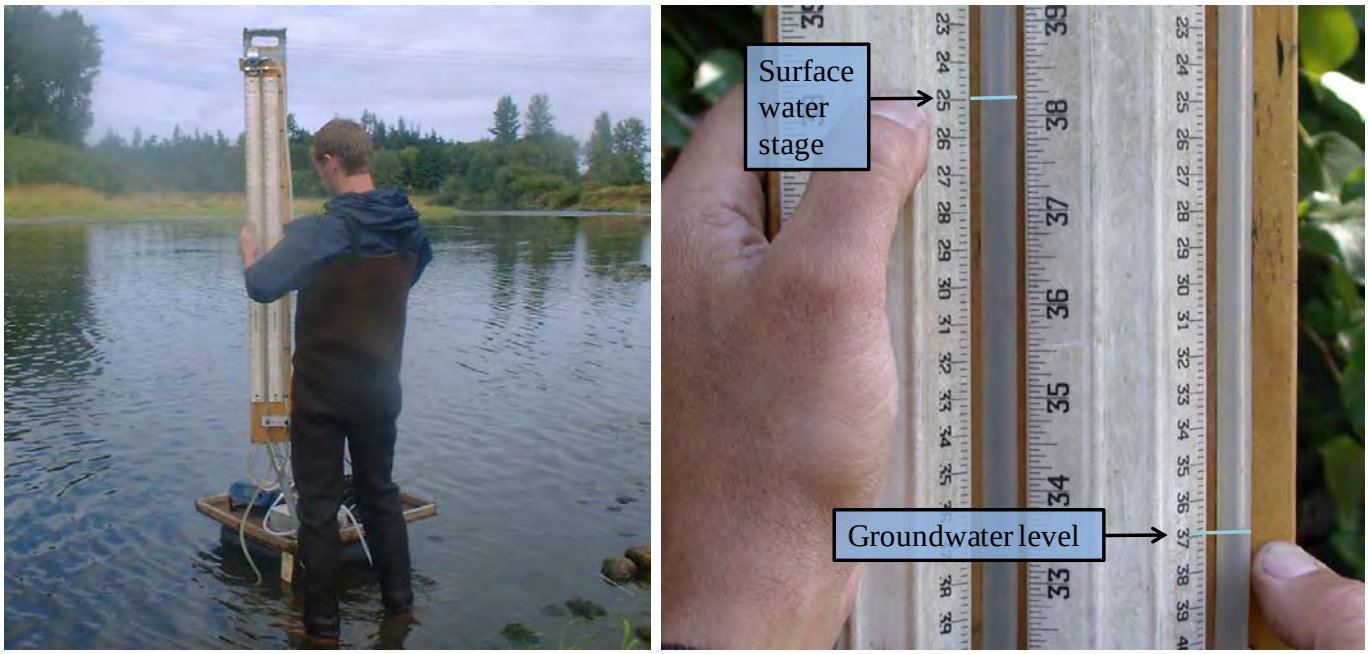
6.17.7.14 Hold the manometer stable and as vertical as possible (use the levels on the board to confirm this) and allow the water levels to stabilize. Read the level at the bottom-most point of the meniscus in each tube and record the values to the nearest centimeter and millimeter in the appropriate columns (surface stage or groundwater level) of the field form (Appendix A).

6.17.7.15 After completing the first reading, *briefly* re-open the top valve and let additional air into the manometer. Again, allow the water levels in each tube to stabilize while holding the manometer steady/vertical. Record the resultant readings on the field form. Repeat this procedure until 5 or more readings have been obtained[6]. (Note: It may be necessary to give the manometer a good rap between measurements to release air bubbles or water droplets stuck to the manometer tubing).

6.17.7.16 If all is working well, the resultant readings should show approximately the same head difference and can be combined to define the average difference (dh) for that site and measurement event. (Note: If the readings are inconsistent or gradually decrease in magnitude from reading to reading, check the manometer for vacuum leaks).

[6] When measuring piezometers with large gradients, it may not be possible to complete all 5 readings without first recharging the manometer with water.

6.17.7.17 If there are no leaks, then it's likely the piezometer is completed in low-permeability sediments and is still recovering after being pumped to charge the manometer. Manometer boards are not well suited for such conditions since the act of charging the manometer may cause the piezometer to run dry or drawdown to non-static head conditions that do not recover to equilibrium conditions within a reasonable time period. A manometer board should not be used to measure heads in these situations.



(In use) (Detail of water levels)

Figure 11 - Manometer board in use and detail of manometer water levels

6.17.7.18 As a final check and memory jog for later data analysis, determine the direction of water movement indicated by the manometer (into or out of the stream or lake) and record this observation on the field form.

6.17.7.19 When the measurements are complete, proceed with thermistor downloads (see Bilhimer and Stohr, 2007 for details) or water quality sampling as appropriate[7]. When done return any continuous data instrumentation to its correct position in the piezometer, note the reinstall time on the field form, and re-cap the casing.

6.18 <u>Decommissioning Piezometers</u>

6.19 The project engineer or hydrogeologist must file a "Notice of Intent to Decommission a Well" form with the regional Water Resources Program office, at least 72 hours before removing (decommissioning) a piezometer (See Appendix A for additional details). The intended decommissioning procedure(s) should follow those outlined in the project well construction variance.

[7] The order of these steps can be rearranged to accommodate the needs of individual piezometers. For example thermistors can be download while waiting for the piezometer water level to stabilize after removing the cap or attaching an extension. The important thing is to complete all the indicated steps.

STANDARD OPERATING PROCEDURE 11

Surface Water Sampling

Purpose and Scope

This SOP describes the techniques to be used in collecting surface water samples. Materials, equipment, and procedures may vary.

Materials and Equipment

- Field log book
- Personal Protective Equipment (PPE) - latex or nitrile gloves, safety glasses, personal floatation device (PFD) and waders (as specified in the Health & Safety Plan)
- Laboratory-supplied sample containers (e.g., 40 mL VOA vials)
- Water Quality Meter (Myron L Ultrameter, or similar)
- Peristaltic pump
- Pump tubing (Rigid/polyethylene tubing with 1/4" or 3/8" outer diameter and corresponding flexible/silicone tubing with 3/16" and 1/4" inner diameter, respectively)
- Digital camera

Sample Collection Procedure

Surface water samples will be collected at select pore water sample stations (see SOP-08, Pore Water Sampling: Well Point Method) in co-location with sediment samples. These samples will be collected from within 6 inches of the sediment surface using a peristaltic pump and tubing technique. Sampling will begin at the most downstream location in bodies of flowing water. The designated sampling locations will be accessed by boat or by wading, depending on water depth (caution: when wading into a body of water, personnel should take special care to minimize the amount of disturbance to the underlying sediment, and the water sample should be collected outside the area of disturbance [upstream of the disturbance in the flowing water]). **Surface water samples are to be collected before co-located sediment samples are collected to minimize disturbance**.

Surface water samples will be collected as follows:

1. Locate sample station and set up sample equipment at shore adjacent to stream (or stable position as applicable).
2. Place approximately 1 foot of flexibile tubing into pump and attach approximately 1-2 feet of rigid sample tubing to flexible tubing (or enough rigid tubing to reach sample spot).

3. Attach open end of rigid tubing to pole using zip tie (rod, stick, or tube can also be used; anything rigid that will hold in place from above the surface of the water and reach to the sediment surface) such that the opening of the tubing is approximately 2 inches from the bottom of the pole.
4. Insert end of the pole with tubing attached into surface water such that the bottom of the pole rests gently on the sediment surface (tubing opening will be within 2 inches of the sediment surface). To prevent intake of disturbed sediment/silt, wait approximately 2 minutes for proceeding to the next step.
5. Turn pump on at slow rate, and flush and move approximately 250 mL of sample water through tubing.
6. Collect water quality parameters (pH, specific conductance, temperature, oxidation-reduction potential [ORP], turbidity, total dissolved solids [TDS], and dissolved oxygen [DO]) will using a handheld water quality meter (Myron L Ultrameter, or similar) and record in the log book.
7. Slowly direct water from tubing directly into the sample containers; fill VOA vials to the top of the container and cap with no head space/air space.
8. Collect field duplicate sediment samples (1 per 10 samples), and matrix spike/matrix spike duplicate (MS/SD; 1 per 20 samples) samples as appropriate.
9. Affix sample labels to the sample containers and then tape over with clear packing tape
10. Place samples into cooler with ice and maintained at 4°$\pm$ 2° C.
11. Collect sample location coordinates using hand held GPS.
12. Collect next sample with new tubing and repeat of Steps 1 through 10.

Field Documentation

The minimum following information must be recorded in the field log book by the project team representative:

- Time and date of sample collection
- Station coordinates (as-sampled)
- Water depth; water quality parameters
- Problems with sample collection (e.g., access issues, cloudiness/turbidity)
- Evidence of contamination (i.e. odor [none, strong, moderate, or faint], sheen, staining)
- Analytical parameters requested
- Other observations as applicable (e.g., water clarity/color, observed debris, habitat characteristics, weather conditions)

STANDARD OPERATING PROCEDURE 12

Sediment Sample Collection

Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to describe protocols for collecting, characterizing and processing surface sediment samples using a core-tube sampling approach.

Materials and Equipment

- 2″ diameter, core tubes (Lexane)
- Core tube end caps
- "Egg shell" core catchers (optional based on sediment conditions)
- 12″plastic ruler
- Dry erase board and marker
- Digital camera
- Cooler(s) with ice
- Field logbook and/or core logs
- Bottleware for samples
- Rope
- Personal Protective Equipment (PPE; as specified in the Health & Safety Plan)
- Pan, bowls and scoops (e.g., stainless steel bowls and utensils, or aluminum pans and high-density polyethylene (HDPE) scoops)
- 1 gallon Ziploc freezer bags

Sample Collection Procedure

Due to the volatile nature of the constituents of concern (VOCs and 1,4-Dioxane), sediment samples will be collected in as close to *in situ* conditions as possible. To accomplish this, sediment samples will be collected from the 0 to 6 inch interval using 2″ diameter lengths of core tubes, to facilitate the least practical amount of sediment disturbance.

In general, sampling will begin at the most downstream location in bodies of flowing water. The designated sampling locations will be accessed by boat or by wading, depending on water depth (caution: when wading into a body of water, personnel should take special care to minimize the amount of disturbance to the underlying sediment, and the sample should be collected upstream of the disturbance in the flowing water). Sediment samples are to be collected ***after*** co-located surface water samples.

Sediment grab samples will be collected as follows:

1. Determine the length of core tube needed for a sample by adding the water depth to the sediment depth, plus an additional 4 feet to assist in core tube extraction.

2. Gently lower the core tube down into the sediment/water interface. After contact with the sediment surface, gently push the core tube into the soft sediment to reduce compaction as far as possible. Placed a core driver (cap or block) over the core tube and use post-hole or sledge hammer to gently advance tube into the clay substrate to refusal (clay plug), or to maximum depth necessary (at a minimum, a target depth of penetration will be about 1 foot to ensure the top 6 inches are captured).

3. Fill the tube to the top with surface water and place end cap over the top end of the tube to seal (caps can be further sealed with duct tape as necessary) and slowly pull the core tube from the sediment (**Note**: rope can be wrapped around the core barrel to assist in extraction).

4. Once at the surface, quickly cap the bottom of the tube and inspect the captured sediment to ensure the proper depth was achieved.

5. If the sample is unacceptable, repeat steps 1 through 4. If sample is acceptable, proceed to Step 6 (**Note**: "egg shell" core catchers might be necessary depending on the sediment conditions and might be inserted into the penetration end of the core tube, as necessary)

6. Remove the top cap and gently decant overlying water, taking care not to disturb the sediment surface.

7. Collect sample for VOC and 1,4-Dioxane analysis:

    a. Gently move any bulk subsurface sediment from a depth greater than 6 inches from the core tube and discard.

    b. For sediment within the 0-6 inch interval, place un-homogenized sediment directly into wide-mouth sample container, filling and capping the container with no head space to avoid oxidizing the sample and loss of volatile constituents.

    c. Affix sample labels to the sample containers, tape over with clear packing tape, and place sample into cooler on ice (maintain at 4°+ 2° C).

8. Collect samples for non-volatile parameters (grain size, TOC, % moisture) and onsite qualitative characterization:

    a. Repeat Steps 1-5 and gently move the entire core of sediment unto a disposable aluminum pan or similar clean, flat disposable surface (plastic sheeting).

    b. Take a photograph of the grab, so that the sediment type and characteristics are observable. A dry erase board should be utilized to include the Station ID, grab number (if more than one is needed) and date ***in*** the photo. The description of the sediment should be recorded in the field logbook (see below for minimum field observations).

    c. Move 0-6 inch sediment into stainless steel bowl, disposable aluminum pan of Ziploc bag. Repeat Steps 1-5 to obtain enough surface sediment to fill bottles for all

additional parameters. Homogenize all sediment material and place into appropriate sample containers.

d. Affix sample labels to the sample containers, tape over with clear packing tape, and place sample into cooler on ice (maintain at 4°+ 2° C).

9. Collect sample location coordinates using hand held GPS.

10. Collect next sample with new core tube and repeat of Steps 1 through 9

Field Documentation

The minimum following information must be recorded in the field log book by the project team representative:

- Time and date of sample collection
- Station coordinates (as-sampled)
- Grab penetration interval
- Water depth; water quality parameters, if measured
- Problems with sample collection (e.g., number of attempts needed to collect an adequate sample)
- Evidence of contamination (i.e. odor [none, strong, moderate, or faint], sheen, staining)
- Analytical parameters requested
- Other observations as applicable (e.g., sediment color/moisture content/texture/grain size/shape, observed debris, habitat characteristics, weather conditions)

STANDARD OPERATING PROCEDURE 13

Personnel and Equipment Decontamination Procedures

Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

Scope

This is a general description of decontamination procedures.

Equipment and Materials

- Distilled or deionized water
- 2.5-percent (W/W) Alconox®, Liquinox®,or equivalent phosphate-free detergent and water solution
- Large plastic pails or tubs for Alconox®, Liquinox®, or equivalent and water, scrub brushes, squirt bottles for detergent solution resealable plastic bags, paper towels, and sheets
- DOT approved 55-gallon drum for disposal of waste
- Unpowdered chemical-resistant gloves (i.e., nitrile gloves)
- Aluminum foil

Procedures and Guidelines

A. Personnel Decontamination

The following procedures are to be performed after the completion of tasks whenever the potential for contamination exists, and also upon leaving the exclusion zone:

1. Wash boots in detergent solution, and then rinse with water. If disposable latex booties are worn over boots in the work area, remove and discard into a DOT-approved 55-gallon drum.
2. Remove and discard outer chemical-resistant gloves into a DOT-approved 55-gallon drum.
3. Remove disposable coveralls (“Tyveks”) and discard into a DOT-approved 55-gallon drum (if worn).

4. Remove respirator (if worn). Dispose of filter cartridges and replace daily.
5. Remove inner gloves and discard.
6. Shower entire body at the end of the work day, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. Sampling Equipment Decontamination—Other Equipment

Reusable sampling equipment is decontaminated after each use as follows:

1. Wear unpowdered chemical-resistant gloves.
2. Rinse and scrub with potable water.
3. Wash all equipment surfaces that came into contact with the potentially contaminated soil/water with detergent solution.
4. Rinse with potable water.
5. Rinse with distilled water.
6. Completely air dry or wipe dry with a clean paper towel. Wrap exposed areas with aluminum foil (shiny side out) or enclose equipment in clean plastic for transport and handling if equipment will not be used immediately.
7. Collect all rinsate and place in a DOT-approved 55-gallon drum.
8. Dispose of decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment in DOT-approved 55-gallon drums.

C. Health and Safety Monitoring Equipment Decontamination

1. Wrap soil contact points in plastic before use, to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with detergent solution, and finally two times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

D. Sample Container Decontamination

The outside of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure for sample container decontamination is as follows:

1. Wipe container with a paper towel dampened with detergent solution, or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used detergent solution and paper towels in a DOT-approved 55-gallon drum or in trash bags placed into appropriate dumpsters, keeping liquids and solids in separate drums.

Attachments

None.

Key Checks and Items

1. Do not use acetone for decontamination.
2. Drum all contaminated rinsate.
3. Clean with solutions of Alconox®, Liquinox®, or equivalent phosphate-free detergent, and distilled water.

STANDARD OPERATING PROCEDURE 14

Packaging and Shipping Procedures for Low-Concentration Samples

Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

Equipment and Materials

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

Procedures and Guidelines

Low Concentration Samples

1. Prepare coolers for shipment:
   - Tape drains shut.
   - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
   - Place mailing label with laboratory address on top of coolers.

2. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.
3. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
4. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.
5. Arrange sample bottles in coolers so that they do not touch.
6. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.
7. Fill remaining spaces with vermiculite or absorbent pads.
8. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.
9. Close lid and latch.
10. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
11. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.
12. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium and High Concentration Samples

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. The sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier.

Attachments

- None.

Key Check and Items

- Verify laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form

- Include custody seals

STANDARD OPERATING PROCEDURE 15

Sample Handling and Chain-of-Custody Procedures

Purpose

The purpose of this SOP is to provide a definition of "custody" and describe protocols for documenting the transfer of custody from one party to the next (e.g., from the site to the laboratory). A documented custody trail is established through the use of sample tags and a USEPA chain-of-custody form that uniquely identifies each sample container, and who has possession of it from the sample's origin to its final destination. The chain-of-custody form also describes the sampling point, date, time, and analysis parameters.

Scope

Sample personnel should be aware that a sample is considered to be in a person's custody if the sample meets the following conditions:

- It is in a person's actual possession
- It is in view after being in a person's possession
- It is locked up so that no one can tamper with it after having been in physical custody

When samples leave the custody of the sampler, the cooler must be custody-sealed and possession must be documented.

Equipment and Materials

- Sample labels
- Chain-of-custody forms
- Indelible black ink pen

Procedures and Guidelines

A. Sample Identification

Information which shall be recorded in the field logbook, when measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s)
- Task Order (TO) Number
- Project Sample Number
- Sample location or sampling station number
- Date and time of sample collection and/or measurement
- Field observations

- Equipment used to collect samples and measurements
- Calibration data for equipment used

Measurements and observations shall be recorded using indelible black ink.

B. Sample Labels

Each sample container will be identified with a uniquely numbered sample label. Each label will contain the following information:

- Project and TO Number
- The unique sample number for sample tracking
- Station location (i.e., the sample identifier)
- Date of sampling
- Time the sample was collected (in military time)
- All parameters for which the sample will be analyzed
- Preservative used (if any)
- Sample type (grab or composite)
- Sample concentration (low, medium, high)
- Sample matrix (sediment, etc.)
- The signature or initials of sampler
- Identification when sample is intended to be used by the lab for MS/MSD duplicate

C. Chain-Of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

D. Field Custody Procedures

- Samples are collected as described in the UFP SAP. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample locations in photographs, an easily read sign with the appropriate sample/location number should be included.

- Sample labels shall be completed for each sample, using indelible ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

E. Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (TO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/ time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.
- The custody record is completed using indelible ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.
- Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.
- The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

Attachments

- None.

Key Checks and Items

- All sample containers must be properly labeled.
- Each cooler must have a chain-of-custody form and the samples in the cooler (as identified by the sample labels) must match what is on the chain-of-custody form.
- Each chain-of-custody form must be properly relinquished (signature, date, time).
- The custody seal numbers must be written on each chain-of-custody form.
- The shipping cooler must be custody sealed in at least two places.

STANDARD OPERATING PROCEDURE 16

EPA Region 1 Calibration of Field Instruments

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 1

DRAFT CALIBRATION OF FIELD INSTRUMENTS
(temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction potential [ORP], and turbidity)

I. SCOPE & APPLICATION

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction potential [ORP], and turbidity. This SOP supplements, but does not replace, EPA analytical methods listed in 40 CFR 136 and 40 CFR 141 for temperature, dissolved oxygen, conductivity/specific conductance, pH and turbidity.

This SOP is written for instruments that utilize multiple probes (temperature, pH, dissolved oxygen, conductivity/specific conductance, and/or oxidation/reduction potential [ORP]) and the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature. Communications to the instrument (programming and displaying the measurement values) are performed using a display/logger or a computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instructions for entering information into the instrument.

For ground water monitoring, the instrument must be equipped with a flow-through-cell, and the display/logger or computer display screen needs to be large enough to simultaneously contain the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured in a flow-through-cell. This procedure is applicable for use with the EPA Region 1 Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells.

II. GENERAL

All monitoring instruments must be calibrated before they are used to measure environmental samples. Part of the calibration is performed prior to the field event. For instrument probes that rely on the temperature sensor (pH, dissolved oxygen, conductivity/specific conductance, and oxidation/reduction potential [ORP]), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instructions.

Most instruments will require at least two standards to bracket the expected measurement range, that is, one standard less than the expected value and one higher. Calibration must be performed at the beginning of each sampling day prior to sample collection. To determine if the instruments have remained in calibration during transport to each sampling location, use one of the previously used standards as a check standard at the sampling site. If the check measurement does not agree with the initial calibration or to within the specifications of the instrument, then the instrument must be re-calibrated. When an environmental sample measurement falls outside the calibration range, the instrument must be re-calibrated to bracket the new range before continuing measurements.

This SOP requires that the manufacturer's instruction manual (including the instrument specifications) accompany the instrument into the field.

III. CALIBRATION PROCEDURES

Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements.

Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, percent dissolved oxygen, mg/l dissolved oxygen, conductivity, specific conductance, and ORP.

The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor (see manufacturer's instructions for additional information).

While calibrating or measuring, make sure there are no air bubbles lodged between the probe and the probe guard.

TEMPERATURE

Most instrument manuals state there is no calibration of the temperature sensor, but the temperature sensor must be checked to determine its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was over a year, the temperature sensor accuracy needs to be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor must be checked.

Verification Procedure

1. Allow a container filled with water to come to room temperature.

2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST), and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

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3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually ±0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

pH (electrometric)

The pH of a sample is determined electrometrically using a glass electrode.

Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For ground water, the pH will usually be close to seven. Three standards are needed for the calibration: one close to seven, one at least two pH units below seven and the other at least two pH units above seven. For those instruments that will not accept three standards, the instrument will need to be re-calibrated if the water sample's pH is outside the initial calibration range described by the two standards.

Calibration Procedure

1. Allow the buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).

5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select "pH". Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Remove probe from the initial standard, rinse with distilled water, and blot dry.

7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.

8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.

9. Immerse probe in third buffered standard (e.g., pH 9) and repeat step 5.

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10. Remove probe from the third standard, rinse with distilled water, and blot dry.

11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed, immerse the probe into the initial standard. Wait for the readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If re-calibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

12. The calibration is complete. Place pH probe in its storage container.

DISSOLVED OXYGEN

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.

3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Readings must stabilize before continuing to the next step.

5. Select calibration mode, then select "DO %".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure chart attached to the SOP for conversion at selected pressures].

7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.

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8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart attached to the SOP. The numbers should agree. If they do not agree to the accuracy of the instrument (usually ± 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution.

9. Remove the probe from the container and place it into a 0.0 mg/L DO standard (see note). The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (Method 4500-O G). The method basically states to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is stored with no head space.

SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C.

Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.

3. Select monitoring/run mode. Wait until the probe temperature has stabilized.

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4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.

5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.

7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, re-calibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

8. When monitoring ground water or surface water, use the specific conductance readings.

OXIDATION/REDUCTION POTENTIAL (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent.

Calibration or Verification Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.

2. Remove the probe from its storage container, and place it into the standard.

3. Select monitoring/run mode.

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4. While stirring the standard, wait for the probe temperature to stabilize, then read the temperature.

5. Look up the millivolt (mv) value at this temperature from the millivolt versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.

6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

7. If the instrument instruction manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

TURBIDITY

The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source.

Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEPA-1) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.

2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.

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4. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.

5. Using a standard in the range of 5 - 20 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.

7. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

IV. DATA MANAGEMENT AND RECORDS MANAGEMENT

All calibration records must be documented in the project's log book. At a minimum, include the instrument manufacturer, model number, instrument identification number, standards used to calibrate the instruments (including source), calibration date, and the instrument readings.

References

Standard Methods for the Examination of Water and Wastewater, 19th edition, 1995.

Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.

Turbidity - Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, August 1993.

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ATTACHMENT C

Laboratory Standard Operating Procedures

Lab Manager: Brad Madadian

QA Officer: Mark Warren

TITLE: **METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY SW846 6010B**

TEST METHOD REFERENCE: SW846 6010B, Revision 2, December 1996;

REVISED SECTIONS: 10.9.2

SCOPE & APPLICATION

1.1 This method is applicable for the determination of Total metals in ground waters, domestic and industrial wastes, TCLP leachates, sludges, soils, sediments, and various other wastes.

NOTE: **Dissolved elements are determined after filtration with 0.45 micron filter paper and preserved with Nitric acid.**

1.2 Test Codes: A variety of metals can be analyzed by ICP. These include: Al, Sb, As, Au, B, Ba, Be, Cd, Ca, Cr, Cu, Co, Fe, Pb, Pd, Pt, Li, Mn, Mg, Mo, Ni, K, Se, Ag, Na, Si, Sn, Sr, Ti, Tl, V, W, Zn.

2.0 SUMMARY

2.1 Prior to analysis, samples must be digested using the appropriate digestion method. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved prior to analysis.

2.2 This method describes multi-elemental determinations by ICP/AES using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by a radio-frequency ICP. Background correction is required for trace element determination.

3.0 METHOD DETECTION AND REPORTING LIMITS

3.1 Reporting limits are established at the lowest concentration standard. RL's may vary depending on matrix difficulties, sample volumes or weight, percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 Method Detection Limits

3.2.1 Detection limits are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample weight or volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

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3.2.2 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDL studies are performed on an annual basis or after any major changes to the instrumentation. For additional detail regarding MDL studies, refer to the MDL SOP MQA245.

3.2.3 The MDL represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.2.4 Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis

4.2 BACKGROUND CORRECTION – a technique to compensate for variable background contribution to the instrument signal in the determination of trace elements.

4.3 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch.

4.4 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

4.5 CALIBRATION BLANK - a volume of acidified deionized/distilled water

4.6 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

4.7 CONTINUING CALIBRATION – analytical standard run every 10 samples or 2 hours, whichever is more frequent, to verify the calibration of the analytical system.

4.8 DISSOVED METALS – elements in an aqueous sample which will pass through a 0.45 um filter.

4.9 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying in an oven.

4.10 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

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4.11 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.12 HOLDING TIME – the elapsed time expressed in days from the date of sampling until the date of its analysis.

4.13 INDUCTIVELY COUPLED PLASMA (ICP) – a technique for the simultaneous or sequential multi-element determination of elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Characteristic atomic line emission spectra are produced by excitation of the sample in a radio frequency ICP.

4.14 INSTRUMENT CHECK SAMPLE – a solution containing both interfering and analyte elements of known concentration that can be used to verify background and interelement correction factors.

4.15 INSTRUMENT CHECK STANDARD – a multi-element standard of known concentrations prepared by the analyst to monitor and verify instrument performance on a daily basis.

4.16 INTERFERENTS – substances which affect the analysis for the element of interest.

4.17 MATRIX - the predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, a sample matrix is either water or soil/sediment. Matrix is <u>not</u> synonymous with phase (liquid or solid).

4.18 MATRIX EFFECT - in general, the effect of a particular matrix (water or soil/sediment) on the constituents with which it contacts. This is particularly pronounced for clay particles which may adsorb chemicals and catalyze reactions. Matrix effects may prevent extraction of target analytes, and may affect surrogate recoveries. In addition, non-target analytes may be extracted from the matrix causing interferences.

4.19 MATRIX SPIKE - aliquot of a matrix (water or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

4.20 MATRIX DUPLICATE - a second aliquot of the original sample that is brought through the entire sample preparation and analytical process in order to determine the precision of the method.

4.21 METHOD BLANK - an analytical control consisting of all reagents, that is carried throughout the entire analytical procedure. The method blank is used to define the level of laboratory, background, and reagent contamination.

4.22 PERCENT DIFFERENCE (%D) - As used in this SOP to compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero.

4.23 REAGENT WATER- Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water. Water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

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4.24 SERIAL DILUTION – the dilution of a sample by a factor of five. When corrected by the dilution factor, the diluted sample must agree with the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

4.25 SOIL - used herein synonymously with soil/sediment and sediment.

4.26 TOTAL METALS – analyte elements which have been digested prior to analysis.

4.27 Linear Dynamic Range(Linearity studies) The concentration range over which the instrument response to an analyte is linear.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous. In addition, all acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, & HOLDING TIMES

6.1 Preservation. All aqueous samples should be preserved with nitric acid at the time of collection. Both soils and aqueous samples should be kept under refrigeration at $4^{o} \pm 2°C$.

6.2 Holding Time. All samples should be analyzed within 6 months of the time of collection.

7.0 APPARATUS and MATERIALS

7.1 Currently three ICAPs are available for use in the lab. There are two Thermo Jarrell Ash 61E Trace ICP, and one solid state trace SS6500 with simultaneous spectrometer system that use ionized argon gas as the plasma. The computer software is equipped with macro programs (macro is a preset sequence of commands to execute a specific task.

7.2 Peristaltic pump

7.3 Auto-sampler

7.4 Volumetric flasks of suitable precision and accuracy

7.5 Argon gas supply - Liquid, high purity grade (99.999%), supplied by Air Products, Inc.

7.6 Instrument maintenance

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7.6.1 Recommended periodic maintenance includes the items outlined below. All maintenance should be recorded in the instrument maintenance log.

7.6.2 Change the pump tubing weekly or as needed.

7.6.3 Clean the filter on the re-circulating pump every one to two weeks and dust off the power supply vents every one to two weeks.

7.6.4 Clean the nebulizer, torch, and injector tube every week or more often as required.

7.6.5 Clean the pump once per month.

7.6.6 Change the sampler tip as needed (every one to two months).

7.6.7 Clean the recirculating pump lines,if needed.

8.0 STANDARDS AND REAGENTS

8.1 All chemicals listed below are reagent or trace grade unless otherwise specified. Distilled, deionized water from Accutest's DI system should be used whenever water is required.

8.2 Concentrated hydrochloric acid, trace metal grade.

8.3 Concentrated nitric acid, trace metal grade.

8.4 Stock metals standard solution (generally 1000 mg/L), ICAP grade.

NOTE: Combined stock standards can be ordered or made from ICAP purity standards.

8.5 Hydrochloric acid (1:1) - Add 500 ml conc. HCl to 400 ml of DI. Cool and dilute to 1 Liter.

8.6 Nitric acid (1:1) - Add 500 ml of conc. HNO_3 to 400 ml of DI. Cool and dilute to 1 Liter.

8.7 Rinse Blank - To 800 mls DI water, add 30 ml of conc. HNO_3 and 50 ml of Conc. HCl. Dilute to 1 liter.

8.8 Calibration Blank - To 800 mls DI, add 30 ml of conc. HNO_3 and 50 ml of Conc. HCl. Dilute to 1 liter.

8.9 Tuning solution (Peak profile) - Dilute 0.50ml of 1000 ppm As ICAP grade to 100 ml with calibration blank(8.8).

8.10 Calibration Standards

8.10.1 Premixed stocks purchased from Inorganic Ventures, Absolute standards and other vendors are used in this section along with individual standards, and subsequent dilutions.

8.10.2 ACTST-CAL4B (Inorganic Ventures,Inc.), contains the following analytes and concentration:

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Analyte	Conc. (Mg/L)
Sb, As, Ba, Be, B, Cd, Cr, Co	1000
Cu, Pb, Mn, Ni, Se, Tl, Zn	1000

8.10.3 ICP mix#2 (6 Components)

Analyte	Conc. (Mg/L)
Al, Ca, Fe, Mg, K, Na	5000

8.10.4 Individual 1000, and 10000 ppm analytes.

8.10.5 In general there are 3 different standards are recommended to be used for calibration. Other combinations and concentrations maybe used.

STANDARD#1:

Analyte	61E Trace Conc. (mg/l)	61E Trace utrasonic Conc. (mg/l)	SS 6500 Trace Conc. (mg/l)
Sb, As. Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Tl, Zn	4.0	0.20	4.0
Ag	0.50	0.20	0.50

STANDARD#2:

Analyte	61E Trace Conc. (mg/l)	61E Trace utrasonic Conc. (mg/l)	SS 6500 Trace Conc. (mg/l)
Al, Ca, Fe, Mg, K, Na, Li	20	20	20

STANDARD #3:

Analyte	61E Trace Conc. (mg/l)	61E Trace utrasonic Conc. (mg/l)	SS 6500 Trace Conc. (mg/l)
Pd, Pt, Au, Si, Sn, Sr, Ti, V, W	4.0	0.20	4.0

NOTE: Since addition of silver may result in an initial precipitation,

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you may warm the flask until solution clears. Cool to room temperature an use.

8.11 Continuing Calibration Verification (CCV)

Prepare mixed CCV solution by combining appropriate volumes of the individual stock standards or by using the premixed stock purchased from Inorganic Ventures, Inc., ACTST-CAL-4B and ICP Mix#2, and subsequent dilutions. Continuing Calibration Verification (CCV)- The CCV solution must be prepared in the same acid matrix using the same standards used for calibration at a concentration near the mid point of the calibration curve. Below are the recommended concentrations of CCV to use with the above calibration standards.

NOTE: Since addition of silver may result in an initial precipitation, you may warm the flask until the solution clears. Cool to room temperature and use.

The CCV will contain the following analytes and concentrations.

Analyte	61E Trace Conc. (mg/l)	61E Trace utrasonic Conc. (mg/l)	SS 6500 Trace Conc. (mg/l)
Sb, As. Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Tl, Zn, Pd, Au, Si, Sn, Sr, Ti, V, W,Au, Pd, Pt	2.0	0.10	2.0
Al, Ca, Fe, Mg, K, Na, Li	10	10	10
Ag	0.25	0.10	0.25

8.12 Initial Calibration Verification/Quality Control Standard (ICV/QCS)- This standard is prepared by combining compatible elements from a standard source different than that of the calibration standards and at the concentrations should be within the linear working range of the instrument.

Below are the recommended concentrations of ICV. Dilute the individual stocks, and premixed standards such as ICQ500-19 or the equivalents. (ICQ500-19 is a multi element standard purchased and contains multiple analytes).The ICV will contain the following analytes and concentrations.

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Analyte	61E Trace Conc. (mg/l)	61E Trace utrasonic Conc. (mg/l)	SS 6500 Trace Conc. (mg/l)
Sb, As. Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Tl, Zn, Pd, Au, Si, Sn, Sr, Ti, V, W, Au, Pd, Pt	3.0	0.20	3.0
Al, K, Na, Li	15	15	15
Ca, Fe, Mg	18	15.2	18
Ag	0.50	0.15	0.50

8.13 Spectral Interference Check I (ICSA) - Dilute the following listed aliquot volumes of individual stock standards to 1 Liter with calibration blank (8.8).

Analyte	Stock Conc. (mg/L)	Aliquot Vol. (ml)	Final Conc. (mg/l)
Al, Ca, Mg	10000	50	500
Fe	10000	20	200

8.14 Spectral Interference Check II (ICSAB) - Dilute the following listed aliquot volumes of individual stock standards and 10 ml of CLPILM 030 Analystes B standard to 1 Liter with cal blank(8.8)

- CLPILM030 Analytes B standard contains the following analytes and concentrations: (Ag,Cd,Ni,Pb,Zn 100 mg/L each), and Ba,Be,Co,Cr,Cu,Mn,V)50 mg/L each

Analyte	Stock Conc. (mg/L)	Aliquot Vol. (ml)	Final Conc. (mg/l)
Al, Ca, Mg,K	10000	50	500
Fe	10000	20	200
As, Se, Tl, Sb	1000	2.0	2.0
Ag, Cd, Ni, Pb, Zn	CLPILM030	10	1.0
Ba, Be, Co, Cr, Cu, Mn, V			0.50

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Mo	**1000**	**1.0**	**1.0**
Sr	**1000**	**1.0**	**1.0**
Sn	**1000**	**1.0**	**1.0**
B	**1000**	**1.0**	**1.0**
Ti	**1000**	**0.50**	**0.50**
Si, W *	**1000**	**2.0**	**2.0**
Au, Pd* , Pt*	**1000**	**0.5**	**0.50**

* When the element is requested ICSAB will be made accordingly.

Internal Standard/Ionization suppressant solution (5.0 mg/L Y, 1000 mg/L Li) In a 1000 ml volumetric flask, dilute 5 ml of yttrium stock standard 1000 ppm and 100 ml of lithium stock standard 10000 ppm to the mark with calibration blank (8.8) **Note: If Na,Ca,Mg, and K are not being analyzed Li can be excluded in the mix. If Li requested, use 5 ppm Y and 50 ppm Indium solution.**

8.15 Low level Calibration Check (CRI). The CRI standard contains the elements of interest at levels near the low end of the curve. Typically the concentration of CRI is at/or twice the reporting limits. Check with the area supervisor or the client tech specs, to see which CRI needs to be analyzed. The in house acceptance criteria of 50 to 150 percent will be applied unless there are specific instructions set by client or program. Table below, indicates some of the programs, and possible examples ..

Program/Client	CRI Concentration Level	CRI acceptance criteria	Non Conformance
MCP	At the RL	+/- 30%	Re-calibrated & re-analyze.
RCP	At the RL	+/- 30% *	Re-calibrated & re-analyze.
In house Limits	At or twice RL	+/- 50 %	Re-calibrated & re-analyze.
Example Client 1	Twice the RL	+/- 20%	Narrate –non conformance
Example Client 2	At the RL	+/- 20%	Narrate –non conformance

* Except +/-50% for As, Sb, Tl, Co

9.0 INTERFERENCES

9.1 Several types of interference effects may cause inaccuracies in the determination of an analyte in this method. These interferences can be summarized as follows:

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9.1.1 Spectral Interferences: Spectral interferences are caused by overlap of a spectral line from another element, unresolved overlap of molecular band spectra, background contribution from stray light from the line emission of high concentration elements. Corrections for these interferences can be made by using interfering element corrections, by choosing an alternate analytical line, and/or by applying background correction points.

9.1.2 Physical Interferences: Physical interferences are generally considered to be effects associated with the sample introduction (nebulization and transport processes). Such properties as change in viscosity or surface tension can cause significant inaccuracies especially in samples which may contain high dissolved solids and/or high acid concentrations. The use of a peristaltic pump, sample dilution and/or utilization of standard addition techniques will reduce these interferences.

9.1.3 Chemical Interferences: Chemical interferences are not pronounced with the ICAP techniques due to the high temperature of plasma, however, if they are present, they can be reduced by optimizing the analytical condition (i.e. power level, torch height).

9.1.4 Memory Interferences : Memory interferences result when analytes in a previous sample contribute to the signal measured in the new sample. This results from sample build up in the plasma torch spray chamber. This can be reduced by flushing the system between samples with rinse blanks. (sec. 8.7). A minimum of 60 seconds rinse time must be applied.

9.2 The occurrence of interferences described above are primarily attributed to the sample matrix. To ensure the absence of any type of interferences, the following precautions may be taken:

9.2.1 Serial Dilution: See section 11.9.1.

9.2.2 Analyte Addition (Post Digestion Spike – PDS): An analyte spike added to a portion of prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the IDL for that element.

9.2.3 Method of Standard Addition (MSA). If the PDS does not meet criteria, the MSA may be used. Standards are added at one or more levels to portions of a prepared sample. This technique compensates for enhancement or depression of an analyte signal by a matrix. It will not correct for additive interferences, such as contamination, interelement interferences, or baseline shifts. This technique is valid in the linear range when the interference effect is constant over the range, the added analyte responds the same as the endogenous analyte, and the signal is corrected for additive interferences. The simplest version of this technique is the single addition method. This procedure calls for two identical aliquots of the sample solution to be taken. To the first aliquot, a small volume of standard is added; while to the second aliquot, a volume of acid blank is added equal to the standard addition. The sample concentration is calculated by: multiplying the intensity value for the unfortified aliquot by the volume (Liters) and concentration (mg/L or mg/kg) of the standard addition to make the numerator; the difference in intensities for the fortified

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sample and unfortified sample is multiplied by the volume (Liters) of the sample aliquot for the denominator. The quotient is the sample concentration.

9.2.4 An alternative to using the method of standard addition is the internal standard technique. Add yttrium to the standards, samples, and blanks at a concentration to be sufficient for optimum precision, but not so high as to alter the salt concentration of the matrix. The element intensity is used by the instrument as an internal standard to ratio the analyte intensity signals for both calibration and quantitiation.

9.2.5 Wavelength Scanning: Wavelength scanning of the sample can be performed and compared to the scan of the analyte to detect potential spectral interferences.

10.0 PROCEDURE

General procedure on how to operate the TJA Trace ICP 61E, and SS6500 are described below.

10.1 Before bringing up the instrument, make sure that the sample tubings, the nebulizer, and the spray chamber are clean and that there are no leaks in the torch area.

10.2 Turn on the recirculating cooler. .

10.3 Engage the peristaltic pump.

10.4 Make sure reagent reservoirs (wash solution and internal std solution) are filled with enough solution to last for a full days run. The rinse reservoir is filled with calibration blank solution (8.7) and internal standard solution (8.13).

NOTE: If the internal standard solution runs out during the run, instrument must be recalibrated with the new standard.

10.5 Ignite the plasma and let the instrument warm up (ICP 61 for one hour and SS6500 for 15 minutes).

10.6 Type up the auto sampler sequence, and set up the trays.

10.7 CALIBRATION

10.7.1 Prior to calibration, make sure a minimum of 60-second rinse time and 60 second up take time is set up in the method/auto-sampler.

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10.7.2 Calibrate the instrument using calibration blank, standard #1, standard #2, and standard #3.

10.8 DAILY CALIBRATION

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10.8.1 Calibrate the instrument using calibration blank (8.8) and calibration standards (8.10.5).

10.8.2 When calibration is complete, a printout of slopes will be printed for each line and calibration is automatically approved.

10.9 Dilutions.

10.9.1 If a sample result exceeds the upper linear range of the calibration a dilution must be made using solution 8.8. The diluted result should be within the upper range of the calibration curve.

10.9.2 If particulate were observed in the samples, then they should be re-filtered along with the associated blanks.

11.0 QUALITY ASSURANCE

NOTE: It is recommended to profile the instrument every hour to ensure the optical alignment.

Note: The system must be rinsed with the calibration blank solution between each sample analysis for a minimum of 60 seconds.

11.1 Set up the autosampler sequence as described below.

11.2 Analyze the initial calibration verification (ICV - 8.11.1) The analyzed value of each analyte must be within 90%-110% of its expected value.

11.3 Analyze the Initial Calibration Blank (ICB) (8.8). The ICB results should be less than three times the IDL or less than 1/10 of the concentration of the action level of interest. (all ICB values should be less than the reporting limits for an element). If not, re-calibrate.

11.4 Analyze the Continuing Calibration Verification (CCV – 8.11.2) and Continuing Calibration Blank(CCB). The acceptance criteria for CCV and CCB are discussed in section 11.9.4.

11.5 Analyze the CRI standards at the beginning and the end of the run.

11.6 Analyze the Spectral Interference Check I (ICSA) and Spectral Interference Check II (ICSAB)

11.6.1 The analyzed value of Al, Ca, Mg, and Fe must be between 80-120%. The analyzed value of each remaining analyte in ICSA should be less than twice the reporting limit. If not, rerun one more time, if still not, either recalibrate or no sample for failed analyte in ICSA can be reported. You may have to perform inter-element correction of interfering elements.

11.6.2 The analyzed value of each analyte in ICSAB should be within $\pm$ 20% of its expected value. If not, repour and reanalyze. If still outside the limit, recalibrate. If after recalibration ICSAB is still outside the limit, you may have to perform interelement correction of interfering elements and recalibrate.

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11.6.3 The ICSA and ICSAB should be run prior to sample analysis and at the end of the run.

11.7 If all initial quality control steps mentioned above were satisfied, you may start the analysis of the samples.

11.8 For each analysis run a laboratory reagent blank (method blank), laboratory fortified blank (spike blank), laboratory control sample (LCS – for soil samples), laboratory fortified sample (matrix spike), a matrix duplicate must be analyzed. If samples that were prepared on several different days are analyzed, make sure that the method blanks and spike blanks from all of the preparation dates are also analyzed. (A matrix spike, matrix duplicate, spike blank, and a method blank are prepared with each set of 20 samples).

Analyte recovery: Until sufficient data becomes available the following limits should be exercised:

Spike Blank Recovery	± 20%
Spike Blank Duplicate RPD	≤ 20% (AQ) ≤ 30% (SO)
Matrix Spike Recovery	± 25% *
RPD	± 20%

Note: The Spike Blank Duplicate is an MCP/RCP requirement. A project-specific matrix duplicate or matrix spike duplicate may be used in lieu of the spike blank duplicate for MCP.

* If the % Recovery of an analyte falls outside the ± 25% limit but spike blank recovery falls within the accepted range, then the recovery problem is judged to be matrix related, not system related. Sample results need to be footnoted and a post spike must be analyzed. (Analyze the post digestion spike for the specific client request see section 9.2.2) Note, For some clients the unspiked aliquot of the sample should be spiked at two –times the indigenous level or two times their specific –required detection limit, which ever is greater. The results of post spike must be reported in their summary report (check with Dept. manager for client specific lists) If post spike recoveries are not within the 75%-125% criteria, a matrix effect should be suspected. The use of a standard addition analysis procedure can usually compensate for this effect.

For the soil LCS – the manufacturer QC limits should be used for evaluation.

The method blank results must be less than the reporting limit for an element. If not, and any sample results in the associated batch has a positive result for that element, the batch must be re-digested and reanalyzed.

11.9 For each analysis analyze the following:

11.9.1 A minimum of 1 serial dilution per analytical run. The analysis of a (1:5) dilution should agree within 10% of the original sample result. If the analyte concentration is not high enough and the serial dilution is not within 10 % of the original sample but less than 50 times the IDL for that analyte, serial dilution results are acceptable. In addition, serial dilution should be done on every sample that is from a significantly different matrix or if a matrix interference is

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suspected. If analysis of the dilution does not meet the 10% criteria, a matrix interference may be suspected.

11.9.2 Analyte Addition (Post Digestion Spike – PDS): An analyte spike added to a portion of prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the IDL for that element

11.9.3 Analyze CRI, the spectral interference check ICSA and ICSAB.

11.9.4 Analyze the continuing calibration verification (CCV) and continuing calibration blank (CCB) after every 10 samples and at the end of the sample run. The analyzed value of each analyte in the CCV should be within 90% to 110% of its expected value with relative standard deviation less than 5% between the replicates (minimum of three). If an analyte value is still outside the range, the instrument should be recalibrated and all samples following the last acceptable CCV solution should be reanalyzed. All calibration blanks (CCB) should be less than three times the IDL or less than 1/10 of the concentration of the action level of interest. (All CCB values should be less than the reporting limits for an element). If not, it can be reanalyzed two more times. The average of the three readings must be within 3 standard deviations of the background mean. If these criteria are not met, no samples can be reported in the area bracketed by the failing CCB for the failing elements.

11.9.5 Internal standard. Yttrium or a combination of yttrium and lithium (if minerals are going to be analyzed for) is used for an internal standard. Internal standard is added to all standards and samples. Acceptance criteria for the internal standard is ±30% as compared to the ICB.

11.9.6 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis, and if any major changes have been made to the instrument. Four replicates or blank spikes are analyzed using the same conditions for sample analysis. The percent recoveries are compared to limits as described in section 11.8 (spike blank). The standard deviation results of the 4 blank spike recoveries should be $\leq$ 20%. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.9.7 Linearity studies should be determined quarterly and whenever there is significant change in instrument response. The study must be performed using minimum 5 different concentration standards across the range, and 1 standard must be near the upper limit. Acceptance criteria for linearity studies is ±10%.

11.9.8 MDLs and IDLs are determined annually, or if significant maintenance has been performed on the instrument. The IDL concentration must be $\leq$ the MDL concentration. The study must be repeated for any analytes that do not meet this criteria.

11.9.9 Interelement spectral interference determination routine must be verified every 6 months.

11.9.10 Quality control data are generated at least on an annual basis by QA using an in-house program. Blank spike and MS/Dup data are pooled for the previous year (or other specified

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time frame) and the data is processed and evaluated by QA. The annual QC data is filed with QA.

11.9.11 All NELAC-accredited target compounds must be spiked in the blank spike and matrix spike within a two-year period. All target compounds reported for a project are spiked and evaluated in the blank spike and MS/MSD.

12.0 DOCUMENTATION

12.1 Make sure that all sample ID's and standard lot# are recorded in analysis log book. All comments and edits MUST BE clearly documented and initialed. Generate run logs from the LIMS system along with all quality control data.

12.2 Each analyst should review all data and assemble a data package consisting of :

- Print out of the digestion
- Print out of automated analysis runlog
- LIMS generated run log
- Raw data
- LIMS generated batch list
-

12.3 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.4 The Accutest lot number must be cross-referenced on the standard bottle. Expiration date must be noted on standard bottle.

12.5 The instrument Maintenance logbook must be completed daily. Each instrument will have a separate log.

12.6 All laboratory logbooks must be reviewed and initialed or signed by the lab manager. A signed or initialed copy of the logbook page filed with the daily batch is sufficient.

12.7 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

12.8 The inter-element spectral interference determination routine must be kept on file.

12.9 Linearity studies must be kept on file.

13.0 DATA REPORTING

13.1 A results page including positive results and/or RLs for all target elements, units, methodology, dates of digestion and analysis, data qualifiers, are reported. Additional quality control data including calibration summaries, MS/DUP percent recoveries and RPDs, blank spike recoveries, method and calibration blank results, and any associated raw support data may be reported upon request of the client.

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13.2 Data may be submitted to the client in a specified electronic format (EDD).

13.3 Data may be submitted to the client in PDF via e-hardcopy.

13.4 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

13.5 Procedures for handling non-conforming data.

13.5.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

13.5.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

14.0 DATA REVIEW

14.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

14.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

14.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

14.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of

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standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual quality control data generated by QA, and the annual MDL study results. Refer to section 3.0 for MDLs, and section 11.9.10 for QC data.

17.0 ADDITIONAL REFERENCES

17.1 MA DEP WSC-CAM IIIA, Rev. No. 5, 5/28/04

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Lab Manager: Doug Yargeau

QA Officer: Mark Warren

TITLE: **DETERMINATION OF VOLATILE ORGANICS USING GC/MS SYSTEM**

TEST METHOD REFERENCE: SW846 8260B, Rev. 2, December 1996

REVISED SECTIONS: 10.1.3, Note after 10.2.4

1.0 SCOPE & APPLICATION

1.1 The following method describes the analytical procedures which are utilized by Accutest to aquire samples for the analysis of volatile organic compounds. Refer to Tables 8, 9 or use the Compound List function in LIMS to view the compounds analyzed by this method. Additional compounds may be appended to the SOP.

1.2 This analytical method is designed for nearly all types of samples, regardless of water content, including groundwater, aqueous sludges, oily waste, sediments, and soils.

1.3 The purgeable organics can be quantitated by Gas Chromatograph/Mass Spectrometer (GC/MS) following purge and trap utilizing the internal standard technique.

1.4 The Reporting (RL) is based on the lowest calibration standard. RL'S may vary depending on matrix difficulties and sample volumes or weight and percent moisture. Additionally, RL's will vary between some compounds.

2.0 SUMMARY

2.1 This method is performed in accordance with EPA methodologies 8260B and 5030B (purge and trap), from SW-846, 3rd edition.

2.2 An inert gas is bubbled through a 5 ml sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and back flushed with the inert gas to desorb the purgeables onto a gas chromatographic (GC) column.

2.3 The volatile compounds are separated by the temperature programmed GC column and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information.

2.4 The peaks detected are qualitated by comparison to characteristic ions and retention times specific to the known target list of compounds.

2.5 Once identified the compound is quantitated by internal standard technique with an average response factor generated from a calibration curve containing a minimum of five points. . Additional points may be added to meet client requirements.

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2.6 Additional unknown peaks with a response > 10 % of the closest internal standard may be processed through a library search with comparison to a data base of approximately 70,000 spectra. An estimated concentration is quantitated by assuming a response factor of 1.

3.0 METHOD DETECTION LIMIT

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs. Refer to the MDL SOP (MQA245) for additional detail of procedures.

3.5 Current MDLs are entered into the LIMS, and can be viewed by printing out the compound list from the LIMS. Additionally, MDLs are reported on the result page upon client request. Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch.

4.3 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

4.4 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

4.5 CONTINUING CALIBRATION – analytical standard run every 12 hours to verify the initial calibration of the analytical system.

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4.6 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying in an oven.

4.7 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.8 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

4.9 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.10 HOLDING TIME – the elapsed time expressed in days from the date of sampling until the date of its analysis.

4.11 INTERFERENTS – substances which affect the analysis for the analyte of interest.

4.12 GAS CHROMATOGRAPH (GC) - the instrument used to separate analytes on a stationary phase within a chromatographic column. The analytes are volatized directly from the sample (VOA water and low-soil) volatized from the sample extract (VOA medium soil), or injected as extracts (SVOA and PEST). In VOA and SVOA analysis, the compounds are detected by a Mass Spectrometer (MS). In PEST analysis, the compounds are detected by an Electron Capture (EC) detector. In the screening procedure (all fractions), the Flame Ionization Detector (FID) is used as the detector.

4.13 INITIAL CALIBRATION - analysis of analytical standards for a series of different specified concentrations; used to define the linearity and dynamic range of the response of the mass spectrometer or electron capture detector to the target compounds.

4.14 INITIAL CALIBRATION VERIFICATION – analysis of a check standard from a second source (either vendor or lot) from the initial calibration standards to verify the initial calibration.

4.15 INTEGRATION TIME RANGE - the retention time at the beginning of the area of integration to the retention time at the end of the area of integration.

4.16 INSUFFICIENT QUANTITY - when there is not enough volume (water sample) or weight (soil/sediment) to perform any of the required operations: sample analysis or extraction, percent moisture, MS/MSD, etc.

4.17 MATRIX - the predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, a sample matrix is either water or soil/sediment. Matrix is <u>not</u> synonymous with phase (liquid or solid).

4.18 MATRIX EFFECT - in general, the effect of a particular matrix (water or soil/sediment) on the constituents with which it contacts. This is particularly pronounced for clay particles which may adsorb chemicals and catalyze reactions. Matrix effects may prevent extraction of target analytes, and may affect surrogate recoveries. In addition, non-target analytes may be extracted from the matrix causing interferences.

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4.19 MATRIX SPIKE - aliquot of a matrix (water or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

4.20 MATRIX SPIKE DUPLICATE - a second aliquot of the same matrix as the matrix spike (above) that is spiked in order to determine the precision of the method.

4.21 MASSACHUSETTS CONTINGENCY PLAN (MCP) – A Massachusetts Department of Environmental Protection (MA DEP) program which deals with environmental cleanups within the state. For the purposes of this SOP MCP specifically refers to data quality and reporting guidelines established under the MCP Data Enhancement Program.

4.22 METHOD BLANK - an analytical control consisting of all reagents, internal standards, and surrogate standards (or SMCs for VOA), that is carried throughout the entire analytical procedure. The method blank is used to define the level of laboratory, background, and reagent contamination.

4.23 METHANOL PRESERVATION DILUTION EFFECT – target analyte concentrations in solid samples preserved with methanol are subject to a systematic negative bias if the potential increase of the total solvent volume during the methanol extraction process is not considered. This increase in extraction solvent volume is a direct result of the solubility of the entrained sample moisture (water) in the methanol. The total solvent volume is the additive sum of the volume of methanol and the entrained sample moisture that partitions into the methanol during extraction. The volume of water partitioned is estimated from the percent moisture determination (and the assumption that 1 g of water occupies a volume of 1 ml). This is a conservative correction regarding calculated VOC concentrations because some fraction of the samples percent moisture may not partition into the methanol, due to various physiochemical binding forces. The total solvent/water volume (V_m) is calculation using the equation described in section 10.4.7. The potential for under reporting VOC concentrations is more pronounced the greater the percent moisture content of the sample.

4.24 PERCENT DIFFERENCE (%D) - As used in this SOW and elsewhere to compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero. (In contrast, see relative percent difference.)

4.25 PERCENT MOISTURE - an approximation of the amount of water in a soil/sediment sample made by drying an aliquot of the sample at 105 °C. The percent moisture determined in this manner also includes contributions from all compounds that may volatilize at or below 105 °C, including water. Percent moisture may be determined from decanted samples and from samples that are not decanted.

4.26 PURGE AND TRAP (DEVICE) - analytical technique (device) used to isolate volatile (purgeable) organics by stripping the compounds from water or soil by a stream of inert gas, trapping the compounds on an adsorbent such as a porous polymer trap, and thermally desorbing the trapped compounds onto the gas chromatographic column.

4.27 PURGEABLES - volatile compounds.

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4.28 REAGENT WATER - water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.29 RELATIVE PERCENT DIFFERENCE (RPD) - As used in this SOP to compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.30 RELATIVE RESPONSE FACTOR (RRF) - a measure of the relative mass spectral response of an analyte compared to its internal standard. Relative Response Factors are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples. RRF is determined by the following equation:

$$RRF = \frac{A_x}{A_{is}} x \frac{C_{is}}{C_x}$$

Where,

A = area of the characteristic ion measured
C = concentration, or amount (mass)
is = internal standard
x = analyte of interest

4.31 RELATIVE RETENTION TIME (RRT) - the ratio of the retention time of a compound to that of a standard (such as an internal standard).

$$RRT = \frac{RT_c}{RT_{is}}$$

Where,

RT_c = Retention time for the volatile target or surrogate compound in continuing calibration.
RT_{is}= Retention time for the internal standard in calibration standard or in a sample.

4.32 RESPONSE - or Instrumental Response: a measurement of the output of the GC detector (MS, EC, or FID) in which the intensity of the signal is proportionate to the amount (or concentration) detected. Measured by peak area or peak height.

4.33 SOIL - used herein synonymously with soil/sediment and sediment.

4.34 SURROGATES (Surrogate Standard) – for volatiles, semivolatiles and pesticides/Aroclors, compounds added to every blank, sample, matrix spike, matrix spike duplicate, and standard; used to evaluate analytical efficiency by measuring recovery. Surrogates are brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media.

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4.35 TWELVE-HOUR TIME PERIOD - The twelve (12) hour time period for GC/MS system instrument performance check, standards calibration (initial or continuing calibration), and method blank analysis begins at the moment of injection of the DFTPP or BFB analysis that the laboratory submits as documentation of instrument performance. The time period ends after 12 hours have elapsed according to the system clock. For pesticide/Aroclor analyses performed by GC/EC, the twelve hour time period in the analytical sequence begins at the moment of injection of the instrument blank that precedes sample analyses, and ends after twelve hours have elapsed according to the system clock.

4.36 VOLATILE COMPOUNDS - compounds amenable to analysis by the purge and trap technique. Used synonymously with purgeable compounds.

4.37 RETENTION TIME (RT) - the time a target analyte is retained on a GC column before elution. The identification of a target analyte is dependent on a target compound's retention time falling within the specified retention time window established for that compound. Retention time is dependent on the nature of the column's stationary phase, column diameter, temperature, flow rate, and other parameters.

4.38 DEIONIZED WATER (DI water) - water that has passed through Accutest's deionization system. Used as reagent water (water that an interferant is not observed at or above the minimum quantitation limit of the parameters of interest).

4.39 SPIKE BLANK OR LABORATORY CONTROL SAMPLE (LCS) – A blank spiked with a known concentration of analyte (from a second source from the calibration standard) or an external quality control standard with a known concentration of analyte used to determine accuracy of the method.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIMES

6.1 Collection and Preservation

6.1.1 Soil/Sediment: Refer to SOP MSM207 (Collection and Preservation of Solid Samples for Volatile Organics Analysis by SW846 5035 Methodology).

6.1.2 Aqueous: Samples are collected in certified pre-cleaned 40 ml VOA vials equipped with a teflon-lined silicone septum cap. Samples must be preserved with 1: 1 HCL to a pH of < 2. The pH of the samples are checked using wide-range pH paper <u>after</u> the sample is analyzed. A clean Pasteur pipette is used to obtain a small aliquot of the sample, and it is applied to the wide-range pH paper. The pH is noted in the analysis log. Water samples must be checked for headspace. The client must be notified of any samples exhibiting headspace greater than "pea size" (>6mm). The client must provide permission to

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analyze any samples with headspace greater than "pea-size", and this permission must be documented with the project.

Note: The pH of aqueous volatile samples must be checked AFTER analysis. If sample is not properly preserved, this information must be communicated to the client.

6.1.3 Volatile samples must be protected from light and stored segregated from samples for other analyses at a temperature of 4°C ± 2°C from the time of receipt to analysis.

6.2 Hold Time: Samples must be analyzed within 14 days of sampling.

7.0 APPARATUS & MATERIALS

7.1 SYRINGE

7.1.1 10, 25, 50, 100, 500 and 5000 ul graduated syringes, manually held (Hamilton or equiv.).

7.1.2 5 ml glass gas tight syringes with Luerlok end, if applicable to the purging device.

7.2 BALANCE

7.2.1 Analytical balance capable of weighing 0.0001 gram.

7.2.2 Top-loading balance capable of weighing 0.1 g.

7.3 PURGE AND TRAP DEVICES

7.3.1 Tekmar LSC2000, Solatek 72, Velocity XPT, Aquatek 70 and O.I. Analytical 4552, 4560, 4660 (Eclipse), and 4551-a are used for purging, trapping and desorbing the sample into GC column.

7.3.2 The sample purge vessel must be designed to accept 5 ml samples with a water column at least 3 cm deep.

7.3.3 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 inch. The trap must be packed to contain the following absorbents (3-ring):

7.3.3.1 2,6-Diphenylene oxide polymer.
7.3.3.2 Silica gel.
7.3.3.3 Charcoal packing.
7.3.3.4 Or equivalent

7.3.4 The trap should be conditioned according to manufacturer specifications by back flushing with a Helium gas flow of at least 20 ml/min prior to use.

7.3.5 The desorber should be capable of rapidly heating the trap to 180°C for desorption.

7.3.6 O.I. 4552 and Solatek 72 is equipped with sample heater for analyzing low-level soils.

7.4 GAS CHROMATOGRAPH/MASS SPECTROMETER SYSTEM

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7.4.1 Gas Chromatograph.

7.4.1.1 An alytical system complete with a temperature programmable gas chromatograph and all required accessories including syringes, analytical columns, and gases.

7.4.2 Column.

7.4.2.1 For 5890: 75 m x 0.53 mm I.D., 3 um film DB-624; J&W Scientific. Or equivalent. For 6890: 60 m x 0.25 mm I.D., 1.4 um film DB-VRX; J&W Scientific. Or equivalent.

7.4.3 Mass Spectrometer.

7.4.3.1 Capable of scanning from 35-260 amu every second or less utilizing a 70 volt (nominal) electron energy in the electron impact ionization mode.

7.4.3.2 Capable of producing a mass spectrum which meets all the criteria in Table 2 when injecting 50 ng of Bromofluorobenzene(BFB).

7.5 DATA SYSTEM

7.5.1 A computer system is interfaced to the mass spectrometer which allows the continuous acquisition and storage on machine readable media (disc) of all mass spectra obtained throughout the duration of the chromatographic program.

7.5.2 The computer utilizes software which allows searching any GC/MS data file for target analytes which display specific fragmentation patterns.

7.5.3 The Enviroquant data system is capable of quantitation using multipoint calibration and multipoint internal standards.

7.5.4 The recent version of the EPA/NIH mass spectral library (70,000 compounds) is being used for non target peak tentative identification.

7.5.5 Data can be archived to magnetic tape for long term storage.

8.0 STANDARDS & REAGENTS

Note: All applicable standard/reagent preparation information, including vendor, lot number, date of preparation, date of expiration, calculations, and initials must be entered in the appropriate standard/reagent preparation logbook. Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

8.1 Solvent

8.1.1 Methanol: Omni Solvent or equivalent. Store apart from other solvents.

8.2 Reagent water

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8.2.1 Reagent water is defined as water in which an interferant is not observed at the method detection limit of the parameters of interest.

8.2.1.1 Reagent water is generated by either passing tap water through a bed of approximately one pound of activated carbon or by using the water purification system at Accutest which is a series of deionizers and carbon cartridges.

8.3 Stock standard solutions

8.3.1 Commercially prepared standards used:

Calibration Standards:

- Ethanol standard M-502A-R-10X @ 100,000 ug/ml
- M-502A-R-10X 2.0 mg/ml
- M-502B-10X @ 2.0 mg/ml
- Cus-6580 Ultra
- Cus-6581 Ultra
- O-Cymene @ 2470 ug/ml

Spike standards (second source)

- Ethanol standard @ 100,000 ug/ml
- Cus-6580-ICV @ various conc.
- Cus 6581-ICV @ various conc.
- M-502-10X
- O-cymene @ 2150 ug/ml

Or equivalent standards.

8.3.2 Stock standard solutions (except gases) must be replaced after 6 months or according to manufacturers expiration date if comparison with quality control check samples indicates a problem.

8.3.2.1 The purgeable gases standard may need to be replaced weekly or sooner if comparison to quality control samples indicates a problem. Purgeable gas standards may be kept longer than a week if acceptability can be documented by the calibration check standard.

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8.3.2.2 Stock standard solutions should be stored according to manufacturers specifications. Opened ampules should be stored at -10°C to -20°C except for acrolein/acrylonitrile (solution in water) – should be refrigerated at 4°C ± 2°C (or stored according to the manufacturer).

8.4 Internal Standard and Surrogate Solution.

8.4.1 Four internal standards (see Table 3) are used that exhibit similar analytical behavior to the compounds of interest:

Internal Std: Ultra, Internal Standard Mixture # STM-341N ; 2.0 mg/ml in methanol or equivalent; TBA-d9 ISTD Restek, 50,000 ug/ml or equivalent.

Surrogate: Ultra, Surrogate Standard Mixture # STM-330N; 2.0 mg/ml in methanol or equivalent. Refer to section 8.3.2.2 for storage conditions.

8.5 Working standards

8.5.1 A 200 ug/ml working standard is used for the O.I. 4552 and 4551a autosamplers. A 1:10 dilution of these standards may also be prepared to use in the 3 lowest calibration levels.

8.5.1.1 The blank spike and matrix spike solutions are prepared independently from the calibration standards using a different vendor or lot number. Note: It is recommended to use a different vendor – if unavailable verify that the source materials are from separate lots.

8.5.2 See Table 10 for preparation of working standard.

8.5.4 Working standard solutions should be stored at -10°C to -20°C.

9.0 INTERFERENCES

9.1 The data from all blanks, samples, and spikes must be evaluated for interferences.

9.2 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. The use of non-TFE tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

9.3 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal into the sample during shipment and storage. A field blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

9.4 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

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10.0 PROCEDURE

10.1 CALIBRATION (See Section 10.1.6.4 before proceeding)

10.1.1 The calibration range covered by the standards is 0.5, 1, 2, 5, 25, 50, 100, 200, 400 ug/l. The ICAL analyzed for Army Corps project samples must have a low standard no lower than 5 ppb. Refer to the specific Army Corps project QAPP for additional guidance for the ICAL analysis. The Analyte Reporting Limit (RL) can not be lower than the lowest calibration level utilized.

10.1.2 The linear range covered by this calibration is 100 % of highest concentration standard (up to 400 ug/L).

10.1.3 For the O.I. autosamplers internal standards are added from a reservoir at a concentration of 250 ug/ml. For the Tekmar autosamplers internal and surrogate standards are added from a reservoir at a concentration of 125 ug/ml. 1 ul is added to the standard, sample or blank prior to analyses (O.I), and 2 ul is added to the standard, sample, or blank prior to analyses (Tekmar). Surrogate standards are added to each calibration standard at the same level as corresponding target analytes.

10.1.4 Each analyte is quantitatively determined by internal standard technique using the closest eluting internal standard and the corresponding area of the major ion. See Table 7.

10.1.5 The Response Factor (RF) is defined in section 10.4.1.

10.1.6 Initial calibration

The following criteria must be met for the initial calibration to be valid.

10.1.6.1 The percent relative standard deviation (% RSD) (see section 10.4.2) of calibration check compound (CCC) (see Table 5) must be $\leq$ 30 %. The % RSD should be $\leq$ 15% for the rest of the compounds for quantitation versus an average response factor to take place. For compounds with % RSD > 15, linear regression or quadratic curve may be used provided the linear coefficient of determination is greater than or equal to 0.990 . A minimum of five calibration levels must be used for a Linear regression and a minimum of six levels must be used for a Quadratic curve. Forcing the curve through the origin (zero) is acceptable in some instances (If used – verify acceptability with the department supervisor).

10.1.6.2 The minimum average response factor (RF) of the system performance check compound (SPCC) (see Table 5) is 0.300 ($\geq$0.10 for Bromoform and 0.10 for chloromethane and 1,1-Dichloroethane).

10.1.6.3 Evaluation of retention times. The relative retention time of each target analyte in each calibration standard should agree within 0.06 relative retention time units.

10.1.6.4 Internal standard area response should not drift by more than a factor of 2 (one half or 2X) as compared to the mid-level standard. All standards run during the initial calibration must pass this criteria.

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10.1.6.5 The analyst is allowed to remove a low point or a high point on a curve to meet criteria. Middle points may not be removed unless there is clear evidence of some obvious error (such as a poor purge or an incorrect spike concentration) – and this must be confirmed by a supervisor and documented in the instrument run logbook. Removal of a low point to meet criteria will raise the reporting limit, while removal of a high point will lower the calibration range. The minimum of 5 (or 6 points for quadratic) points must be maintained.

10.1.6.6 The concentration of the calibration standard at the upper limit of the curve will be reduced if the instrument response indicates signs of detector saturation.

10.1.6.7 An initial calibration is a single event. Reanalysis of a calibration standard must occur within the same tuning period as the initial calibration – and before sample analysis occurs.

10.1.6.8 For Selective Ion Monitoring (SIM) analysis the initial calibration curve uses lower concentration calibration standards than normal analyses: 0.1, 0.5, 1.0, 5.0, 20, 50, and 100 ppb (may vary). Additionally, since SIM analysis is usually performed for a small number of compounds, the CCCs and SPCCs may not be analyzed and evaluated. In this case the target compounds will be evaluated against an RF acceptance criteria of a minimum of 0.05 and an RSD acceptance criteria of less than 15%.

10.1.7 Initial calibration verification (ICV)

10.1.7.1 The initial calibration is verified for accuracy immediately following the last standard with a verification standard from a source independent of the calibration standards (either a lot or vendor different from the calibration standards – preferably a different vendor). ICV acceptance criteria are the same for CCC and SPCC compounds as the calibration check acceptance criteria 10.1.8.3 and 10.1.8.4) Acceptance criteria for non-CCC compounds is $\leq$ 30%D. However, up to 10% of the non-CCC compounds may exceed this criteria as long as the %D is $\leq$ 50%.

10.1.7.2 The SIM ICV is analyzed at a concentration of 5.0 ppb (may vary). Acceptance criteria is $\leq$ 30%D (evaluate CCC and SPCC compounds as previously described if analyzed).

10.1.8 Calibration Check (CBCHK)

10.1.8.1 A continuing calibration check standard at mid-level concentration (100 ug/ml) must be acquired every 12 hrs. All continuing and initial calibration standards are prepared in volumetric flasks and transferred to 40 ml vials.

10.1.8.2 The RF's generated for each parameter must be compared to the average RF in the Initial calibration for each analyte to determine the percent difference (% D) (see section 10.4.3).

10.1.8.3 The minimum RF of check standard for SPCC compound is 0.300 $\geq$0.10 for Bromoform, 0.10 for chloromethane and 1,1-Dichloromethane

10.1.8.4 The % D for CCC compounds must be less than or equal to 20.

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10.1.8.5 The % D for non-CCC compounds must be less than or equal to 30. Up to 10% of the non-CCC compounds may exceed 30% D as long as the %D is ≤ 50%.

10.1.8.6 If the above specified criteria are met, the continuing calibration is considered valid.

10.1.8.7 If either of the criteria fail, corrective action must be performed. Standard data is evaluated to determine if an analytical system problem exists. If there is problem which does not require making major changes to the system, then those changes are made and the continuing calibration is re-analyzed. If a major problem exists or major changes need to be performed, then the Supervisor is notified for further instruction.

10.1.8.8 If any of the internal standard areas change by a factor of two (- 50% to + 100%) from the last mid-point initial calibration standard, the analytical system must be inspected for malfunctions and corrections will be made, as appropriate.

10.1.8.9 If the retention time for the Internal Standards change by more than 30 seconds from the most recent mid-point initial calibration standard, the system must be inspected for malfunctions. When corrections are made the sample must be reanalyzed.

10.1.8.10 A calibration check may only be repeated once. If the second analysis fails, a new initial calibration must be performed. In situations where the first check fails to meet criteria, the instrument logbook should have clear documented notations as to what the problem was and what the corrective actions was performed to enable the second analysis to meet criteria.

10.1.8.11 If the calibration verification is being performed using an autosampler for night batch analysis, two vials of standard solution may be set up for analysis. The second standard must meet calibration check criteria. The second check may be discarded due to poor purge or incorrect spike concentration – however, the first check must meet criteria. This scenario must be approved by the supervisor, and documented in the instrument run logbook.

10.1.8.12 The SIM calibration check is analyzed at a concentration of 5.0 ppb (may vary). Acceptance criteria is ≤ 30%D (evaluate CCC and SPCC compounds as previously described if analyzed).

10.2 ANALYSIS

10.2.1 Instrument conditions.

10.2.1.1 Recommended instrument conditions are listed in Table 1 Modifications are allowed as long as criteria of calibration are met.

10.2.1.2 For SIM analysis, the Scan Parameters are changed. Scanning windows are established in the instrument run method which use a minimum of one target ion and one secondary ion for each target analyte. Appropriate time is allowed for the elution of each peak of interest.

10.2.2 Purge and Trap Conditions.

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10.2.2.1 Recommended instrument conditions are listed in Table 1.

10.2.3 Daily GC/MS performance check.

10.2.3.1 Every 12 hours, evaluate the BFB tune (using the calibration check).

10.2.3.2 The GC/MS system must be checked to verify acceptable performance criteria are achieved (see Table 2)

10.2.3.3 This performance test must be passed before any samples, blanks or standards are analyzed.

10.2.3.4 If all the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are met.

10.2.3.5 The injection time of the acceptable tune analysis, is considered the start of the 12 hour clock.

10.2.4 Procedure for the evaluation of the BFB tune.

Note: The BFB Tune may be performed either as a separate analysis or evaluated from the daily calibration check.

10.2.4.1 Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.

10.2.4.2 Background subtraction is required, and must be accomplished using a single scan acquired no more than 20 scans prior to the elution of BFB. The background subtraction should be designed only to eliminate column bleed or instrument background ions. Do not subtract part of the BFB peak.

10.2.4.3 As a secondary procedure, an individual scan (the apex or the scans preceding or following the apex) may be used. Background subtraction may be used in the same manner as the first approach.

10.2.5 Daily calibration check

10.2.5.1 See section 10.1.8

10.2.6 Method blank (reagent water)

10.2.6.1 An acceptable method blank must be analyzed for every 12 hour time period.

10.2.6.2 For O.I. and Tekmar autosamplers, fill a clean 40 ml voa vial with deionized water. Replace teflon lined cap being sure not to leave any air bubbles in vial. Analyze as per 10.2.

10.2.6.3 Surrogates must meet in-house acceptance limits (or other regulatory program/client QAPP limits as applicable).

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10.2.6.4 Evaluate the method blank for target compound contamination to the MDL. If target compounds are detected in the method blank above ½ the RL, the source of contamination must be identified and corrective action must be taken (and documented in the run log) before continuing with sample analysis. The method blank must be re-analyzed and evaluated before sample analysis can begin (must meet surrogate and contamination criteria). Common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and chloroform may not be present in the method blank greater than 5 times the RL.

10.2.7 Sample analysis

10.2.7.1 Rinse 5 ml syringes at least three times with organic-free water (reagent water).

10.2.7.2 Establish dilution of sample in order to fall within the upper portion of the calibration range.

10.2.7.2.1 from acquired sample data.
10.2.7.2.2 from history program.
10.2.7.2.3 sample characteristics (appearance, sheen, etc.)

10.2.7.3 Water sample

10.2.7.3.1 Place 40 ml vial into appropriate position on autosampler.
10.2.7.3.2 Record pH using 0-14 pH paper and record in logbook.
10.2.7.3.3 The pH is checked after analysis is completed (refer to section 6.1.2).

10.2.7.4 Sediment/ soil sample

<u>Low-level soil method (Requires separate initial and continuing calibrations)</u>

- Low level initial calibrations and calibration checks are prepared in sodium bisulfate solution.

10.2.7.4.1 Low level soils are collected in the field preserved in sodium bisulfate. If sample is not preserved – the analyst adds 5 mls of DI water to 5 g of sample (and a stir bar) in a 40 ml voa vial. Soil samples are generally purged on O.I. 4552 instrumentation. Surrogates and IS are loaded onto the instrument (in vials) and automatically injected into the sample. The samples are heated, stirred, and purged onto the trap.
10.2.7.4.2 Alternately, accurately weigh approximately 5 g (or less) sample into clean 40 ml voa vial.
10.2.7.4.3 Add 5 ml reagent water and 1 stir bar to voa vial.
10.2.7.4.4 Place vial into autosampler.

<u>Medium-level soil method</u>

- Medium level initial calibrations and calibration checks are prepared in water containing methanol equivalent to a 1:50 dilution.

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The sample should be extracted in methanol if sample contains analytes above working calibration range or exhibits severe matrix interference.

10.2.6.4.5 weigh 10 g sample into VOA vial containing 10 ml methanol and seal with Teflon lined septum.
10.2.6.4.6 mix by hand shaking vigorously for 1 minute.
10.2.6.4.7 let settle.
10.2.6.4.8 aliquot proper amount of extract by using gas tight microsyringe.
10.2.6.4.9 add aliquoted sample (extract) to a 50 ml volumetric flask (filled to mark with DI water). Cap and swirl gently (or invert gently 3 times) to mix.

10.2.6.5 For medium-level soil analyses, add 5 ul of 50 ug/ml internal standard (I.S.) to syringe containing sample. The concentration of each I.S. should be 50 ug/l without any dilution factors.

10.2.6.6 Fill a 40 ml voa vial with the diluted sample extract (no headspace) and place in autosampler.

10.2.6.7 For analysis of low-level soils soils, heat the sample vial to 40°C while purging and stirring the sample for 11 minutes with Helium. Water samples are not heated. Sample dry purge time is 2 minutes for both matrices.

10.2.6.8 Desorb the sample for 1-4 minutes by rapidly heating the trap to 180°C while backflushing with Helium. The desorb time should be set based on the trap manufacturer's specification.

10.2.6.9 Bake the trap for 12 minutes at 225°C or at the manufacturers specifications to remove any residual purgeable compounds.

10.2.6.10 If the quantitation value for any analyte exceeds the working range of the GC/MS system, dilute the sample and re-analyze.

Note: Internal standard and surrogate is added by the autosampler

10.3 DATA INTERPRETATION

10.3.1 Qualitative identification.

10.3.1.1 The targeted compounds shall be identified by analyst with competent knowledge in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. The analyst or supervisor may use professional judgement to supercede identification criteria in certain cases (especially when evaluating low-level results). The criteria required for a positive identification are:

10.3.1.2 The sample component must elute at the same relative retention time (RRT) as the daily standard. Criteria is the RRT of sample component must be within ± 0.06 RRT units of the standard.

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10.3.1.3 All ions present in the standard mass spectra at a relative intensity greater than 10% (major abundant ion in the spectrum equals 100%) must be present in the sample spectrum.

10.3.1.4 The relative intensities of these ion must agree within ± 30% between the daily standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80%).

10.3.2 Quantitative analysis.

10.3.2.1 When a target compound has been identified, concentration (see section 10.4) will be based on the integrated area of the quantitation ion, normally the base peak (see Table 7).

10.3.2.2 If the sample produces an interference for the primary ion, use a secondary ion to quantitate (see Table 7). This is characterized by an excessive background signal of the same ion which distorts the peak shape beyond a definitive integration. Also an interference could severely inhibit the response of the internal standard ion.This secondary ion must also be used to generate new calibration response factors.

10.3.3 Library search for tentatively identified compounds.

10.3.3.1 If a library search is requested, the analyst should perform a forward library search of NBS mass spectral library to tentatively identify 15 non-reported compounds.

10.3.3.2 Guidelines for making tentative identification are:

10.3.3.2.1 These compounds should have a response greater than 10% of the nearest internal standard. The response is obtained from the integration for peak area of the Total Ion Chromatogram (TIC).

10.3.3.2.2 The search is to include a spectral printout of the 3 best library matches for a particular substance. The results are to be interpreted by analyst.

10.3.3.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

10.3.3.2.4 Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) should be present in the sample spectrum.

10.3.3.2.5 The relative intensities the major ions should agree within ± 20%.

10.3.3.2.6 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

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10.3.3.2.7 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible background subtraction from the sample spectrum because of background contamination or coeluting peaks.

10.3.3.2.8 Quantitation of the tentatively identified compounds is obtained from the total ion chromatogram based on a response factor of 1 and is to be tabulated on the library search summary data sheet.

10.3.3.2.9 Quantitation will be performed by using the nearest internal standard.

10.3.3.2.10 Report result as estimated.

10.4 CALCULATION

10.4.1 Response Factor (RF)

$$RF = \frac{As \ x \ Cis}{Ais \ x \ Cs}$$

where: As = Area of the characteristic ion for the compound being measured.
Ais = Area of the characteristic ion for the specific internal standard.
Cs = Concentration of the compound being measured (ug/l).
Cis = Concentration of the specific internal standard (ug/l).

10.4.2 Percent Relative Standard Deviation (% RSD)

$$\%RSD = \frac{SD}{RFav} \ x \ 100$$

where: SD = Standard Deviation
RFav = Average response factor from initial calibration.

10.4.3 Percent Difference (% D)

$$\%D = \frac{|RFav - RFc|}{RFav} \ x \ 100$$

where: RFc = RF from continuing calibration (CBCHK)

10.4.4 Concentration (Conc.)

<u>For water:</u>

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$$Conc.\ (ug / l) = \frac{Ac \times Cis \times Vp}{Ais \times RFav \times Vi}$$

For soil/sediment (on a dry weight basis):

$$Conc.\ (ug / kg) = \frac{Ac \times Cis \times Vp}{Ais \times RFav \times Ws \times M}$$

Where: Ac = Area of characteristic ion for compound being measured.
Vp = 5 ml (Total Purge Volume)
Vi = Initial volume of water purged (ml).
Ws = Weight of sample extracted (g).
M = (100 - % moisture in sample) / 100 or % solids / 100

10.4.5 Percent Recovery (% R)

$$\%R = \frac{Concentration\ Found}{Concentration\ Spiked} \times 100$$

10.4.6 Relative Percent Difference (RPD)

$$RPD = \frac{|MSC - MSDC|}{(\frac{1}{2})(MSC + MSDC)} \times 100$$

Where: MSC = Matrix Spike Concentration
MSDC = Matrix Spike Duplicate Concentration

10.4.7Data Correction for Target Analyte Calculations for Methanol Preservation Dilution Effect.

10.4.7.1 Results for soil/sediment samples must be corrected for the Methanol Preservation Dilution Effect. The potential for under reporting results is more pronounced the greater the percent moisture content of the sample if this procedure is not used.

10.4.7.2 ml solvent/water (Vm) = ml methanol + ((%moisture/100) X g of sample) – this calculation is automatically performed by the LIMS.

11.0 QUALITY ASSURANCE

11.1 QC Requirements Summary

BFB	Every 12 hrs.
ICV	Every ICAL
Calibration Check std.	Every 12 hrs.

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Method blank	Every 12 hrs. and/or every batch*
Blank Spike*	Every 12 hrs. and/or every batch*
Blank Spike Duplicate**	Every 12 hrs. and/or every batch*
Matrix Spike	one per 20 samples.
Matrix Spike Duplicate	one per 20 samples.
Blank Spike	one per batch.*
Surrogate	every sample and standard.
Internal Standard	every sample and standard.

*The maximum number of samples per analytical batch is twenty.
**MCP Requirement.

11.2 Daily GC/MS performance check - refer to section 10.2.3

11.3 ICV – refer to section 10.1.7

11.4 Daily calibration check - refer to section 10.1.8

11.5 Method blank (reagent water) - refer to section 10.2.5

11.6 Matrix Spike(MS)/Matrix Spike Duplicate(MSD).

11.6.1 One sample is selected at random from each analytical batch of similar matrix types and spiked in duplicate with select compounds to check precision and reproducibility.

11.6.2 Matrix spikes are prepared by spiking an actual sample at a concentration of 50 ug/l or 50 ug/kg based on 5 g dry weight. This is analyzed as outlined in 10.2.

11.6.3 Percent recoveries (% R) (see section 10.4.5) are compared to 70-130% or to in-house control limits.

11.6.4 A relative percent deviation (RPD) (see section 10.4.6) is calculated and compared to acceptance criteria of 30 or to in-house control limits.

11.6.5 If matrix spikes do not meet criteria and the QC check sample (blank spike) passed acceptance criteria, a matrix interference is to be assumed and the data is reportable and must be footnoted.

11.6.6 A relative percent deviation (RPD) (see section 10.4.6) is calculated and must $\leq$ 20.

11.6.7 If matrix spikes do not meet criteria and the QC check sample (blank spike) passed acceptance criteria (in-house limits), a matrix interference is to be assumed and the data is reportable and must be footnoted.

11.7 Blank Spike/Blank Spike Duplicate.

NOTE: **The BSPD is an MCP requirement.**

11.7.1 Reagent water is used for the Blank Spike.

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11.7.2 Blank Spikes are prepared by adding 5uls of blank Spike solution (prepared independently and from a second source as the calibration standards) to 5mls reagent water. For O.I. 4552 and 4551a , 10 uls are added to 40 mls. reagent water. See Table 10 for standard preparation. For the MCP, the blank spike is prepared and analyzed in duplicate.

11.7.3 Percent recoveries are compared to 70-130% or in-house acceptance limits. The RPD acceptance criteria is less than or equal to 25. If RPD criteria is not met, the source of the non-conformance must be determined and resolved before sample analysis can proceed. If samples have been analyzed, the non-conformance must be discussed in the case narrative.

11.7.4 Blank spike values are used to verify results when Matrix spike/matrix spike duplicate results indicate a potential problem due to sample matrix.

11.7.5 If blank spike recoveries are biased high, and sample results are non-detected, these results may be reported without qualification. If blank spike recoveries are biased low, the samples (and blank spike) must be re-analyzed.

11.8 Surrogate

11.8.1 All blanks, samples, and standards contain surrogate compounds which are used to monitor method performance.

11.8.2 If the recovery of any surrogate compound does not meet the control limits specified by in-house acceptance limits the calculation must be checked.

11.8.3 The sample must be reanalyzed if the recovery of any one surrogate is out of control limits of 70-130% or in-house control limits.

11.8.4 Above conditions (section 11.8.3) are not required for samples having severe matrix interference problems.

11.8.5 If surrogate recoveries are acceptable upon reanalysis, the data from the reanalysis is reported. If the reanalysis date did not meet the hold time, then both sets of data have to submitted with the reanalysis reported.

11.8.6 If surrogates are still outside control limits upon reanalysis, then both sets of data should be submitted with the first analysis reported.

11.9 Internal Standard.

11.9.1 Retention time for all internal standard must be within ± 30 seconds of the corresponding internal standard in the latest continuing calibration or 100 ug/l standard of initial calibration if samples are analyzed directly following an initial calibration.

11.9.2 The area (Extracted Ion Current Profile) of the internal standard in all analyses must be within 50 to 200% of the corresponding area in the latest calibration standard (12 hr. time period).

11.9.3 If area of internal standard does not meet control limits, the calculations must be checked. If a problem is not discovered, the sample must be reanalyzed.

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11.9.4 If areas are acceptable upon reanalysis, the reanalysis data is reported.

11.9.5 If areas are unacceptable upon reanalysis, then both set of data are submitted with the original analysis reported.

11.10 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recoveries are compared to 70-130% or in-house control limits. The standard deviation of the 4 replicate percent recoveries are compared to 30 or in-house limits. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.11 Quality control limits are generated at least on an annual basis by QA using an in-house program. Blank spike, MS/MSD, and surrogate QC data are pooled for the previous year (or other specified time frame) and the data is processed and evaluated by QA. The new limits are maintained on the QA server. The annual QC limit data is filed with QA.

11.12 All NELAC-accredited target compounds must be spiked in the blank spike and matrix spike within a two-year period. All target compounds reported for a project are spiked and evaluated in the blank spike and MS/MSD.

11.13 Cleanup blanks.

11.13.1 Blanks may be analyzed in certain situations in order to clean up the analytical system or prevent carryover to client samples. However, the analysis of these cleanup blanks must be performed in a manner which does not bias analytical results or create unfair treatment of quality assurance samples.

11.13.2 A clean up blank may be analyzed after the calibration check and blank spike or MS/MSD in order to prevent low-level (< the RL) carry-over of heavier compounds such as naphthalene and trimethylbenzenes. It may not be necessary to analyze a clean up blank after the MS/MSD if the client does not require estimated ("J" flag) results or if the heavier compounds are not to be reported.

11.13.3 A clean up blank should be analyzed after a suspected highly contaminated sample in order to prevent carryover. If samples analyzed after the clean up blank exhibit concentrations consistent with carryover (and the clean up blank also exhibits these low concentrations) then either the affected samples should be re-analyzed or results narrated.

12.0 DOCUMENTATION

12.1 The analytical logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

12.2 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.3 The standard preparation logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

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12.4 The Accutest lot number must be cross-referenced on the standard vial.

12.5 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.6 All laboratory logbooks must be reviewed and initialed or signed by the lab manager.

12.7 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.3 The Client Services Staff performs a tertiary review on all data prior to release to the client that includes a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

13.5 Follow the client or regulatory program – specified technical specifications for quality control evaluation as applicable. These technical specifications are found in the "Client Tech Specs" folder on the QA server (LINUXMA1). Any special requirements – including client or regulatory program technical specifications – will be described in the project comments field in the daily work list.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, surrogate recoveries, analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/MSD (or duplicate) percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client. Raw data may be reported to the client on request.

14.2 Data may be submitted to the client in a specified electronic format (EDD).

14.3 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

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14.4 Data assessment and acceptance criteria for quality control. For samples collected under the MCP: If QC do not meet acceptance criteria (method blank, blank spike, surrogate recoveries, and internal standard area counts) and are reanalyzed outside of the recommended holding time – the lab must report results of both the initial and reanalysis. For surrogate recoveries and internal standard area counts– if the sample is not reanalyzed due to obvious interference the lab must provide a copy of the chromatogram.

14.5 Procedures for handling non-conforming data.

14.5.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.5.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual quality control limits generated by QA, and the annual MDL study results. Refer to section 3.5 for MDLs, and section 11.11 for QC limits.

17.0 ADDITIONAL REFERENCES

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17.1 SW846 5030B, Rev. 2, December, 1996, SW846 5035 Rev. 1, December, 1996, SW846 5035A, Draft Rev. 1, December 1996, SW846 8000C, Rev. 3, March, 2003, MA DEP WSC-CAM-IIA, Rev. 4, 5/28/04

Table 1

RECOMMENDED OPERATING CONDITION

Gas Chromatograph/ Mass Spectrometer	5890/5970MSD	6890/5975/ 6890/5973
Carrier Gas(linear velocity)	Helium at 30 cm/sec	1.2 ml/min
Mass range	35 - 260 amu	"
Electron Energy	70 volts (nominal)	"
Scan time	not to exceed 7 sec. per scan	"
Injection port temperature	250degC	"
Source temperature	200 – 250degC	"
Transfer line temperature	250 – 300degC	"
Analyzer temperature	220 – 260degC	"
Initial temperature	36degC	42
Time 1	3 minutes	2 minutes
Column temperature rate	8deg/min.	10deg/min to 80degC 14deg/min to 210degC 16deg/min to 240degC
Final temperature	200degC. 3 min. hold	80degC 2.9min hold
Total run time	30 minutes	20 minutes

Purge and Trap Unit

Water Samples

Purge flow	40 mls/ min.
Purge time	11 min.
Dry Purge	2 min
Desorb preheat	175degC
Desorb	1-4 min. at 180 degC
Bake	8-12 min. at 225degC
Transfer line	100 – 110degC
Valve temperature	approx. transfer line temp.

Purge and Trap Unit

Soil Samples

Purge flow	40 mls/ min.
Purge time	11 min.
Dry Purge	2 min
Desorb preheat	175degC
Desorb	4 min. at 180degC
Bake	8-12 min. at 200 - 225degC

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Transfer line	100 – 110degC
Valve temperature	approx. transfer line temp.
Preheat	40degC
Preheat time	3 min.

These conditions are recommendations and may be optimized.

Table 2

BFB KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
50	15 - 40 of mass 95
75	30 - 60 of mass 95
95	Base peak, 100% relative abundance
96	5 - 9% of mass 95
173	<2% of mass 174
174	>50% of mass 95
175	5 - 9% of mass 174
176	>95% and <101% of mass 95
177	5 - 9% of mass 176

Table 3

INTERNAL STANDARD

Internal Standard	Prim./Sec. Ions
Pentafluorobenzene	168
Chlorobenzene-d5	117 / 82, 119
TBA-d9	65/46
1,4-Difluorobenzene	114 / 63, 88
1,4-Dichlorobenzene-d4	152, 115, 150

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Table 4

SURROGATES

Compound	(Prim./Sec. ions)	Control Limit (%)	
		Water	Soil
Dibromofluoromethane	(113)	70-130%	70-130%
Toluene-d8	(92 / 91,65)	70-130%	70-130%
4-Bromofluorobenzene	(95 / 174,176)	70-130%	70-130%

Table 5

Criteria for CCC and SPCC

Initial Calibration: Maximum % RSD for CCC is 30%

Continuing Calibration: Maximum % D for CCC is 20%

Minimum acceptable average relative response factor (RRF) is 0.300 for SPCC ($\geq$0.10 for Bromoform, chloromethane & 1,1 Dichloroethane).

Calibration check compounds (CCC)

Volatile
Vinyl Chloride
1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene

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System Performance Check Compounds (SPCC)

Volatile
Chloromethane
1,1-Dichloroethane
Bromoform
1,1,2,2-Tetrachloroethane
Chlorobenzene

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Table 7
Volatile Internal Standards with Corresponding Analytes Assigned for Quantitation

Pentafluorobenzene	ions	Chlorobenzene-d5	ions
Acetone	(43/58)	1,1,2-Trichloroethane	(97,99,61)
Acrylonitrile	(53/52,51)	Chlorobenzene	(112/114,77)
Acrolein	(56/55,58)	Ethylbenzene	(106/91)
Bromochloromethane	(128,49,130)	1,3-Dichloropropane	(76,78)
Bromomethane	(94/96,79)	*Ethyl methacrylate	(69/41,99)
Carbon disulfide	(76/78)	2-Hexanone	(43/58,57)
Chloroethane	(64/66,49)	Styrene	(104/78,103)
Chloroform	(83/85,47)	Tetrachloroethene	(164/129,131)
Chloromethane	(50/52,49)	Toluene-d8	(surr.)
Dichlorodifluoromethane	(85/87,50)	Xylenes	(106/91)
1,1-Dichloroethane	(63/65,83)	Chlorodibromomethane	(129/208,206)
2,2-Dichloropropane	(77,97)	1,1,1,2-Tetrachloroethane	(131,133,206)
1,2-Dichloroethane	(surr.)	Bromoform	(173/171,175,252)
1,1-Dichloroethene	(96/61,98)	Trans-1,4-dichloro-2-butene	(53)
Iodomethane	(142/127,141)		
Methylene chloride	(84/49,51)		
Vinyl chloride	(62/64,61)		
trans-1,2-Dichloroethene	(96/61,98)		
Trichlorofluoromethane	(101/103,66)		
Tertiary butyl alcohol	(59/41)		
Vinyl Acetate	(43,86)		
cis-1,2-Dichloroethene	(96,61,98)		
Tetrahydrofuran	(42/71/72)		
Acetonitrile	(41)		
Di-isopropyl ether	(45)		
Isobutyl alcohol	(43)		
Ethyl-tert butyl ether	(59)		
Cyclohexane	(56)		
Chloroprene	(53)		
Ethanol	(45)		
Ethyl acetate	(43)		
Freon 113	(101)		
Ethyl ether	(59)		
Methacrylonitrile	(41)		
1,4-Difluorobenzene	ions	1,4-Dichlorobenzene-D4	ions
Benzene	(78/52,77)	Isopropylbenzene	(105,120)
Bromodichloromethane	(83/85,129)	Bromobenzene	(156,77,158)
2-Butanone	(72/57,43)	1,2,3-Trichloropropane	(75/110,77,61)
Carbon tetrachloride	(117/119,121)	n-Propylbenzene	(91,120)
2-Chloroethyl vinyl ether	(63/65,106)	1,1,2,2 Tetrachloroethane	(83/85,131,133)
Dibromomethane	(93/174,95)	2-chlorotoluene	(91,126)

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1,4-Dichloro-2-butene	(75/53,89)	4-chlorotoluene	(91,126)
1,2-Dichloropropane	(63/62,41)	1,3,5-Trimethylbenzene	(105,120)
cis-1,3-Dichloropropene	(75/77,390	t-Butlybenzene	(119,91,134)
trans-1,3-Dichloropropene	(75/77,39)	sec-Butlybenzene	(105,134)
1,1,1-Trichloroethane	(97/99,117)	1,3-Dichlorobenzene	(146/148,111)
Trichloroethene	(130/95,97,132)	1,3-Dichlorobenzene	(146/148,111)
Vinyl acetate	(43/86)	1,2-Dichlorobenzene	(146/148,111)
Methyl tert butyl ether	(73/57)	p-Isopropyltoluene	(119,134,91)
1,4-Dioxane	(88/58)	n-Butylbenzene	(91,92,134)
Ethyl acetate	(43/45,61)	1,2-Dibromo-3-chloropropane	(75,155,157)
Bromofluorobenzene	(surr.)	1,2,4-Trichlorobenzene	(180,182,145)
1,1-Dichloropropane	(75,110,77)	Naphthalene	(128)
1,2-Dichloroethane	(62,64,98)	Hexachlorobutadiene	(225,223,227)
Toluene	(91/92,65)	1,2,3-Trichlorobenzene	(180,182,145)
4-methyl-2-pentanone	(43/58,100)		
1,2-Dibromoethane	(107, 109)		
Tert-amyl ethyl ether	(73)		
Ethyl methacrylate	(69)		
Methyl methacrylate	(69)		
Methylcyclohexane	(83)		

<u>TBA-d9</u>

Tert butyl alcohol (TBA)	(59)

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Table 8

Compounds reported by 8260B

COMPOUND	CAS #
ACETONE	67-64-1
ACETONITRILE	75-05-8
ACROLEIN	107-02-08
ACRYLONITRILE	107-13-1
ALLYL CHLORIDE	107-05-1
BENZENE	71-43-2
BROMOBENZENE	108-86-1
BROMOCHLOROMETHANE	74-97-5
BROMODICHLOROMETHANE	75-27-4
BROMOFORM	75-25-2
BROMOMETHANE	74-83-9
2-BUTANONE	78-93-3
n-BUTLYBENZENE	104-51-8
sec-BUTYLBENZENE	135-98-8
tert-BUTYLBENZENE	98-06-6
CARBON DISULFIDE	75-15-0
CARBON TETRACHLORIDE	56-23-5
CHLOROBENZENE	108-90-7
CHLOROETHANE	75-00-3
CHLOROFORM	67-66-3
CHLOROMETHANE	74-87-3
CHLOROPRENE	126-99-8
CYCLOHEXANE	110-82-7
2-CHLOROETHYL VINYL ETHER	110-75-8
2-CHLOROTOLUENE	95-49-8
4-CHLOROTOLUENE	106-43-4
DIBROMOCHLOROMETHANE	124-48-1
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8
1,2-DIBROMOETHANE	106-93-4
DIBROMOMETHANE	74-95-3
1,2-DICHLOROBENZENE	95-50-1
1,3-DICHLOROBENZENE	540-73-1
1,4-DICHLOROBENZENE	106-46-7
DICHLORODIFLUOROMETHANE	75-71-8
1,1-DICHLOROETHANE	75-34-3
1,2-DICHLOROETHANE	107-06-02
1,1-DICHLOROETHYLENE	75-35-4
1,4-DIOXANE	123-91-1
DI-ISOPROPYL ETHER	108-20-3
cis-1,2-DICHLOROETHYLENE	156-59-2
trans-1,2-DICHLOROETHYLENE	156-60-5

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Table 8 (cont.)

Compounds reported by 8260B

COMPOUND	CAS #
1,3-DICHLOROPROPANE	142-28-9
1,2-DICHLOROPROPANE	78-87-5
2,2-DICHLOROPROPANE	594-20-7
1,1-DICHLOROPROPENE	563-58-6
cis-1,3-DICHLOROPROPENE	10061-01-5
trans-1,3-DICHLOROPROPENE	10061-02-6
ETHYLBENZENE	100-41-4
ETHYL METHACRYLATE	97-63-2
ETHYL ACETATE	141-78-6
FREON 113	76-13-1
FREON 114	76-14-2
HEXACHLOROBUTADIENE	87-68-3
ETHANOL	64-17-5
ETHYL ETHER	60-29-7
2-HEXANONE	591-78-6
IODOMETHANE	74-88-4
ISOPROPYLBENZENE	98-82-8
ISOBUTYL ALCOHOL	78-83-1
p-ISOPROPYLTOLUENE	99-87-6
METHYLENE CHLORIDE	75-09-2
4-METHYL-2-PENTANONE	108-10-1
METHACRYLONITRILE	126-98-7
METHYL METHACRYLATE	80-62-6
METHYLCYCLOHEXANE	108-87-2
METHYL ACETATE	79-20-9
NAPHTHALENE	99-20-3
METHYL TERT BUTYL ETHER	1634-04-4
n-PROPYLBENZENE	103-65-1
PROPIONITRILE	107-12-0
PENTACHLOROETHANE	76-01-7
STYRENE	100-42-5
1,1,1,2-TETRACHLOROETHANE	630-20-6
1,1,2,2-TETRACHLOROETHANE	79-34-5
TETRACHLOROETHYLENE	127-18-4
TETRAHYDROFURAN	109-99-9
TOLUENE	108-88-3
TRANS-1,4-DICHLORO-2-BUTENE	110-57-6
TERT-AMYL METHYL ETHER	994-05-8
TERT-BUTYL ETHYL ETHER	637-92-3
1,2,3-TRICHLOROBENZENE	87-61-6
1,2,4-TRICHLOROBENZENE	120-82-1
1,1,1-TRICHLOROETHANE	71-55-6

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Table 8 (cont.)

Compounds reported by 8260B

1,1,2-TRICHLOROETHANE	79-00-5
TRICHLOROETHYLENE	79-01-6
TRICHLOROFLUOROMETHANE	75-69-4
1,2,3-TRICHLOROPROPANE	96-18-4
1,2,4-TRIMETHYLBENZENE	95-63-6
1,3,5-TRIMETHYLBENZENE	108-67-8
TERT BUTYL ALCOHOL	637-92-3
VINYL ACETATE	108-05-4
VINYL CHLORIDE	75-01-4
m-XYLENE	108-38-3
p-XYLENE	106-42-3
o-XYLENE	95-47-6
TOTAL XYLENES	1330-20-7

Note: Analysis of additional compounds may be appended to this SOP.

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Table 9
SINGLE LABORATORY ACCURACY AND PRECISION DATA FOR VOLATILE ORGANIC COMPOUNDS IN WATER DETERMINED WITH A WIDE-BORE CAPILLARY COLUMN *

COMPOUND	CONC. RANGE (UG/L)	RECOVERY (%)	STANDARD DEVIATION OF REC.	PERCENT RSD
ACETONE	ND **	ND	ND	ND
ACROLEIN	ND	ND	ND	ND
ACRYLONITRILE	ND	ND	ND	ND
BENZENE	0.1-10	97	6.5	5.7
BROMOBENZENE	0.1-10	100	5.5	5.5
BROMOCHLOROMETHANE	0.5-10	90	5.7	6.4
BROMODICHLOROMETHANE	0.1-10	95	5.7	6.1
BROMOFORM	0.5-10	101	6.4	6.3
BROMOMETHANE	0.5-10	95	7.8	8.2
2-BUTANONE	ND	ND	ND	ND
n-BUTLYBENZENE	0.5-10	100	7.6	7.6
sec-BUTYLBENZENE	0.5-10	100	7.6	7.6
tert-BUTYLBENZENE	0.5-10	102	7.4	7.3
CARBON DISULFIDE	ND	ND	ND	ND
CARBON TETRACHLORIDE	0.5-10	84	7.4	8.8
CHLOROBENZENE	0.1-10	98	5.8	5.9
CHLOROETHANE	0.5-10	89	8.0	9.0
CHLOROFORM	0.5-10	90	5.5	6.1
CHLOROMETHANE	0.5-10	93	8.3	8.9
2-CHLOROETHYL VINYL ETHER	ND	ND	ND	ND
2-CHLOROTOLUENE	0.1-10	90	5.6	6.2
4-CHLOROTOLUENE	0.1-10	99	8.2	8.3
DIBROMOCHLOROMETHANE	0.1-10	92	6.5	7.0
1,2-DIBROMO-3-CHLOROPROPANE	0.5-10	83	16.6	19.9
1,2-DIBROMOETHANE	0.5-10	102	4.0	3.9
DIBROMOMETHANE	0.5-10	100	5.6	5.6
1,2-DICHLOROBENZENE	0.1-10	93	5.8	6.2
1,3-DICHLOROBENZENE	0.5-10	99	6.8	6.9
1,4-DICHLOROBENZENE	0.2-20	103	6.6	6.4
DICHLORODIFLUOROMETHANE	0.5-10	90	6.9	7.7
1,1-DICHLOROETHANE	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND
1,1-DICHLOROETHYLENE	ND	ND	ND	ND
cis-1,2-DICHLOROETHYLENE	ND	ND	ND	ND
trans-1,2-DICHLOROETHYLENE	ND	ND	ND	ND
1,2-DICHLOROPROPANE	0.1-10	97	5.9	6.1
1,3-DICHLOROPROPANE	0.1-10	96	5.7	6.0
2,2-DICHLOROPROPANE	0.5-10	86	14.6	16.9
1,1-DICHLOROPROPENE	0.5-10	98	8.7	8.9
cis-1,3-DICHLOROPROPENE	ND	ND	ND	ND

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Table 9 (cont.)

COMPOUND	CONC. RANGE (UG/L)	RECOVERY (%)	STANDARD DEVIATION OF REC.	PERCENT RSD
trans-1,3-DICHLOROPROPENE	ND	ND	ND	ND
ETHYLBENZENE	0.1-10	99	8.4	8.6
HEXACHLOROBUTADIENE	0.5-10	100	6.8	6.8
2-HEXANONE	ND	ND	ND	ND
IODOMETHANE	ND	ND	ND	ND
ISOPROPYLBENZENE	0.5-10	101	7.7	7.6
p-ISOPROPYLBENZENE	0.1-10	99	6.7	6.7
METHYLENE CHLORIDE	0.1-10	95	5.0	5.3
4-METHYL-2-PENTANONE	ND	ND	ND	ND
NAPHTHALENE	0.1-100	104	8.6	8.2
n-PROPYLBENZENE	0.1-10	100	5.8	5.8
STYRENE	0.1-100	102	7.3	7.2
1,1,1,2-TETRACHLOROETHENE	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	0.1-10	91	5.7	6.3
TETRACHLOROTOLUENE	ND	ND	ND	ND
TOLUENE	0.5-10	102	8.1	8.0
1,2,3-TRICHLOROBENZENE	0.5-10	109	9.4	8.6
1,2,4-TRICHLOROBENZENE	0.5-10	108	9.0	8.3
1,1,1-TRICHLOROETHANE	0.5-10	98	7.9	8.1
1,1,2-TRICHLOROETHANE	0.5-10	104	7.6	7.3
TRICHLOROETHYLENE	0.5-10	90	6.5	7.3
TRICHLOROFLUOROMETHANE	0.5-10	89	7.2	8.1
1,2,3-TRICHLOROPROPANE	0.5-10	108	15.6	14.4
1,2,4-TRIMETHYLBENZENE	0.5-10	99	8.0	8.1
1,3,5-TRIMETHYLBENZENE	0.5-10	92	6.8	7.4
VINYL ACETATE	ND	ND	ND	ND
VINLY CHLORIDE	0.5-10	98	6.5	6.7
m-XYLENE	0.1-10	97	6.3	6.5
p-XYLENE	0.5-10	104	8.0	7.7
o-XYLENE	0.1-31	103	7.4	7.2

*** Criteria from SW846 method 8260B**
**** ND; not determined**

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Table 10
WORKING STANDARD PREPARATION

Internal standard and Surrogate mixture	**O.I. (250 ug/ml)**	**Tekmar (125 ug/ml)**
Internal Standard (2000 ug/ml)	1250 ul	1250 ul
Surrogates (2000 ug/ml)	1250 ul	1250 ul
TBA (50,000 ug/ml)	500 ul	500 ul
Methanol	7.0 mls	17.0 mls
Final volume	10ml	20 mls

Calibration mixture

2 ml Ethanol Standard @ 100,000 ug/ml

1 ml M-502A-R-10X @ 2.0 mg/ml

1 ml M-502-B-10X @ 2.0 mg/ml

1 ml Cus-6580 Ultra

1 ml Cus-6581 Ultra

0.8 ml 0-Cymene @ 2470 ug/ml

3200 ul Methanol

FV = 10 ml

Blank Spike/ Matrix Spike (2nd source)

2 mls Ethanol Standard @ 100,000 ug/ml

1 ml Cus-5680-ICV @ various conc.

1ml Cus-6581 @ various conc.

1ml M-502-10X

0.93 ml O-Cymene @ 2150 ug/ml

4070 ul Methanol

FV = 10 ml

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LABORATORY ACCREDITATION BUREAU

Certificate of Accreditation

ISO/IEC 17025:2005 ***Certificate Number L2235***

Accutest Laboratories of New England, Inc

495 Technology Center West, Bldg One
50 D'Angelo Drive
Marlborough, MA 07152

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: January 6, 2013

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 6th of January 2010

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

LABORATORY ACCREDITATION BUREAU

Certificate #L2235

Scope of Accreditation
For
Accutest Laboratories of New England, Inc.

495 Technology Center West, Bldg One
50 D'Angelo Drive
Marlborough, MA 01752
Reza Tand
1-508-481-6200

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Accutest Laboratories of New England, Inc. to perform the following tests:

Accreditation granted through: **January 6, 2013**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260	1 1 1 2-Tetrachloroethane
GC/MS	8260	1 1 1-Trichloroethane
GC/MS	8260	1 1 2 2-Tetrachloroethane
GC/MS	8260	1 1 2-Trichloroethane
GC/MS	8260	1 1-Dichloroethane
GC/MS	8260	1 1-Dichloroethylene
GC/MS	8260	1 1-Dichloropropene
GC/MS	8260	1 2 3-Trichlorobenzene
GC/MS	8260	1 2 3-Trichloropropane
GC/MS	8260	1 2 4-Trichlorobenzene
GC/MS	8260	1 2 4-Trimethylbenzene
GC/MS	8260	1 2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260	1 2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	8260	1 2-Dichlorobenzene
GC/MS	8260	1 2-Dichloroethane
GC/MS	8260	1 2-Dichloropropane
GC/MS	8260	1 3 5-Trimethylbenzene
GC/MS	8260	1 3-Dichlorobenzene
GC/MS	8260	1 3-Dichloropropane
GC/MS	8260	1 4-Dichlorobenzene
GC/MS	8260	1,4-Dioxane

Non-Potable Water

Technology	Method	Analyte
GC/MS	8260	2 2-Dichloropropane
GC/MS	8260	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	8260	2-Chloroethyl vinyl ether
GC/MS	8260	2-Chlorotoluene
GC/MS	8260	2-Hexanone
GC/MS	8260	4-Chlorotoluene
GC/MS	8260	4-Methyl-2-pentanone (MIBK)
GC/MS	8260	Acetone
GC/MS	8260	Acetonitrile
GC/MS	8260	Acrolein (Propenal)
GC/MS	8260	Acrylonitrile
GC/MS	8260	Allyl chloride (3-Chloropropene)
GC/MS	8260	Benzene
GC/MS	8260	Bromobenzene
GC/MS	8260	Bromochloromethane
GC/MS	8260	Bromodichloromethane
GC/MS	8260	Bromoform
GC/MS	8260	Carbon disulfide
GC/MS	8260	Carbon tetrachloride
GC/MS	8260	Chlorobenzene
GC/MS	8260	Chloroethane
GC/MS	8260	Chloroform
GC/MS	8260	Chloroprene
GC/MS	8260	cis-1 2-Dichloroethylene
GC/MS	8260	cis-1 3-Dichloropropene
GC/MS	8260	Cyclohexane
GC/MS	8260	Dibromochloromethane
GC/MS	8260	Dibromomethane
GC/MS	8260	Di-isopropyl ether (DIPE)
GC/MS	8260	Dichlorodifluoromethane
GC/MS	8260	Ethanol
GC/MS	8260	Ethyl methacrylate
GC/MS	8260	Ethyl Acetate
GC/MS	8260	Ethylbenzene
GC/MS	8260	Ethyl-t-butylether (ETBE)
GC/MS	8260	Freon-113
GC/MS	8260	Hexachlorobutadiene
GC/MS	8260	Iodomethane (Methyl iodide)
GC/MS	8260	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	8260	Isopropylbenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	8260	m+p-Xylenes
GC/MS	8260	Methacrylonitrile
GC/MS	8260	Methyl bromide (Bromomethane)
GC/MS	8260	Methyl chloride (Chloromethane)
GC/MS	8260	Methyl acetate
GC/MS	8260	Methyl methacrylate
GC/MS	8260	Methyl tert-butyl ether (MTBE)
GC/MS	8260	Methylcyclohexane
GC/MS	8260	Methylene chloride
GC/MS	8260	Naphthalene
GC/MS	8260	n-Butylbenzene
GC/MS	8260	n-Propylbenzene
GC/MS	8260	o-Xylene
GC/MS	8260	p-Dioxane
GC/MS	8260	p-Isopropyltoluene
GC/MS	8260	Propionitrile (Ethyl cyanide)
GC/MS	8260	sec-Butylbenzene
GC/MS	8260	Styrene
GC/MS	8260	T-amylmethylether (TAME)
GC/MS	8260	Tert-Butyl Alcohol
GC/MS	8260	tert-Butylbenzene
GC/MS	8260	Tetrachloroethylene (Perchloroethylene)
GC/MS	8260	Tetrahydrofuran
GC/MS	8260	Toluene
GC/MS	8260	trans-1 2-Dichloroethylene
GC/MS	8260	trans-1 3-Dichloropropylene
GC/MS	8260	trans-1 4-Dichloro-2-butene
GC/MS	8260	Trichloroethene (Trichloroethylene)
GC/MS	8260	Trichlorofluoromethane
GC/MS	8260	Vinyl acetate
GC/MS	8260	Vinyl chloride
GC/MS	8260	Xylene (total)
GC/MS	8270	1 2 4 5-Tetrachlorobenzene
GC/MS	8270	1 2 4-Trichlorobenzene
GC/MS	8270	1 2-Dichlorobenzene
GC/MS	8270	1 2-Diphenylhydrazine
GC/MS	8270	1 3 5-Trinitrobenzene (1 3 5-TNB)
GC/MS	8270	1 3-Dichlorobenzene
GC/MS	8270	1 3-Dinitrobenzene (1 3-DNB)
GC/MS	8270	1 4-Dichlorobenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	8270	1,4-Dioxane
GC/MS	8270	1 4-Dinitrobenzene
GC/MS	8270	1 4-Naphthoquinone
GC/MS	8270	1 4-Phenylenediamine
GC/MS	8270	1-Naphthylamine
GC/MS	8270	2 3 4 6-Tetrachlorophenol
GC/MS	8270	2 4 5-Trichlorophenol
GC/MS	8270	2 4 6-Trichlorophenol
GC/MS	8270	2 4-Dichlorophenol
GC/MS	8270	2 4-Dimethylphenol
GC/MS	8270	2 4-Dinitrophenol
GC/MS	8270	2 4-Dinitrotoluene (2 4-DNT)
GC/MS	8270	2 6-Dichlorophenol
GC/MS	8270	2 6-Dinitrotoluene (2 6-DNT)
GC/MS	8270	2-Acetylaminofluorene
GC/MS	8270	2-Chloronaphthalene
GC/MS	8270	2-Chlorophenol
GC/MS	8270	2-Methyl-4 6-dinitrophenol
GC/MS	8270	2-Methylnaphthalene
GC/MS	8270	2-Methylphenol (o-Cresol)
GC/MS	8270	2-Naphthylamine
GC/MS	8270	2-Nitroaniline
GC/MS	8270	2-Nitrophenol
GC/MS	8270	2-Picoline (2-Methylpyridine)
GC/MS	8270	3 3`-Dichlorobenzidine
GC/MS	8270	3 3`-Dimethylbenzidine
GC/MS	8270	3,4-Methylphenol
GC/MS	8270	3-Methylcholanthrene
GC/MS	8270	3-Nitroaniline
GC/MS	8270	4-Aminobiphenyl
GC/MS	8270	4-Bromophenyl phenyl ether
GC/MS	8270	4-Chloro-3-methylphenol
GC/MS	8270	4-Chloroaniline
GC/MS	8270	4-Chlorophenyl phenylether
GC/MS	8270	4-Dimethyl aminoazobenzene
GC/MS	8270	4-Methylphenol (p-Cresol)
GC/MS	8270	4-Nitroaniline
GC/MS	8270	4-Nitrophenol
GC/MS	8270	5-Nitro-o-toluidine
GC/MS	8270	7 12-Dimethylbenz(a) anthracene

Non-Potable Water

Technology	Method	Analyte
GC/MS	8270	a-a-Dimethylphenethylamine
GC/MS	8270	Acenaphthene
GC/MS	8270	Acenaphthylene
GC/MS	8270	Acetophenone
GC/MS	8270	Aniline
GC/MS	8270	Anthracene
GC/MS	8270	Aramite
GC/MS	8270	Benzidine
GC/MS	8270	Benzo(a)anthracene
GC/MS	8270	Benzo(a)pyrene
GC/MS	8270	Benzo(b)fluoranthene
GC/MS	8270	Benzo(g h i)perylene
GC/MS	8270	Benzo(k)fluoranthene
GC/MS	8270	Benzoic acid
GC/MS	8270	Benzyl alcohol
GC/MS	8270	bis(2-Chloroethoxy)methane
GC/MS	8270	bis(2-Chloroethyl) ether
GC/MS	8270	bis(2-Chloroisopropyl) ether (2 2`-Oxybis(1-chloropropane))
GC/MS	8270	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	8270	Butyl benzyl phthalate
GC/MS	8270	Carbazole
GC/MS	8270	Chlorobenzilate
GC/MS	8270	Chrysene
GC/MS	8270	Diallate
GC/MS	8270	Dibenz(a h)anthracene
GC/MS	8270	Dibenzofuran
GC/MS	8270	Diethyl phthalate
GC/MS	8270	Dimethoate
GC/MS	8270	Dimethyl phthalate
GC/MS	8270	Di-n-butyl phthalate
GC/MS	8270	Di-n-octyl phthalate
GC/MS	8270	Dinoseb (2-sec-butyl-4 6-dinitrophenol DNBP)
GC/MS	8270	Disulfoton
GC/MS	8270	Diphenylamine
GC/MS	8270	Ethyl methanesulfonate
GC/MS	8270	Famphur
GC/MS	8270	Fluoranthene
GC/MS	8270	Fluorene
GC/MS	8270	Hexachlorobenzene
GC/MS	8270	Hexachlorobutadiene

Non-Potable Water

Technology	Method	Analyte
GC/MS	8270	Hexachlorocyclopentadiene
GC/MS	8270	Hexachloroethane
GC/MS	8270	Hexachlorophene
GC/MS	8270	Hexachloropropene
GC/MS	8270	Indeno(1 2 3-cd)pyrene
GC/MS	8270	Isodrin
GC/MS	8270	Isophorone
GC/MS	8270	Isosafrole
GC/MS	8270	Kepone
GC/MS	8270	Methapyrilene
GC/MS	8270	Methyl methanesulfonate
GC/MS	8270	Methyl parathion (Parathion methyl)
GC/MS	8270	Naphthalene
GC/MS	8270	Nitrobenzene
GC/MS	8270	Nitroquinoline-1-oxide
GC/MS	8270	n-Nitrosodiethylamine
GC/MS	8270	n-Nitrosodimethylamine
GC/MS	8270	n-Nitroso-di-n-butylamine
GC/MS	8270	n-Nitrosodi-n-propylamine
GC/MS	8270	n-Nitrosodiphenylamine
GC/MS	8270	n-Nitrosomethylethylamine
GC/MS	8270	n-Nitrosomorpholine
GC/MS	8270	n-Nitrosopiperidine
GC/MS	8270	n-Nitrosopyrrolidine
GC/MS	8270	o o o-Triethyl phosphorothioate
GC/MS	8270	o-Toluidine
GC/MS	8270	Parathion ethyl
GC/MS	8270	Pentachlorobenzene
GC/MS	8270	Pentachloronitrobenzene
GC/MS	8270	Pentachloroethane
GC/MS	8270	Pentachlorophenol
GC/MS	8270	Phenacetin
GC/MS	8270	Phenanthrene
GC/MS	8270	Phenol
GC/MS	8270	Phorate
GC/MS	8270	Pronamide (Kerb)
GC/MS	8270	Pyrene
GC/MS	8270	Pyridine
GC/MS	8270	Safrole
GC/MS	8270	Sulfotepp

Non-Potable Water

Technology	Method	Analyte
GC/MS	8270	Thionazin (Zinophos)
GC/ECD	8081	4 4`-DDD
GC/ECD	8081	4 4`-DDE
GC/ECD	8081	4 4`-DDT
GC/ECD	8081	Aldrin
GC/ECD	8081	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	8081	Alachlor
GC/ECD	8081	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	8081	Chlordane (tech.)
GC/ECD	8081	Chlorobenzilate
GC/ECD	8081	delta-BHC
GC/ECD	8081	Dieldrin
GC/ECD	8081	Endosulfan I
GC/ECD	8081	Endosulfan II
GC/ECD	8081	Endosulfan sulfate
GC/ECD	8081	Endrin aldehyde
GC/ECD	8081	Endrin ketone
GC/ECD	8081	Endrin
GC/ECD	8081	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	8081	Heptachlor epoxide
GC/ECD	8081	Heptachlor
GC/ECD	8081	Kepone
GC/ECD	8081	Methoxychlor
GC/ECD	8081	Hexachlorobenzene
GC/ECD	8081	Toxaphene (Chlorinated camphene)
GC/ECD	8081	alpha-Chlordane
GC/ECD	8081	gamma-Chlordane
GC/ECD	8082	Aroclor-1016 (PCB-1016)
GC/ECD	8082	Aroclor-1221 (PCB-1221)
GC/ECD	8082	Aroclor-1232 (PCB-1232)
GC/ECD	8082	Aroclor-1242 (PCB-1242)
GC/ECD	8082	Aroclor-1248 (PCB-1248)
GC/ECD	8082	Aroclor-1254 (PCB-1254)
GC/ECD	8082	Aroclor-1260 (PCB-1260)
GC/ECD	8082	Arolclor-1262 (PCB-1262)
GC/ECD	8082	Aroclor-1268 (PCB 1268)
GC/ECD	8151	2 4 5-T
GC/ECD	8151	2 4-D
GC/ECD	8151	Silvex (2 4 5-TP)
GC/ECD	8151	Dalapon

Non-Potable Water

Technology	Method	Analyte
GC/ECD	8151	Dicamba
GC/FID	8015	Diesel range organics (DRO)
GC/FID	8015	Gasoline range organics (GRO)
Gravimetric	1664A	Oil & Grease
Gravimetric	9070	Oil & Grease
UV/VIS	9012	Total cyanide
UV/VIS	9065/ 420.4	Total phenolics
TOC	9060	Total organic carbon
UV/VIS	7196	Chromium VI
ISE	SM 4500 F-C	Fluoride
Turbidimetric	ASTM D516-90-02	Sulfate
Titration	SM 4500-CI C	Chloride
Colorimetric	353.2	Nitrate
Colorimetric	353.2	Nitrite
UV/VIS	SM 4500-P E	Orthophosphate as P
ICP	6010	Aluminum
ICP	6010	Antimony
ICP	6010	Arsenic
ICP	6010	Barium
ICP	6010	Beryllium
ICP	6010	Boron
ICP	6010	Cadmium
ICP	6010	Calcium
ICP	6010	Chromium
ICP	6010	Cobalt
ICP	6010	Copper
ICP	6010	Iron
ICP	6010	Lead
ICP	6010	Magnesium
ICP	6010	Manganese
ICP	6010	Molybdenum
ICP	6010	Nickel
ICP	6010	Potassium
ICP	6010	Selenium
ICP	6010	Silver
ICP	6010	Sodium
ICP	6010	Strontium
ICP	6010	Thallium
ICP	6010	Tin
ICP	6010	Titanium

Non-Potable Water

Technology	Method	Analyte
ICP	6010	Vanadium
ICP	6010	Zinc
CVAA	7470	Mercury
HPLC	8330	HMX
HPLC	8330	RDX
HPLC	8330	1,3-Dinitrobenzene
HPLC	8330	2,6-Dinitrotoluene
HPLC	8330	2,4-Dinitrotoluene
HPLC	8330	2-amino-4,6-Dinitrotoluene
HPLC	8330	4-amino-2,6-Dinitrotoluene
HPLC	8330	Nitrobenzene
HPLC	8330	o-Nitrotoluene
HPLC	8330	m-Nitrotoluene
HPLC	8330	p-Nitrotoluene
HPLC	8330	Tetryl
HPLC	8330	1,3,5-Trinitrobenzene
HPLC	8330	2,4,6-Trinitrotoluene
HPLC	8330	PETN
HPLC	8310	Acenaphthene
HPLC	8310	Acenaphthylene
HPLC	8310	Anthracene
HPLC	8310	Benzo(a)anthracene
HPLC	8310	Benzo(a)pyrene
HPLC	8310	Benzo(b)fluoranthene
HPLC	8310	Benzko(k)fluoranthene
HPLC	8310	Benzo(g,h,i)perylene
HPLC	8310	Chrysene
HPLC	8310	Dibenz(a h)anthracene
HPLC	8310	Fluoranthene
HPLC	8310	Fluorene
HPLC	8310	Indeno(1 2 3-cd)pyrene
HPLC	8310	2-Methylnaphthalene
HPLC	8310	Naphthalene
HPLC	8310	Phenanthrene
HPLC	8310	Pyrene
GC/PID	8021	Benzene
GC/PID	8021	Toluene
GC/PID	8021	Ethylbenzene
GC/PID	8021	Xylene (total)
GC/PID	8021	Methyl-tert-butyl ether (MTBE)

Non-Potable Water

Technology	Method	Analyte
HPLC	8315	Acetaldehyde
HPLC	8315	Formaldehyde
GC/PID	MA DEP VPH	Benzene
GC/PID	MA DEP VPH	Ethylbenzene
GC/PID	MA DEP VPH	Methy-tert-buty ether (MTBE)
GC/PID	MA DEP VPH	Naphthalene
GC/PID	MA DEP VPH	Toluene
GC/PID	MA DEP VPH	m,p-Xylene
GC/PID	MA DEP VPH	o-Xylene
GC/PID	MA DEP VPH	C5-C8-Aliphatics (Unadjusted)
GC/PID	MA DEP VPH	C9-C12 Aliphatics (Unadjusted)
GC/PID	MA DEP VPH	C9-C10 Aromatics (Unadjusted)
GC/PID	MA DEP VPH	C5-C8-Aliphatics
GC/PID	MA DEP VPH	C9-C12 Aliphatics
GC/FID	MA DEP EPH	Acenaphthene
GC/FID	MA DEP EPH	Acenaphthylene
GC/FID	MA DEP EPH	Anthracene
GC/FID	MA DEP EPH	Benzo(a)anthracene
GC/FID	MA DEP EPH	Benzo(a)pyrene
GC/FID	MA DEP EPH	Benzo(b)fluoranthene
GC/FID	MA DEP EPH	Benzo(g,h,i)perylene
GC/FID	MA DEP EPH	Benzo(k)fluoranthene
GC/FID	MA DEP EPH	Chrysene
GC/FID	MA DEP EPH	Dibenzo(a,h)anthracene
GC/FID	MA DEP EPH	Fluoranthene
GC/FID	MA DEP EPH	Fluorene
GC/FID	MA DEP EPH	Indeno(1 2 3-cd)pyrene
GC/FID	MA DEP EPH	2-Methylnaphthalene
GC/FID	MA DEP EPH	Naphthalene
GC/FID	MA DEP EPH	Phenanthrene
GC/FID	MA DEP EPH	Pyrene
GC/FID	MA DEP EPH	C9-C18 Aliphatics (Unadjusted)
GC/FID	MA DEP EPH	C19-C36 Aliphatics (Unadjusted)
GC/FID	MA DEP EPH	C11-C22 Aromatics (Unadjusted)
GC/FID	MA DEP EPH	C9-C18 Aliphatics
GC/FID	MA DEP EPH	C19-C36 Aliphatics
GC/FID	MA DEP EPH	C11-C22 Aromatics

Non-Potable Water

Preparation	Method	Type
Organic Preparation	3510	Seperatory Funnel Extraction
Inorganics Preparation	3010	Hotblock
Volatile Organics Preparation	5030	Closed System Purge and Trap
Organic Cleanup	3660B	Sulfur cleanup
Organic Cleanup	3665	Sulfuric acid cleanup
Organic Cleanup	3630	Silica gel cleanup

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8260	1 1 1 2-Tetrachloroethane
GC/MS	8260	1 1 1-Trichloroethane
GC/MS	8260	1 1 2 2-Tetrachloroethane
GC/MS	8260	1 1 2-Trichloroethane
GC/MS	8260	1 1-Dichloroethane
GC/MS	8260	1 1-Dichloroethylene
GC/MS	8260	1 1-Dichloropropene
GC/MS	8260	1 2 3-Trichlorobenzene
GC/MS	8260	1 2 3-Trichloropropane
GC/MS	8260	1 2 4-Trichlorobenzene
GC/MS	8260	1 2 4-Trimethylbenzene
GC/MS	8260	1 2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260	1 2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	8260	1 2-Dichlorobenzene
GC/MS	8260	1 2-Dichloroethane
GC/MS	8260	1 2-Dichloropropane
GC/MS	8260	1 3 5-Trimethylbenzene
GC/MS	8260	1 3-Dichlorobenzene
GC/MS	8260	1 3-Dichloropropane
GC/MS	8260	1 4-Dichlorobenzene
GC/MS	8260	1,4-Dioxane
GC/MS	8260	2 2-Dichloropropane
GC/MS	8260	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	8260	2-Chloroethyl vinyl ether
GC/MS	8260	2-Chlorotoluene
GC/MS	8260	2-Hexanone
GC/MS	8260	4-Chlorotoluene
GC/MS	8260	4-Methyl-2-pentanone (MIBK)
GC/MS	8260	Acetone
GC/MS	8260	Acetonitrile

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8260	Acrolein (Propenal)
GC/MS	8260	Acrylonitrile
GC/MS	8260	Allyl chloride (3-Chloropropene)
GC/MS	8260	Benzene
GC/MS	8260	Bromobenzene
GC/MS	8260	Bromochloromethane
GC/MS	8260	Bromodichloromethane
GC/MS	8260	Bromoform
GC/MS	8260	Carbon disulfide
GC/MS	8260	Carbon tetrachloride
GC/MS	8260	Chlorobenzene
GC/MS	8260	Chloroethane
GC/MS	8260	Chloroform
GC/MS	8260	Chloroprene
GC/MS	8260	cis-1 2-Dichloroethylene
GC/MS	8260	cis-1 3-Dichloropropene
GC/MS	8260	Cyclohexane
GC/MS	8260	Dibromochloromethane
GC/MS	8260	Dibromomethane
GC/MS	8260	Di-isopropyl ether (DIPE)
GC/MS	8260	Dichlorodifluoromethane
GC/MS	8260	Ethanol
GC/MS	8260	Ethyl methacrylate
GC/MS	8260	Ethyl Acetate
GC/MS	8260	Ethylbenzene
GC/MS	8260	Ethyl-t-butylether (ETBE)
GC/MS	8260	Freon-113
GC/MS	8260	Hexachlorobutadiene
GC/MS	8260	Iodomethane (Methyl iodide)
GC/MS	8260	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	8260	Isopropylbenzene
GC/MS	8260	m+p-Xylenes
GC/MS	8260	Methacrylonitrile
GC/MS	8260	Methyl bromide (Bromomethane)
GC/MS	8260	Methyl chloride (Chloromethane)
GC/MS	8260	Methyl acetate
GC/MS	8260	Methyl methacrylate
GC/MS	8260	Methyl tert-butyl ether (MTBE)
GC/MS	8260	Methylcyclohexane
GC/MS	8260	Methylene chloride

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8260	Naphthalene
GC/MS	8260	n-Butylbenzene
GC/MS	8260	n-Propylbenzene
GC/MS	8260	o-Xylene
GC/MS	8260	p-Dioxane
GC/MS	8260	p-Isopropyltoluene
GC/MS	8260	Propionitrile (Ethyl cyanide)
GC/MS	8260	sec-Butylbenzene
GC/MS	8260	Styrene
GC/MS	8260	T-amylmethylether (TAME)
GC/MS	8260	Tert-Butyl Alcohol
GC/MS	8260	tert-Butylbenzene
GC/MS	8260	Tetrachloroethylene (Perchloroethylene)
GC/MS	8260	Tetrahydrofuran
GC/MS	8260	Toluene
GC/MS	8260	trans-1 2-Dichloroethylene
GC/MS	8260	trans-1 3-Dichloropropylene
GC/MS	8260	trans-1 4-Dichloro-2-butene
GC/MS	8260	Trichloroethene (Trichloroethylene)
GC/MS	8260	Trichlorofluoromethane
GC/MS	8260	Vinyl acetate
GC/MS	8260	Vinyl chloride
GC/MS	8260	Xylene (total)
GC/MS	8270	1 2 4 5-Tetrachlorobenzene
GC/MS	8270	1 2 4-Trichlorobenzene
GC/MS	8270	1 2-Dichlorobenzene
GC/MS	8270	1 2-Diphenylhydrazine
GC/MS	8270	1 3 5-Trinitrobenzene (1 3 5-TNB)
GC/MS	8270	1 3-Dichlorobenzene
GC/MS	8270	1 3-Dinitrobenzene (1 3-DNB)
GC/MS	8270	1 4-Dichlorobenzene
GC/MS	8270	1,4-Dioxane
GC/MS	8270	1 4-Dinitrobenzene
GC/MS	8270	1 4-Naphthoquinone
GC/MS	8270	1 4-Phenylenediamine
GC/MS	8270	1-Naphthylamine
GC/MS	8270	2 3 4 6-Tetrachlorophenol
GC/MS	8270	2 4 5-Trichlorophenol
GC/MS	8270	2 4 6-Trichlorophenol
GC/MS	8270	2 4-Dichlorophenol

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8270	2 4-Dimethylphenol
GC/MS	8270	2 4-Dinitrophenol
GC/MS	8270	2 4-Dinitrotoluene (2 4-DNT)
GC/MS	8270	2 6-Dichlorophenol
GC/MS	8270	2 6-Dinitrotoluene (2 6-DNT)
GC/MS	8270	2-Acetylaminofluorene
GC/MS	8270	2-Chloronaphthalene
GC/MS	8270	2-Chlorophenol
GC/MS	8270	2-Methyl-4 6-dinitrophenol
GC/MS	8270	2-Methylnaphthalene
GC/MS	8270	2-Methylphenol (o-Cresol)
GC/MS	8270	2-Naphthylamine
GC/MS	8270	2-Nitroaniline
GC/MS	8270	2-Nitrophenol
GC/MS	8270	2-Picoline (2-Methylpyridine)
GC/MS	8270	3 3`-Dichlorobenzidine
GC/MS	8270	3 3`-Dimethylbenzidine
GC/MS	8270	3,4-Methylphenol
GC/MS	8270	3-Methylcholanthrene
GC/MS	8270	3-Nitroaniline
GC/MS	8270	4-Aminobiphenyl
GC/MS	8270	4-Bromophenyl phenyl ether
GC/MS	8270	4-Chloro-3-methylphenol
GC/MS	8270	4-Chloroaniline
GC/MS	8270	4-Chlorophenyl phenylether
GC/MS	8270	4-Dimethyl aminoazobenzene
GC/MS	8270	4-Methylphenol (p-Cresol)
GC/MS	8270	4-Nitroaniline
GC/MS	8270	4-Nitrophenol
GC/MS	8270	5-Nitro-o-toluidine
GC/MS	8270	7 12-Dimethylbenz(a) anthracene
GC/MS	8270	a-a-Dimethylphenethylamine
GC/MS	8270	Acenaphthene
GC/MS	8270	Acenaphthylene
GC/MS	8270	Acetophenone
GC/MS	8270	Aniline
GC/MS	8270	Anthracene
GC/MS	8270	Aramite
GC/MS	8270	Benzidine
GC/MS	8270	Benzo(a)anthracene

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8270	Benzo(a)pyrene
GC/MS	8270	Benzo(b)fluoranthene
GC/MS	8270	Benzo(g h i)perylene
GC/MS	8270	Benzo(k)fluoranthene
GC/MS	8270	Benzoic acid
GC/MS	8270	Benzyl alcohol
GC/MS	8270	bis(2-Chloroethoxy)methane
GC/MS	8270	bis(2-Chloroethyl) ether
GC/MS	8270	bis(2-Chloroisopropyl) ether (2 2`-Oxybis(1-chloropropane))
GC/MS	8270	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	8270	Butyl benzyl phthalate
GC/MS	8270	Carbazole
GC/MS	8270	Chlorobenzilate
GC/MS	8270	Chrysene
GC/MS	8270	Diallate
GC/MS	8270	Dibenz(a h)anthracene
GC/MS	8270	Dibenzofuran
GC/MS	8270	Diethyl phthalate
GC/MS	8270	Dimethoate
GC/MS	8270	Dimethyl phthalate
GC/MS	8270	Di-n-butyl phthalate
GC/MS	8270	Di-n-octyl phthalate
GC/MS	8270	Dinoseb (2-sec-butyl-4 6-dinitrophenol DNBP)
GC/MS	8270	Disulfoton
GC/MS	8270	Diphenylamine
GC/MS	8270	Ethyl methanesulfonate
GC/MS	8270	Famphur
GC/MS	8270	Fluoranthene
GC/MS	8270	Fluorene
GC/MS	8270	Hexachlorobenzene
GC/MS	8270	Hexachlorobutadiene
GC/MS	8270	Hexachlorocyclopentadiene
GC/MS	8270	Hexachloroethane
GC/MS	8270	Hexachlorophene
GC/MS	8270	Hexachloropropene
GC/MS	8270	Indeno(1 2 3-cd)pyrene
GC/MS	8270	Isodrin
GC/MS	8270	Isophorone
GC/MS	8270	Isosafrole
GC/MS	8270	Kepone

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8270	Methapyrilene
GC/MS	8270	Methyl methanesulfonate
GC/MS	8270	Methyl parathion (Parathion methyl)
GC/MS	8270	Naphthalene
GC/MS	8270	Nitrobenzene
GC/MS	8270	Nitroquinoline-1-oxide
GC/MS	8270	n-Nitrosodiethylamine
GC/MS	8270	n-Nitrosodimethylamine
GC/MS	8270	n-Nitroso-di-n-butylamine
GC/MS	8270	n-Nitrosodi-n-propylamine
GC/MS	8270	n-Nitrosodiphenylamine
GC/MS	8270	n-Nitrosomethylethylamine
GC/MS	8270	n-Nitrosomorpholine
GC/MS	8270	n-Nitrosopiperidine
GC/MS	8270	n-Nitrosopyrrolidine
GC/MS	8270	o o o-Triethyl phosphorothioate
GC/MS	8270	o-Toluidine
GC/MS	8270	Parathion ethyl
GC/MS	8270	Pentachlorobenzene
GC/MS	8270	Pentachloronitrobenzene
GC/MS	8270	Pentachloroethane
GC/MS	8270	Pentachlorophenol
GC/MS	8270	Phenacetin
GC/MS	8270	Phenanthrene
GC/MS	8270	Phenol
GC/MS	8270	Phorate
GC/MS	8270	Pronamide (Kerb)
GC/MS	8270	Pyrene
GC/MS	8270	Pyridine
GC/MS	8270	Safrole
GC/MS	8270	Sulfotepp
GC/MS	8270	Thionazin (Zinophos)
GC/ECD	8081	4 4`-DDD
GC/ECD	8081	4 4`-DDE
GC/ECD	8081	4 4`-DDT
GC/ECD	8081	Aldrin
GC/ECD	8081	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	8081	Alachlor
GC/ECD	8081	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	8081	Chlordane (tech.)

Solid and Chemical Materials

Technology	Method	Analyte
GC/ECD	8081	Chlorobenzilate
GC/ECD	8081	delta-BHC
GC/ECD	8081	Dieldrin
GC/ECD	8081	Endosulfan I
GC/ECD	8081	Endosulfan II
GC/ECD	8081	Endosulfan sulfate
GC/ECD	8081	Endrin aldehyde
GC/ECD	8081	Endrin ketone
GC/ECD	8081	Endrin
GC/ECD	8081	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	8081	Heptachlor epoxide
GC/ECD	8081	Heptachlor
GC/ECD	8081	Kepone
GC/ECD	8081	Methoxychlor
GC/ECD	8081	Hexachlorobenzene
GC/ECD	8081	Toxaphene (Chlorinated camphene)
GC/ECD	8081	alpha-Chlordane
GC/ECD	8081	gamma-Chlordane
GC/ECD	8082	Aroclor-1016 (PCB-1016)
GC/ECD	8082	Aroclor-1221 (PCB-1221)
GC/ECD	8082	Aroclor-1232 (PCB-1232)
GC/ECD	8082	Aroclor-1242 (PCB-1242)
GC/ECD	8082	Aroclor-1248 (PCB-1248)
GC/ECD	8082	Aroclor-1254 (PCB-1254)
GC/ECD	8082	Aroclor-1260 (PCB-1260)
GC/ECD	8082	Arolclor-1262 (PCB-1262)
GC/ECD	8082	Aroclor-1268 (PCB 1268)
GC/ECD	8151	2 4 5-T
GC/ECD	8151	2 4-D
GC/ECD	8151	Silvex (2 4 5-TP)
GC/ECD	8151	Dalapon
GC/ECD	8151	Dicamba
GC/FID	8015	Diesel range organics (DRO)
GC/FID	8015	Gasoline range organics (GRO)
UV/VIS	9012	Total cyanide
UV/VIS	9065	Total phenolics
TOC	9060	Total organic carbon
UV/VIS	7196	Chromium VI
ICP	6010	Aluminum
ICP	6010	Antimony

Solid and Chemical Materials

Technology	Method	Analyte
ICP	6010	Arsenic
ICP	6010	Barium
ICP	6010	Beryllium
ICP	6010	Boron
ICP	6010	Cadmium
ICP	6010	Calcium
ICP	6010	Chromium
ICP	6010	Cobalt
ICP	6010	Copper
ICP	6010	Iron
ICP	6010	Lead
ICP	6010	Magnesium
ICP	6010	Manganese
ICP	6010	Molybdenum
ICP	6010	Nickel
ICP	6010	Potassium
ICP	6010	Selenium
ICP	6010	Silver
ICP	6010	Sodium
ICP	610	Strontium
ICP	6010	Thallium
ICP	6010	Tin
ICP	6010	Titanium
ICP	6010	Vanadium
ICP	6010	Zinc
CVAA	7471	Mercury
HPLC	8330	HMX
HPLC	8330	RDX
HPLC	8330	1,3-Dinitrobenzene
HPLC	8330	2,6-Dinitrotoluene
HPLC	8330	2,4-Dinitrotoluene
HPLC	8330	2-amino-4,6-Dinitrotoluene
HPLC	8330	4-amino-2,6-Dinitrotoluene
HPLC	8330	Nitrobenzene
HPLC	8330	o-Nitrotoluene
HPLC	8330	m-Nitrotoluene
HPLC	8330	p-Nitrotoluene
HPLC	8330	Tetryl
HPLC	8330	1,3,5-Trinitrobenzene
HPLC	8330	2,4,6-Trinitrotoluene

Solid and Chemical Materials

Technology	Method	Analyte
HPLC	8330	PETN
HPLC	8310	Acenaphthene
HPLC	8310	Acenaphthylene
HPLC	8310	Anthracene
HPLC	8310	Benzo(a)anthracene
HPLC	8310	Benzo(a)pyrene
HPLC	8310	Benzo(b)fluoranthene
HPLC	8310	Benzko(k)fluoranthene
HPLC	8310	Benzo(g,h,i)perylene
HPLC	8310	Chrysene
HPLC	8310	Dibenz(a h)anthracene
HPLC	8310	Fluoranthene
HPLC	8310	Fluorene
HPLC	8310	Indeno(1 2 3-cd)pyrene
HPLC	8310	2-Methylnaphthalene
HPLC	8310	Naphthalene
HPLC	8310	Phenanthrene
HPLC	8310	Pyrene
GC/PID	8021	Benzene
GC/PID	8021	Toluene
GC/PID	8021	Ethylbenzene
GC/PID	8021	Xylene (total)
GC/PID	8021	Methy-tert-buty ether (MTBE)
HPLC	8315	Formaldehyde
GC/PID	MA DEP VPH	Benzene
GC/PID	MA DEP VPH	Ethylbenzene
GC/PID	MA DEP VPH	Methy-tert-buty ether (MTBE)
GC/PID	MA DEP VPH	Naphthalene
GC/PID	MA DEP VPH	Toluene
GC/PID	MA DEP VPH	m,p-Xylene
GC/PID	MA DEP VPH	o-Xylene
GC/PID	MA DEP VPH	C5-C8-Aliphatics (Unadjusted)
GC/PID	MA DEP VPH	C9-C12 Aliphatics (Unadjusted)
GC/PID	MA DEP VPH	C9-C10 Aromatics (Unadjusted)
GC/PID	MA DEP VPH	C5-C8-Aliphatics
GC/PID	MA DEP VPH	C9-C12 Aliphatics
GC/FID	MA DEP EPH	Acenaphthene
GC/FID	MA DEP EPH	Acenaphthylene
GC/FID	MA DEP EPH	Anthracene
GC/FID	MA DEP EPH	Benzo(a)anthracene

Solid and Chemical Materials

Technology	Method	Analyte
GC/FID	MA DEP EPH	Benzo(a)pyrene
GC/FID	MA DEP EPH	Benzo(b)fluoranthene
GC/FID	MA DEP EPH	Benzo(g,h,i)perylene
GC/FID	MA DEP EPH	Benzo(k)fluoranthene
GC/FID	MA DEP EPH	Chrysene
GC/FID	MA DEP EPH	Dibenzo(a,h)anthracene
GC/FID	MA DEP EPH	Fluoranthene
GC/FID	MA DEP EPH	Fluorene
GC/FID	MA DEP EPH	Indeno(1 2 3-cd)pyrene
GC/FID	MA DEP EPH	2-Methylnaphthalene
GC/FID	MA DEP EPH	Naphthalene
GC/FID	MA DEP EPH	Phenanthrene
GC/FID	MA DEP EPH	Pyrene
GC/FID	MA DEP EPH	C9-C18 Aliphatics (Unadjusted)
GC/FID	MA DEP EPH	C19-C36 Aliphatics (Unadjusted)
GC/FID	MA DEP EPH	C11-C22 Aromatics (Unadjusted)
GC/FID	MA DEP EPH	C9-C18 Aliphatics
GC/FID	MA DEP EPH	C19-C36 Aliphatics
GC/FID	MA DEP EPH	C11-C22 Aromatics
Preparation	**Method**	**Type**
Preparation	1311	Toxicity Characteristic Leaching Procedure
Preparation	1312	Synthetic Precipitation Leaching Procedure
Organic Preparation	3545	Pressurized Fluid Extraction
Inorganics Preparation	3050	Hotblock
Volatile Organics Preparation	5035	Closed System Purge and Trap
Organic Preparation	3550B	Sonnication
Organic Cleanup	3660B	Sulfur cleanup
Organic Cleanup	3665	Sulfuric acid cleanup
Organic Cleanup	3630	Silica gel cleanup

Air and Emissions

Technology	Method	Analyte
GCMS	TO-15	Acetone
GCMS	TO-15	Acrylonitrile
GCMS	TO-15	1,3-Butadiene
GCMS	TO-15	Benzene
GCMS	TO-15	Bromodichloromethane
GCMS	TO-15	n-Butylbenzene
GCMS	TO-15	sec-Butylbenzene

Air and Emissions		
Technology	**Method**	**Analyte**
GCMS	TO-15	Bromoform
GCMS	TO-15	Bromomethane
GCMS	TO-15	Bromoethane
GCMS	TO-15	Benzyl chloride
GCMS	TO-15	Carbon disulfide
GCMS	TO-15	Chlorobenzene
GCMS	TO-15	Chloroethane
GCMS	TO-15	Chloroform
GCMS	TO-15	Chloromethane
GCMS	TO-15	Carbon tetrachloride
GCMS	TO-15	3-Chloropropene
GCMS	TO-15	2-Chlorotoluene
GCMS	TO-15	Cyclohexane
GCMS	TO-15	1,1-Dichloroethane
GCMS	TO-15	1,1-Dichloroethene
GCMS	TO-15	1,2-Dibromoethane
GCMS	TO-15	1,2-Dichloroethane
GCMS	TO-15	1,2-Dichloropropane
GCMS	TO-15	1,3-Dichloropropane
GCMS	TO-15	1,4-Dioxane
GCMS	TO-15	Dichlorodifluoromethane
GCMS	TO-15	Dibromochloromethane
GCMS	TO-15	trans-1,2-dichloroethene
GCMS	TO-15	cis-1,2-dichloroethene
GCMS	TO-15	trans-1,2-dichloropropene
GCMS	TO-15	cis-1,2-dichloropropene
GCMS	TO-15	m-Dichlorobenzene
GCMS	TO-15	o-Dichlorobenzene
GCMS	TO-15	p-Dichlorobenzene
GCMS	TO-15	Ethanol
GCMS	TO-15	Ethylbenzene
GCMS	TO-15	Isopropylbenzene
GCMS	TO-15	Ethyl Acetate
GCMS	TO-15	p-Isopropyltoluene
GCMS	TO-15	4-Ethyltoluene
GCMS	TO-15	Methylene chloride
GCMS	TO-15	Freon 113
GCMS	TO-15	Fren 114
GCMS	TO-15	Heptane
GCMS	TO-15	Hexachlorobutadiene
GCMS	TO-15	Hexane

Air and Emissions		
Technology	**Method**	**Analyte**
GCMS	TO-15	Methyl ethyl ketone
GCMS	TO-15	Methyl Isobutyl ketone
GCMS	TO-15	Methyl tert-butyl ether (MTBE)
GCMS	TO-15	2-Hexanone
GCMS	TO-15	Styrene
GCMS	TO-15	1,1,1-Trichloroethane
GCMS	TO-15	Isopropyl alcohol
GCMS	TO-15	Propylene
GCMS	TO-15	1,1,1,2-Tetrachloroethane
GCMS	TO-15	1,1,2,2-Tetrachloroethane
GCMS	TO-15	1,1,2-Trichloroethene
GCMS	TO-15	1,2,4-Trimethylbenzene
GCMS	TO-15	1,3,5-Trimethylbenzene
GCMS	TO-15	1,2,4-Trichlorobenzene
GCMS	TO-15	2,2,4-Trimethylpentane
GCMS	TO-15	Tetrachloroethylene (Perchloroethylene)
GCMS	TO-15	Tertiary butyl alcohol
GCMS	TO-15	Toluene
GCMS	TO-15	Tetrahydrofuran
GCMS	TO-15	Trichloroethene (Trichloroethylene)
GCMS	TO-15	Trichlorofluoromethane
GCMS	TO-15	Vinyl chloride
GCMS	TO-15	Vinyl acetate
GCMS	TO-15	m,p-Xylene
GCMS	TO-15	o-Xylene
GCMS	TO-15	Xylene (total)

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: January 6, 2010

R. Douglas Leonard
Chief Technical Officer

Issued: 1/6/10

ACCUTEST LABS
STANDARD OPERATING PROCEDURE

Lab Manager_____

QA Manager_____

Effective Date:_____

SOP Title: GRAIN SIZE AND SIEVE TESTING

METHOD REFERENCE: ASTM D422-63

Revised Sections: ***14.2, 14.3, 5.1, 5.2, 15.2***

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1.0 SCOPE AND APPLICATION

1.1 This method is used as a quantitative determination of the distribution of particle size in soils. The distribution of particle sizes larger than 75µm (retained on the number 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75µm is determined by a sedimentation process, using a hydrometer.

2.0 SUMMARY OF METHOD

2.1 An air-dried sample is divided into two portions; one portion is retained on a number 10 sieve and the second portion contains only particles that pass the number 10 sieve. The portion retained on the number 10 is separated into a series of fractions using as many sieves as needed depending on the sample. The portion passing the number 10 sieve is soaked in a dispersing agent for 16 hours, vigorously stirred, transferred to a sedimentation cylinder, and allowed to settle for a period of up to 24 hours with hydrometer readings taken at specific intervals.

3.0 REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 Reporting Limit. The reporting limit is not application for this method. Results are reported as a percent of the total sample weight.

3.2 Method Detection Limit. Method Detection limits studies are not required for this method.

4.0 DEFINITIONS

BATCH: A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20, then each group of 20 samples or less will all be handled as a separate batch.

MATRIX: The component or substrate (e.g., water, soil) which contains the analyte of interest.

MATRIX DUPLICATE: A duplicate sample is analyzed at a minimum of 1 in 20 samples. The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. Assess laboratory performance against the control limits that are specified in the SOP. In house limits are generated once sufficient duplicate data is

available to generate limits (usually a minimum of 20 to 30 analyses). If a duplicate is out of control, flag the results with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control. Note: If control limits are not specified in the SOP, use default limits of ± 20% RPD.

$$\frac{(|\text{Sample Result - Duplicate Result}|) \times 100}{(\text{Sample Result + Duplicate Result})/2} = \text{Duplicate RPD}$$

REAGENT BLANK: The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. (Note: for methods requiring no preparation step, the reagent blank is equivalent to the method blank.) Either a reagent blank or a method blank must be analyzed with each batch of 20 samples or less. The concentration of the analyte of interest in the reagent blank must be less than the reporting limit for that analyte. If the reagent blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the reagent blank level. In addition, if all the samples are less than a client required limit and the reagent blank is also less than that limit, then the results can be reported as less than that limit.

REAGENT GRADE: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

REAGENT WATER: Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water.

5.0 HEALTH & SAFETY

5.1 The analyst must follow normal safety procedures as outlined in the Accutest Laboratory Safety Manual which includes the use of safety glasses and lab coats. In addition, all acids are corrosive and must be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

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

6.0 PRESERVATION & HOLDING TIME

6.1 All samples should be kept under refrigeration at 4^0 C until they are analyzed.

6.2 No specific holding time is listed in this method.

7.0 INTERFERENCES

7.1 No interferences are specified in this method.

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8.0 APPARATUS

The following items are needed for the analysis of samples following the method outlined below:

8.1 Sieves, a series of sieves, of square-mesh woven wire cloth giving uniform spacing of data points for graph. The series of sieves listed below is recommended. An alternate series of sieves is also allowed in the method.

Sieve Name	Particle size
3 in	75.0 mm
1.5 in	37.5 mm
¾ in	19.0 mm
3/8 inch	9.5 mm
No. 4	4.75 mm
No. 8	2.36 mm
No. 10	2.00 mm
No. 16	1.18 mm
No. 30	0.600 mm
No. 50	0.300 mm
No. 100	0.150 mm
No. 200	0.075 mm

8.2 Four decimal place analytical balance. The balance must have its calibration verified with Class S weights

8.3 Stirring apparatus. A mechanically operated stirring device in which a suitably mounted electric motor turns a vertical shaft at a speed of not less than 10000 rom without a load. The shaft shall be equipped with a replaceable stirring paddle made of metal, plastic, or hard rubber. Humboldt model 936 stirrer or equivalent should be used in the lab.

8.4 Dispersion cup equipped with baffle rods. Humboldt model H-2465 or equivalent should be used in the lab.

8.5 Hydrometer, 152H, meeting ASTM specifications. (Hydrometer 151H may also be used as described in the method, but this SOP describes the use of hydrometer 152H.)

8.6 Sedimentation cylinder marked for a volume of 1000 ml and an inside diameter such that the 1000-ml mark is 36 ± 2 cm from the bottom on the inside.

8.7 Thermometer accurate to 1°F (0.5°C)

8.8 Timing device, watch or clock with a second hand

8.9 Beakers, at least 250-ml capacity

9.0 REAGENTS

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9.1 All chemicals listed below are reagent grade unless otherwise specified. Deionized water should be used whenever water is required. Make sure to properly label all reagents and record the reagent preparation in the reagent log book. All chemicals must be low in silica.

9.2 Dispersing Agent, dissolve 40 gm of sodium metaphosphate (sometimes called sodium hexametaphosphate) in DI water with stirring and dilute to 1 liter. **NOTE:** If acidic, solutions of this salt will slowly hydrolyze back to the orthophosphate form with a decrease in dispersive action. New solutions should be made at least once a month or be adjusted to pH of 8 or 9 by means of sodium carbonate.

10.0 SAMPLE PREPARATION PROCEDURE AND SIEVE ANALYSIS

(Note – refer to Figure 1 for a summary of the steps in Sections 10 and 11.)

10.1 Weigh out a sample aliquot of approximately 100 to 200 g. Enough dried sample must be obtained to have 65 g of clay or silt or 115 g of sand that passes through the number 10 sieve. Spread the sample aliquot out evenly on a piece of aluminum foil or other clean surface. Let the sample air dry until dry in appearance. If the sample forms a crust during the drying processing, use a spatula to break up the crust and prevent water from being trapped below the crust. Mix the dried sample well.

10.2 Place an aliquot of the dried sample in the mortar and break it into small pieces with a rubber covered pestle. All clay clumps, etc. should be broken apart. Weigh out enough sample to have approximately 65 g of clay or silt sample passing through the Number 10 sieve or 115 g of sandy sample passing through the Number 10 sieve. Record the final weight.

10.3 Sieve the sample through the number 10 sieve. Shake the sieve stack laterally and vertically, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments of the sample through the sieve by hand. Continue shaking until not more than 1% of the mass remaining on the sieve passes that sieve during 1 minute of shaking. NOTE: Do not overload the sieve to the extent that the soil that would normally be retained on that sieve interferes with the soil that would normally pass through the sieve).

10.4 Pour the sample remaining on the top of the Number 10 sieve back into the mortar and use the pestle to again break up any clumps of clay or dirt.

10.5 Pour this sample back into the number 10 sieve and repeat the sieving process outlined in step 10.3.

10.6 Combine all sample going through the number 10 sieve into a separate container and save for additional sieve testing, moisture testing, and hydrometer testing as outlined below.

10.7 Take the sample remaining on the number 10 sieve and wash it with a small amount of water to remove any dust, etc. still adhering to the particulate. If insignificant dust remains on the sample, then this step may be omitted. Air dry the sample and record the final weight.

10.8 Separate the sample portion retained on the number 10 sieve into a series of fractions using as many sieves as needed depending on the sample or upon the specifications for the material being tested. The normal series of sieves used include the 3 inch sieve, the 1.5 inch

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sieve, the ¾ inch sieve, the 3/8 inch sieve, the number 4 sieve, and the number 8 sieve. Follow the following protocol for each sieve.

10.8.1 Shake the sieve stack laterally and vertically, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments of the sample through the sieve by hand. Continue shaking until not more than 1% of the mass remaining on the sieve passes that sieve during 1 minute of shaking.

10.8.2 When the step 10.8.1 is complete for a given sieve, then weigh the portion of sample remaining on the sieve and record the weight.

10.9 Weigh out an aliquot of approximately 10 g of the sample portion passing through the number 10 sieve (from section 10.6) and record the weight. Dry the aliquot to constant mass at 110 ± 5°C. Constant mass is defined as a change of less than 0.01 in the hygroscopic moisture correction factor. Calculate the hygroscopic moisture correction factor by dividing the mass of the oven dried sample by the mass of the air dried sample. (This correction factor will be used to correct the remaining test material mass to determine an accurate dry mass for the sample in the hydrometer testing).

10.10 Perform the hydrometer testing as outlined in Section 11 using the air dried sample that passed through the number 10 sieve. After the hydrometer testing is complete, pour the suspended sample through a number 200 sieve and wash well with DI water. Then dry the sample in an oven at 110 ± 5°C until completely dry.

10.11 Separate the oven-dried aliquot into a series of fractions using as many sieves as needed depending on the samples or upon the specifications for the material being tested. The normal series of sieves used include the number 16 sieve, the number 30 sieve, the number 50 sieve, the number 100 sieve, and the number 200 sieve. Follow the steps outlined above in 10.8.1 and 10.8.2 for the sieving process.

10.11.1 If hydrometer testing is not performed, then oven dry the whole aliquot of sample to be used for the sieves smaller than number 10.

10.12 Calculate the percentage of sample passing through each sieve. This can be done using the calculation template or it can be calculated by hand.

10.12.1 The equation to be used to calculate the percentage of the sample passing through the number 10 or larger sieve is shown below.

% of sample passing through the sieve (number 10 and larger) =

$$\frac{100 \times (\text{tot. sample wt} - (\text{wt retained on sieve of interest} + \text{wt retained on all larger sieves}))}{\text{tot. sample wt}}$$

10.12.2 The equations to be used to calculate the percentage of the sample passing through a sieve smaller than number 10 are shown below. These calculations include a correction factor to take into account the size of the aliquot used. Note that the weight of the aliquot is the weight of sample put into the hydrometer when

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hydrometer testing is done as the sample is poured through the number 200 sieve when it is first removed from the hydrometer.

A = (wt retained on sieve of interest + wt retained on all larger sieves under 10)

$$\text{Fraction of aliquot} = \frac{(\text{wt. of aliquot} - A)}{\text{wt. of aliquot}}$$

$$\%\ \text{passing through sieve} = \text{Fraction of aliquot} \times \frac{\text{air dry weight passing through 10}}{\text{total air dry weight sieved}}$$

10.13 Calculate the percentage in the sample of gravel, sand, and silt, clay, and colloids. Gravel is defined as the sample passing through the 3 inch sieve and retained on the No. 4 sieve. Sand is defined as the sample passing through the No. 4 sieve and retained on the No. 200 sieve. Silt, clay, and colloids are defined as sample passing through the No. 200 sieve.

11.0 HYDROMETER ANALYSIS PROCEDURE

11.1 Determine hygroscopic moisture correction factor as described in section 10.9 above.

11.2 Determine the Composite Correction for Hydrometer – In a sedimentation cylinder, add 125 ml of the dispersing agent and dilute with DI water to 1000 ml (control sample).

11.2.1 Adjust the temperature of the control sample to 20 deg. C.(or to the lowest temperature expected during the measuring process.) Place the thermometer and the hydrometer into the control sample. Record the hydrometer and thermometer readings. Record the composite correction faction which is the difference between the hydrometer reading and zero.

11.2.1.1 The hydrometer should be read at the top of the meniscus formed on the stem.

11.2.2 Adjust the temperature of the control sample to 24 deg. C.(or to the highest temperature expected during the measuring process.) Place the thermometer and the hydrometer into the control sample. Record the hydrometer and thermometer readings. Record the composite correction faction which is the difference between the hydrometer reading and zero.

11.2.3 Use the known composite correction factors and temperatures to determine composite correction factors at different temperatures in the range tested.

11.3 When the soil is mostly clay and silt sizes, weigh out approximately 50 g of air-dried soil. When the soil is mostly sand, weigh out approximately 100 g. Record the weight used. Place the sample aliquot into a beaker and cover with 125 ml of the sodium metaphosphate solution (5.1). Stir until the soil is thoroughly wetted. Allow it to soak for at least 16 hours.

11.4 After soaking, pour the sample into the dispersion cup, making sure to wash any sediment remaining in the original sample container into the dispersion cup with deionized water. Add deionized water so that the cup is more than half full and stirr for a period of 1

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minute. Immediately after dispersion, transfer the slurry to the sedimentation cylinder, making sure all of the sample is removed from the beaker by using a wash bottle. Dilute to the 1000-ml mark on the cylinder with DI water.

11.5 Using Parafilm and the palm of the hand over the open end of the cylinder (or a robber stopper), turn the cylinder upside down and back for a period of 1 minute to complete the agitation of the slurry. Any soil remaining at the bottom of the cylinder during the first few turns, should be loosened by vigorous shaking while the cylinder is in the inverted position. The number of turns should be about 30, counting the turn upside down and back as one turn.

11.6 Set the sample cylinder next to the control cylinder and take hydrometer readings for the sample and the control at the following time intervals: 2, 5, 15, 30, 60, 250 (4 hours and 10 minutes), and 1440 minutes (24 hours).

11.6.1 When it is time to take a reading, record the temperature and the uncorrected hydrometer reading of the control sample on the data sheet. Then insert the hydrometer into the soil sample cylinder at the approximate depth it will have when the reading is taken (insert hydrometer 20 to 25 seconds before scheduled reading time). Record the uncorrected hydrometer reading for the sample on data sheet. The hydrometer should be read at the top of the meniscus formed on the stem

11.6.2 Clean the hydrometer after each reading in deionized water and store in deionized water between readings. They hydrometer should not be left in the sample after the reading.

11.7 Calculate the final particle sizes and percent smaller than a given diameter using the following equations. These calculations may be done manually or may be done in a spreadsheet.

11.7.1 Percentage of soil in suspension (percent smaller than a given diameter of soil) = (R x a)/W

where R = hydrometer reading with composite correction applied
a = correction factor from Table 1
W = 100 x (air dried mass used for hydrometer x hygroscopic moisture correction factor)/% passing through No. 10 sieve)

Note: Specific gravity of the soil is needed for Table 1. If the specific gravity is not listed on the table, extrapolate to an appropriate correction factor.

11.7.2 Diameter of soil particles = $K (L/T)^{1/2}$

Where K = constant taken from Table 3
L = effective depth taken from Table 2
T = time interval in minutes

Note: Specific gravity of the soil is needed for Table 3. If the specific gravity is not listed on the table, extrapolate to an appropriate K value.

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11.7.3 Plot the diameters of the particles on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters to an arithmetic scale as the ordinate. Read back the percentage of particles smaller than 0.075 mm, 0.005 mm, and 0.001 mm from the graph and record on the data sheet for entry into the LIMS. Note: depending on the conditions of the experiment, there may not be data for the percentage of particles at 0.001. In that case, report the percentage of particles at the lowest diameter available and footnote the result with the actual diameter.

12.0 QC REQUIREMENTS

12.1 A summary of the main quality control requirements are given below. Other requirements specific to a given client or matrix may also be required. Check with the supervisor or manager to determine if there are additional quality control requirements.

12.2 A hydrometer control should be analyzed periodically or whenever a new hydrometer is used.

12.3 A duplicate should be analyzed with each batch of 20 samples or less. Control limits are compiled by Accutest annually and should be used to determine if matrix problems are present. If the duplicate is outside of the control limits, and all other quality control is within limits, then no reanalysis is necessary, but the QC results must be footnoted to indicate possible sample non-homogeneity or matrix interferences. Until control limits can be generated, default control limits of 20% rpd should be applied.

13.0 DOCUMENTATION REQUIREMENTS

13.1 The analyst should document all relevant information, including all sample weights, all sample and control analysis results, and any relevant comments.

13.2 All reagent identification numbers should be recorded on the sample worksheets. In addition, all reagent information such as lot numbers should also be recorded in the reagent log book.

14.0 DATA REVIEW AND REPORTING

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14.1 All samples should be updated to QC batches in the LIMS system. The analyst should calculate all sample results and all duplicate RPD's. They should verify that all calculations are complete and that all reagents are documented and traceable.

14.2 After the analyst review is completed, the supervisor or a designated reviewer shall review the run for technical compliance to the SOP. The supervisor is also responsible for making sure that the QC calculations are done correctly and responsible for reviewing the data entry into the LIMS. No LIMS entry review is necessary when the data is electronically transferred.

14.3 After the supervisor or designated reviewer completes their review, the data is released for client access in the LIMS. The raw data is submitted to the area manager. The department manager does an additional periodic review on the sample data as appropriate. The raw data is then filed electronically in the report generation department.

14.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the waste management SOP, EHS004. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non hazardous aqueous wastes.

15.2.2 Hazardous aqueous wastes

15.2.3 Chlorinated organic solvents

15.2.4 Non-chlorinated organic solvents

15.2.5 Hazardous solid wastes

15.2.6 Non-hazardous solid wastes

16.0 ADDITIONAL REFERENCES

16.1 Refer also to ASTM D421-85 for additional details on preparation of the soil samples.

16.2 Refer to ASTM D422-63 for Tables 1, 2, and 3

16.3 Refer to SOP EGN247 for the process to use to determine soil specific gravities.

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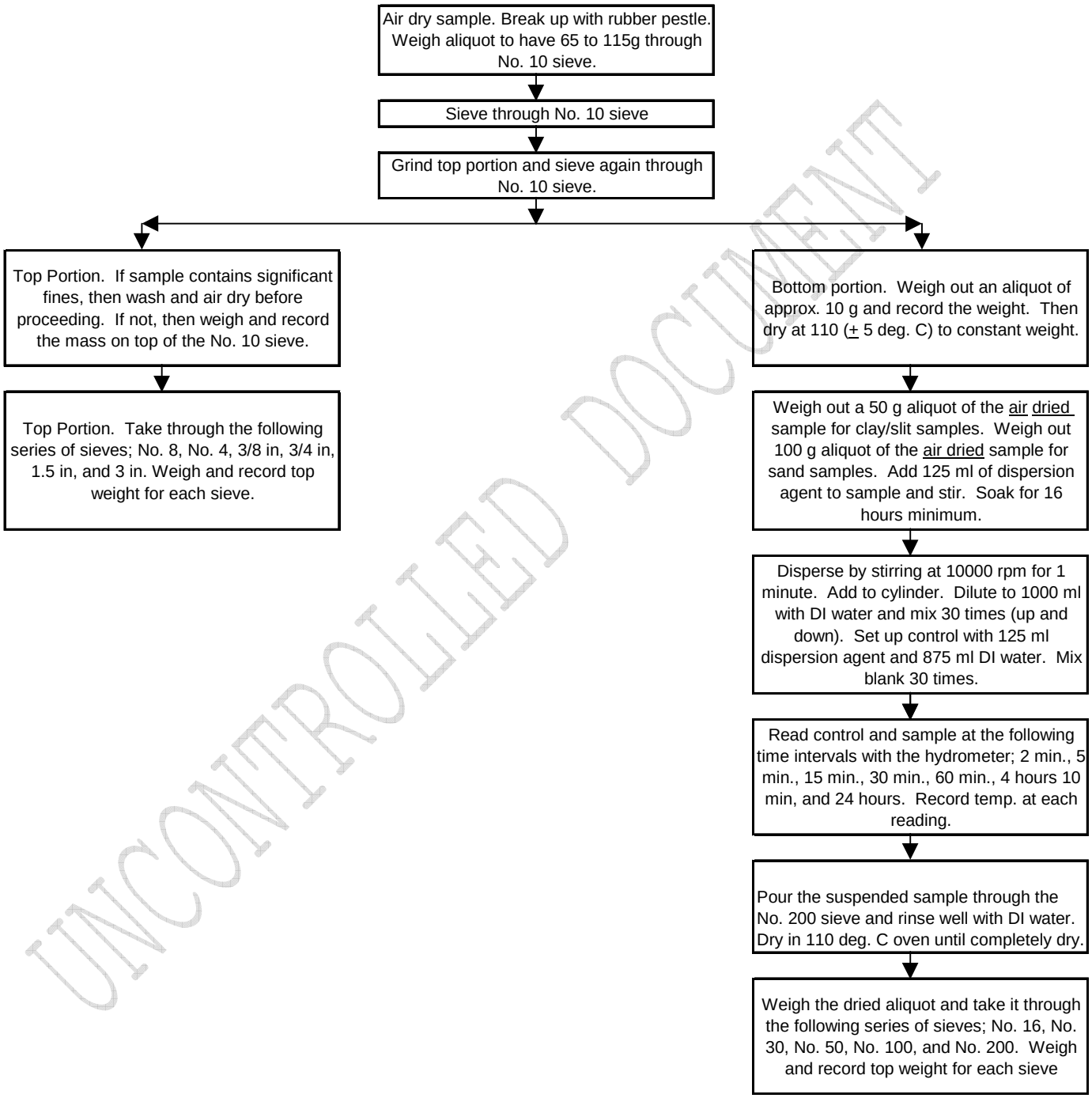
FIGURE 1: SIEVE AND HYDROMETER PROCESS FLOW CHART



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Lab Manager: Brad Madadian

QA Officer: Mark Warren

TITLE: **NITRATE/NITRITE AND NITRATE ONLY BY CADMIUM REDUCTION ANALYSIS (LACHAT AUTOANALYZER)**

TEST METHOD Reference: EPA 353.2 (water) Rev.2.0 1993; EPA 353.2 Mod. (soil

REVISED SECTIONS: **Test Method Ref., 4.16, 4.17, 4.18, 4.25, 11.3, 11.4, 11.5, 11.6**

1.0 SCOPE & APPLICATION

1.1 This method is based on EPA method 353.2 and used as a measure of the nitrate/nitrite or nitrate only in drinkingwater and wastewater samples. A modification of the method can be used as a measure of the nitrate/nitrite in soil samples.

2.0 SUMMARY

2.1 The nitrate is reduced to nitrite by a cadmium reduction column. The nitrite is then determined by diazotizing with sulfanilamide and coupling with N-(1-napthyl)-ethylenediamine dihydrochloride to form a high colored azo dye which is measured colorimetrically.

3.0 METHOD REPORTING LIMIT AND DETECTION LIMIT

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs. Refer to the SOP for MDLs (MQA245) for additional detail regarding MDL study procedures.

3.5 Current MDLs may be entered into the LIMS, and may be viewed by printing out the compound list from the LIMS. Additionally, MDLs are reported on the result page upon client request. Current

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MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch.

4.3 CALIBRATION CHECK STANDARD/CONTINUING CALIBRATION VERIFICATION (CCV). The calibration check standard is a mid-range calibration standard. It is recommended that the calibration check standard or CCV must be run at a frequency of approximately 10 percent. For most methods, the mid-level calibration check standard criteria is ± 10 percent of the true value. Refer to the specific quality control section for each SOP. The exception to this rule is if the recovery on the calibration check standard is high and the samples to be reported are less than the detection limit.

4.4 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

4.5 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

4.6 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying. See Percent Moisture.

4.7 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.8 EXTERNAL CHECK STANDARD/INITIAL CALIBRATION VERIFICATION(ICV). The external check standard or ICV is a standard from a separate source than the calibration curve that is used to verify the accuracy of the calibration standards. An external check must be run a minimum of once per quarter for most analyses where a check is commercially available. The laboratory should initially assess laboratory performance of a check standard using the control limits generated by the external check supplier. Refer to the quality control section for each SOP. If the external check is outside of the control limits for a given parameter, all samples must be reanalyzed for that parameter after the problem has been resolved.

4.9 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

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4.10 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.11 HOLDING TIME – the elapsed time expressed most commonly in days from the date of sampling until the date of its analysis.

4.12 INTERFERENTS – substances which affect the analysis for the analyte of interest.

4.13 INITIAL CALIBRATION - analysis of analytical standards for a series of different specified concentrations; used to define the linearity and dynamic range of the response of the mass spectrometer or electron capture detector to the target compounds.

4.14 INSUFFICIENT QUANTITY - when there is not enough volume (water sample) or weight (soil/sediment) to perform any of the required operations: sample analysis or extraction, percent moisture, MS/MSD, etc.

4.15 MATRIX: The component or substrate (e.g., water, soil) which contains the analyte of interest.

4.16 MATRIX DUPLICATE: A duplicate sample is digested/distilled/analyzed at a minimum of 1 in 10 samples (or 10 samples for certain methods). The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. Assess laboratory performance against the control limits. In house limits are generated once sufficient duplicate data is available to generate limits (usually a minimum of 20 to 30 analyses). If a duplicate is out of control, flag the results with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control. Note: If control limits are not specified, use default limits of ± 20% RPD.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

4.17 MATRIX SPIKE: The laboratory must add a known amount of each analyte to a minimum of 1 in 10 samples. The matrix spike recovery is calculated as shown below. Assess laboratory performance against the control limits of 90-110%. In house limits are generated once sufficient matrix spike data is available to generate limits (usually a minimum of 20 to 30 analyses). If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect. Note:

$$\frac{(\text{Spiked Sample Result} - \text{Sample Result})}{(\text{Amount Spiked})} \times 100 = \text{Matrix Spike Recovery}$$

4.18 METHOD BLANK. The laboratory must digest or distill (as appropriate to the method) and/or analyze a method blank with each set of samples. A minimum of one method blank is required for every 10 samples. If no digestion step is required, then the method blank is equivalent to the reagent blank. The method blank must contain the parameter of interest at levels of less that the reporting limit for that parameter. If the method blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client

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required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

4.19 PERCENT MOISTURE - an approximation of the amount of water in a soil/sediment sample made by drying an aliquot of the sample at 105 °C. The percent moisture determined in this manner also includes contributions from all compounds that may volatilize at or below 105 °C, including water. Percent moisture may be determined from decanted samples and from samples that are not decanted.

4.20 RELATIVE PERCENT DIFFERENCE (RPD) - To compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.21 REAGENT BLANK: The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. (Note: for methods requiring no preparation step, the reagent blank is equivalent to the method blank.) Either a reagent blank or a method blank must be analyzed with each batch of 20 samples or less. The concentration of the analyte of interest in the reagent blank must be less than the reporting limit for that analyte. If the reagent blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the reagent blank level. In addition, if all the samples are less than a client required limit and the reagent blank is also less than that limit, then the results can be reported as less than that limit.

4.22 REAGENT GRADE: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.23 REAGENT WATER: Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water. Water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.24 REFERENCE MATERIAL: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

4.25 SPIKE BLANK OR LAB CONTROL SAMPLE. Digest and analyze a laboratory control sample or spike blank with each set of samples. A minimum of one lab control sample or spike blank is required for every 10 samples. Assess laboratory performance against the control limits of 90-110%. In house limits should also be generated once sufficient external check standard data is available to generate limits (usually a minimum of 20 to 30 analyses). In house limits must equal or better than the required limits. If the lab control is outside of the control limits for a parameter, all samples must be redigested or redistilled and reanalyzed for that parameter. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag.

4.26 STANDARD CURVE: A plot of concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by successively diluting a standard

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solution to produce working standards that cover the working range of the instrument. Standards should be prepared at the frequency specified in the appropriate section. The calibration standards should be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIMES

6.1 Collection and Preservation

6.1.1 Containers 250 ml plastic container (water); 300 ml glass container (soil)

6.2 Preservation Both soils and water samples should be kept under refrigeration at 4°C until analysis. Water samples should be preserved with sulfuric acid to a pH of less than 2 if they are to be analyzed for nitrate + nitrite. If nitrate only is requested, then the sample can be separated into 2 aliquots. The nitrate + nitrite aliquot should be preserved with sulfuric acid and the nitrite aliquot should be unpreserved.

6.3 Holding Time: All preserved samples should be analyzed within 28 days of the date of collection. Unpreserved samples must be analyzed within 48 hours of the time of collection. Nitrite must be analyzed within 48 hours.

7.0 APPARATUS & MATERIALS

7.1 Automated continuous flow analyzer designed to deliver and react sample and reagents in the required order and ratios. Currently, the Lachat 8000 Automated Ion Analyzer is being used.

7.2 Autosampler XYZ

7.3 Multichannel pump

7.4 Reaction manifold, including cadmium-copper reduction column.

7.5 Colorimetric detector

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7.6 Real time data acquisition device (either electronic or hard copies).

7.7 Balance. Analytical balance capable of accurately weighing to the nearest 0.0001 g.

7.8 Volumetric glassware. Class A volumetric pipettes and flasks as required.

8.0 STANDARDS & REAGENTS

Note: All applicable standard/reagent preparation information, including vendor, lot number, date of preparation, date of expiration, calculations, and initials must be entered in the appropriate standard/reagent preparation logbook. Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

8.1 All chemicals listed below are reagent grade unless otherwise specified. Distilled, deionized water should be used whenever water is required.

8.2 15 N Sodium Hydroxide. In a 1 liter beaker, slowly add 150 g of NaOH to 250 ml of DI water. Swirl until dissolved. **Caution - the solution will get very hot!!**

8.3 Ammonium Chloride Buffer Solution. In a 1000 ml beaker, dissolve 85.0 g ammonium chloride (NH_4Cl) and 1.0 g disodium ethylenediamine tetraacetic acid dihydrate (Na_2 EDTA $2H_2O$) in about 800 ml of DI water. Adjust the pH up to 8.5 with 15 M sodium hydroxide. Dilute to 1000ml with DI water in a 1000 ml volumetric flask and mix. Degas this solution with He at 20 psi for 2 min.

NOTE: Ammonium chloride has been found occasionally to contain significant nitrate contamination. If the zero cannot be set, this may be the problem. An alternative way for making ammonium chloride buffer is:
In the hood, to a 1000 ml volumetric flask add 500 ml of DI water, 105 ml concentrated Hcl, 95 ml ammonium hydroxide (NH_4OH), and 1.0 g disodium EDTA. Dissolve and dilute to the mark with DI water. Adjust the pH to 8.5 with concentrated ammonium hydroxide. Degas this solution with He at 20 psi for 2 min.

8.4 Sulfanilamide color reagent. Add 100 ml of concentrated phosphoric acid (H_3PO_4), 40.0 g of sulfanilamide, and 1.0 g of N-(1-napthyl)ethylenediamine dihydrochloride (NED) to a 1 liter volumetric containing approximately 600 ml of DI water. Stir to dissolve and dilute to a final volume of 1 liter with DI water. Store in a dark bottle. This solution is stable for approximately 1 month. Degas this solution with He at 20 psi for 2 min.

8.5 Hydrochloric Acid, 1 N. Add 8 ml of concentrated HCl to approximately 85 ml of DI water. Dilute to a final volume of 100 ml with DI water.

8.6 Carrier solution. Degassed DI water. Degas DI water with He. Use He at 20 psi for 2 min.

8.7 Two percent copper sulfate solution. Dissolve 20 g of copper sulfate (CuSO4.5H2O) in approximately 800 ml of DI water in a 1 liter volumetric flask. Dilute to a final volume of 1 liter and mix well.

8.8 Cadmium reduction column. The cadmium reduction column should be prepared as described below.

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Note 1: It is recommended that extra cadmium be prepared through step 6.8.3 so that new columns may be packed as needed.

Note 2: Cadmium is toxic. Make sure to wear gloves for all procedures and collect any cadmium waste in a marked solid waste container.

8.8.1 Place 10 to 20 g of coarse cadmium granules in a beaker. Cadmium granules ranging from 0.3 to 1.5 mm in diameter are recommended. Wash the Cd first with acetone and then with DI water. Then wash the Cd with two 50 ml portions of 1 N HCl. Rinse the Cd granules well with DI water.

8.8.2 Add 100 ml of 2% copper sulfate solution to the cadmium granules. Swirl for about 5 minutes, then decant the liquid and repeat the process with a fresh portion of 2% copper sulfate solution. Continue this process until the blue color of the copper sulfate solution persists.

8.8.3 Decant off the copper sulfate solution and rinse the copper granules with at least 5 portions of ammonium chloride buffer to remove the colloidal copper. The cadmium should be black or dark gray at this point and can be stored in a capped bottle under ammonium chloride buffer solution.

8.8.4 Open one end of a column, removing the colored lead and the foam plug, and clamp the column so that the open end is pointing up. Fill the column with ammonium chloride buffer. Pour the prepared cadmium granules into the column and tap the column lightly so that the granules settle to the bottom of the column. Fill the column to about 5 mm from the open end. Make sure that there are no air bubbles. Push in the foam plug and screw on the cap. Rinse the outside of the column with DI water.

8.8.5 Insert the column into the manifold by first pumping all reagents into the manifold. Then turn the pump off. Connect the column to the appropriate tubing, making sure that no air is in the tubing. Then return the pump to its normal speed.

8.9 Stock nitrate solution, 1000 mg/l. Dissolve 7.218 g of KNO_3 and dilute to 1 liter with DI water in a 1 liter volumetric flask. Preserve with 2 ml of chloroform per liter. This solution is stable for 6 months.

8.10 Standard nitrate solution, 100 mg/l. Dilute 10.0 ml of 1000 mg/l nitrate solution to 100 ml with DI water in a volumetric flask.

8.11 Standard nitrate solution, 10.0 mg/l. Dilute 10.0 ml of 1000 mg/l nitrate solution to 1000 mg/l with DI water in a volumetric flask.

8.12 Nitrate Calibration Standards. Calibration standards should be made from the above standard solutions as shown below. Class A volumetric pipettes and flasks should be used for all dilutions. A calibration check standard should also be prepared that is at or near the mid-point of the calibration curve.

NOTE: Other calibration standards may be used if necessary. Bring all standards to 100 ml final volume with DI water.

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Ml of 8.11	Ml of 8.10	Final Conc.(mg/l)
0.00		0.00
1.00		0.10
3.00		0.30
5.00		0.50
8.00		0.80
10.0		1.00
	2.00	2.00
	5.00	5.00

8.13 Stock nitrite solution, 1000 mg/l. Dissolve 6.072 g of KNO_2 in 500 ml of DI water and dilute to 1 liter in a 1 liter volumetric flask. Preserve with 2 ml of chloroform and keep under refrigeration.

8.14 Standard nitrite solution, 10.0 mg/l. Dilute 1.0 ml of 1000 mg/l nitrite solution (8.13) to 100 ml with DI water in a volumetric flask.

8.15 2.0 ppm Standard nitrite solutions. The nitrite solution is used to check the efficiency of the cadmium reduction column, by comparing a nitrite standard directly with a nitrite standard of the same concentration. Dilute 20 ml of 10 ppm nitrite solution (8.14) to 100 ml with DI water in a volumetric flask.

8.16 Spike solution 100 Mg/L. Dilute 10 ml of 1000 mg/l nitrate solution (8.9) to 100 ml with DI water in a volumetric flask.

9.0 INTERFERENCES

9.1 Build up of suspended matter in the reduction column will restrict sample flow. However, samples can be filtered through a 0.45 um membrane filter to avoid this interference.

9.2 High concentrations of iron, copper, or other heavy metals can cause low results, but this can be avoided by adding EDTA to the samples to complex the metals.

9.3 Residual chlorine can produce a negative interference. This can be eliminated by dechlorinating the sample with sodium thiosulfate.

9.4 Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. This interference is eliminated by pre-extracting the sample.

10.0 PROCEDURE

10.1 Below is a step by step procedure for the analysis of samples for the determination of nitrate/nitrite and nitrate only. At the end of this SOP is a short summary outlining the overall procedure.

10.2 Install the nitrate reaction manifold, excluding the cadmium column. Check all tubing and change any tubing that is flat, dirty, etc. Install the appropriate sample loop and the appropriate filter. Place the

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tubing in the bottles for the sulfanilamide color reagent, the ammonia buffer solution, and the degassed DI water carrier. Also make sure that the waste container is in place. Refer to the manual for additional information.

10.3 For soil samples, follow the digestion procedure described below. The matrix spike should be prepared by adding 4.0 ml of 100 mg/l nitrate solution directly to the soil and mixing well before the acid digestion. The spike blank should also be prepared by digesting 4.00 ml of the 100 mg/l standard. Make sure to prepare a method blank with each batch of samples.

10.3.1 Weigh out 1.0 g of sample (dry weight) into a 200 ml Erlenmeyer flask. Add 50 ml of DI water and 4 drops of concentrated sulfuric acid. Add another 50 ml of DI water and then boil the sample on a hot plate for 15 minutes.

NOTE: **This procedure is operationally defined, so make sure that the same heating time is used for all samples.**

10.3.2 Transfer the sample to a centrifuge tube and centrifuge for 5 to 10 minutes. Decant the wash into a 200 ml volumetric flask.

10.3.3 Add 50 ml of DI water to the solids in the centrifuge tube and mix well. Then centrifuge the sample for 5 to 10 minutes and decant the wash into the volumetric flask.

10.3.4 Repeat the above step a second time and again decant the wash into the volumetric flask.

10.3.5 Bring the sample to a final volume of 200 ml with DI water. Filter the sample through a 0.45 um filter before analysis.

10.4 For water samples no preparation is necessary unless the sample is turbid. If the sample is turbid, filter before analysis through a 0.45 um membrane filter paper. If the pH of the sample is below 5 or above 9, adjust to between 5 and 9 with either con. HCl or conc NH_4OH. The matrix spike should be prepared by adding 0.2 ml of 100 mg/l nitrate solution to approximately 10 ml of sample. The spike blank should be prepared by diluting 0.2 ml of 100 mg/l nitrate solution to a final volume of 10 ml with DI water. Make sure to analyze a method blank for each batch of samples.

10.5 On the desk top open the lachat software by clicking on the "**Omni"** icon, and then click on "**OPEN"** on top of the tool bar. The "**OPEN"** window will now be on the screen. The templates, specific to each methods, are stored in the data file. Open the appropriate data file (ie., NO3). Click on the template.

10.6 Three windows will open on screen, **("the run worksheet", "run properties", and "channel one**). "**Run worksheet"** will contain the appropriate standards. To extend the worksheet (adding samples and QC, etc), right click on the bottom line of the worksheet (CalBlk), and click on "**append many".** The appended rows window will now be open and the appropriate number of rows needed should be entered, click "**"ok**". The work sheet must now be sequenced to direct the auto-sampler to the correct sample locations.

10.7 Click and drag by starting in the gray sample No. column down to the last sample to highlight the rows (not including STD's). Right click, then go to columns, then to "**Auto Number Cups"** and click. The run should now be in numerical sequence.

IF PRINTED – this SOP may not be latest version. It is the responsibility of the user to verify the status of this SOP.
Property of Accutest – Do Not Duplicate

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10.8 In the **"Run Properties"** window, click on the Run tab and check "**Export Data as CSV file"** There are other areas of the "**Run Properties"** window that contain method specific information such as timing. These settings must not be adjusted without consulting the area lab supervisor, or an experienced analyst.

10.9 Allow the instrument to warm up for 30 minutes.

10.10 Start pumping reagents through the system. When reagents are pumped through the manifold, then the cadmium column can be installed.

10.11 To begin the analysis, click on "START" on toolbar. The instrument will begin to calibrate. The acceptance calibration criteria for correlation coefficient of 0.995 are set within the software. If the criteria is met, the instrument will proceed with sample analysis.

10.12 Observe the peaks in "**Channel One"** window. The baseline should be smooth and peaks must be well shaped and smooth. If peaks look abnormal, that may indicate the chemistry problems, such as pH differences. Small spikes are indicative of air bubbles in the system.

10.13 The run maybe stopped at anytime by clicking **"Stop"** in the top toolbar. It should be noted that every time the run has been stopped and started, a new file is created. If dilutions are required, the dilution factor needs to be entered in the "**Run Worksheet"** window. On **MDF** column, click on the box and enter the dilution factor.

10.14 When the run is completed the file is automatically exported to " **Lachat CSV files**" locally under "My Document" directory. Click on **"Lachat CSV Files**". All generated files are listed based on the following format: **OM_date_time Am or PM** (**OM_4-11-2006_12-10-34PM**). Drag the generated files for that run/day to the current Month/Year directory. For the ease of search later on, at the beginning of each month, create a directory to save the runs for the entire month, and name it based on the month, and the year (ie, **OCT 2006**). Once you have moved your file to the month/year directory, copy this file to" **Lacha**t" directory located on the server **Mafile1\WC_DATA** , rename the file to the format which is acceptable to LIMS. This naming scheme will be based on date, the matrix, no. of the run for that day, and finally the test code extension, (ie, **050206W1.NO3**). Once the files have been renamed, drag the file to Server **LIMS_WC**. Server **LIMS_WC** is the processing branch of the LIMS for Wet Chemistry. Once the Run is processed in LIMS, go to GNAPP, and review the run. Package all raw data, and logbook copies in a folder, and turn the package to the area manager for data review, and quality control check.

10.15 To obtain a print out of the sample run, click on Tools in the top toolbar and then click on custom report. To format the report to contain the calibration curve and dilutions, click on report, then format in the custom report window.

10.16 Make sure to check the cadmium reduction efficiency at the beginning of the run. If the efficiency is outside of the range of 85-115%, then the column should be reactivated.

10.17 At the end of the run, make sure to pump ammonia buffer into the cadmium column and cap off the column, making sure that no air is entrained. Rinse out the remainder of the system with DI water.

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10.18 Results exceeding the upper range of the calibration curve must be diluted and re-analyzed. The diluted result should be within the upper range of the calibration curve.

11.0 QUALITY ASSURANCE

11.1 Calibration curve. The correlation coefficient of the calibration curve must be 0.995 or greater. The curve must be verified using a standard source independent from the calibration standards (second source). Only the low and high points of the curve may be removed to meet correlation coefficient criteria. If a middle point is removed, it must be approved by the supervisor and documented in the analysis logbook. Removing the low point raises the reporting limit, and removing the high point reduces the calibration range.

11.2 Quality Control Sample (also referred to as Initial Calibration Verification Standard (ICV) a standard from a different source than the calibration standard must be analyzed with each initial calibration. Normally this is analyzed at the beginning of the run after the CCV and CCB checks. For this method, the ICV should be within 10% of the true value.

NOTE: It is recommended that this standard be analyzed with each run.

11.3 Method Blank. The laboratory must digest and analyze a method blank with each set of samples. A minimum of one method blank is required for every 10 samples. The method blank must not contain the analyte greater than the reporting limit. If the method blank contains over that limit, the samples must be re-analyzed (if the samples are non-detected they may be reported without qualification).

11.4 Spike Blank. The laboratory must digest and analyze a spike blank with each set of samples. A minimum of one lab control sample or spike blank is required for every 10 samples. Assess laboratory performance against the control limits of 90-110%. In house limits should also be generated once sufficient external check standard data is available to generate limits (usually a minimum of 20 to 30 analyses). In house limits must equal or better than the required limits. If the lab control is outside of the control limits for a parameter, all samples must be redigested or redistilled and reanalyzed for that parameter. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag.

11.5 MATRIX SPIKE: The laboratory must add a known amount of each analyte to a minimum of 1 in 10 samples. The matrix spike recovery is calculated as shown below. Assess laboratory performance against the control limits of 90-110%. In house limits are generated once sufficient matrix spike data is available to generate limits (usually a minimum of 20 to 30 analyses). If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect

$$\frac{(\textit{Spiked Sample Result} - \textit{Sample Result})}{(\textit{Amount Spiked})} \times 100 = \textit{MS Recovery}$$

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11.6 Matrix Duplicate. The laboratory must analyze a duplicate sample for a minimum of 1 in 10 samples. The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. The duplicate RPD should be assessed using in house limits. Until these limits can be generated, then default limits of 20% RPD should be applied. If a duplicate is out of control, then the results should be flagged with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control.

11.8.1The duplicate RPD should be calculated as shown below:

$$\frac{(Sample\ Result\ -\ Duplicate\ Result)\ x\ 100}{(Sample\ Result\ +\ Duplicate\ Result)\ x\ 0.5} = \%RPD$$

11.9 Continuing Calibration Verification. (Also known as the instrument performance check solution). Analyze the continuing calibration verification solution and the continuing calibration blank after the initial calibration, after every tenth sample, and at the end of the sample run. If the CCV solution is not within 10% of the true value, then no samples can be reported in the area bracketed by that CCV.

NOTE: The exception is if the CCV is biased high and the samples are less than the detection limit. In that case, the samples can be reported with no flag.

The CCV concentration should be at or near the mid-range of the calibration curve.

11.10Continuing Calibration Blank. Analyze the CCV solution and the CCB after the initial calibration, after every tenth sample, and at the end of the sample run. If the CCB is not less than the reporting limit, then no samples can be reported in the area bracketed by the failing CCB.

11.11 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recoveries are compared to either default limits of 80-120% or in-house control limits once established. The standard deviation of the 4 replicate percent recoveries are compared to either ±20 or to in-house limits once established. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control. The P&A study must be performed using a source independent from the calibration standards (second source).

11.12 Quality Control data is generated (control charts) and reviewed on an annual basis by Quality Assurance (blank spike/ matrix spike recoveries and matrix duplicate RPDs).

12.0 DOCUMENTATION

12.1 The analytical logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

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12.2 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.3 The standard preparation logbook application must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

12.4 The Accutest lot number must be cross-referenced on the standard vial/container.

12.5 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.6 All laboratory logbooks must be routinely reviewed and initialed or signed by the lab manager.

12.7 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, preparation and/or analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/duplicate percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client. Additionally, raw data including any instrument printouts, laboratory logbooks, etc. may be reported to the client.

14.2 Data may be submitted to the client in a specified electronic format (EDD).

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14.3 Data may be submitted to the client electronically as a PDF (e-hardcopy).

14.4 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.5 Procedures for handling non-conforming data.

14.5.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.5.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual QC limits (control charts) generated by QA, and the annual MDL study results. Refer to section 3.5 for MDLs, and section 11.12 for QC limits.

17.0 ADDITIONAL REFERENCES

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17.1 Lachat QuickChem Method 10-107-04-1-C

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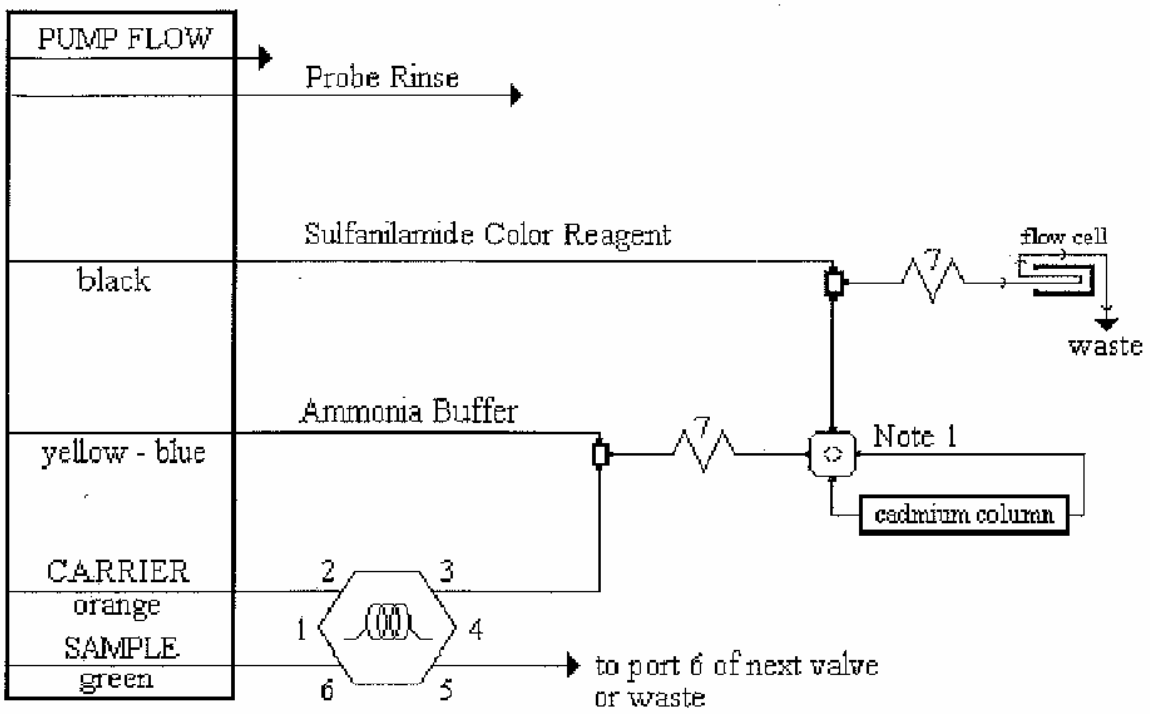
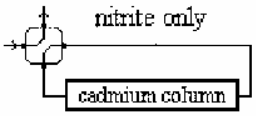


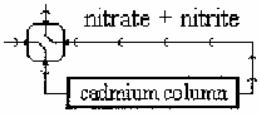
Carrier: Helium Degassed DI water
Manifold Tubing: 0.8 mm (0.032 in) i.d. This is 5.2 µL/cm.
AE Sample Loop: 17 cm x 0.8 mm i.d.
QC8000 Sample Loop: 22.5 cm x 0.8 mm i.d.
Interference Filter: 520 nm

Apparatus: An injection valve, a 10 mm path length flow cell , and a colorimetric detector module is required.

7: 135 cm of tubing on a 7 cm coil support

Note 1: This a 2 state switching valve used to place the cadmium column in-line with the manifold





Lab Manager: John Hamilton

QA Officer: Mark Warren

TITLE: LABORATORY ANALYSIS OF DISSOLVED GASES IN AQUEOUS SAMPLES

TEST METHOD REFERENCES: RSK-175, 8/11/94; RSK 174, 8/11/94, US EPA Region I, 2/21/02

REVISED SECTIONS: 10.1, 10.1.9.2, 10.1.10, 10.3.7, 10.4.2, 10.4.3, 10.4.6, 11.0, 14.3, Removed Section 17.0, Table 1

1.0 SCOPE & APPLICATION

1.1 The analysis of dissolved gases in aqueous samples, primarily groundwater is used to monitor natural attenuation. Natural attenuation is a remedial approach to groundwater contamination that depends upon natural processes to degrade and dissipate contamination constituents. The monitoring of certain dissolved gases can determine if a contaminated site is conducive to aerobic or anaerobic bioremediation. The activity of bioremediation can be determined by certain dissolved gas byproducts as in methane.

1.2 Methane, ethane, ethene, and CO2 are the target compounds for this SOP. The applicable matrix is water (primarily groundwater).

2.0 SUMMARY

2.1 This method is for the determination of trace levels of dissolved gases in aqueous samples, primarily groundwater. A sealed volatile organic vial with teflon septa is prepared at ambient temperature by displacing a certain amount of the water with zero grade helium through the septa. The sample is shaken to disperse the dissolved gases into the headspace which is injected into a calibrated gas chromatograph coupled with a flame ionization detector (FID) and Thermal conductivity detector (TCD). The calibration is performed by external standard technique using a multipoint gas standard containing the compounds of interest in ppmv. The sample is quantitated based on the concentration of the helium headspace in ppmv and is carried through a series of calculations involving Henry's Law constant, temperature of the sample, volume of sample vial, headspace volume, dilution factor, and the molecular weight of the gas. Results are reported in ug/l of each dissolved gas.

3.0 METHOD REPORTING AND DETECTION LIMITS

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification. Reporting limits are:

3.1.1	Methane:	10 ug/l
3.1.2	Ethane:	10 ug/l
3.1.3	Ethene:	10 ug/l
3.1.4	CO2:	100 ug/l

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3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs.

3.5 Current MDLs are entered into the LIMS and may be reported upon request. Additionally, current MDLs are also located in the MDL file on the QA server (LINUXMA1). These summary tables are saved under the applicable year. MDL hardcopy summary tables are also filed with QA and are available for review upon request. Obsolete hardcopy MDL summaries are filed with QA.

3.6 Refer to the Procedure for Developing Detection Limits SOP (MQA245) for additional procedural detail.

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch. Batch size for this test is 20 samples or less.

4.3 BLANK SPIKE – a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

4.4 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

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4.5 CALIBRATION FACTOR (CF) - a measure of the gas chromatographic response of a target analyte to the mass injected. The calibration factor is analogous to the Relative Response Factor (RRF) used in the Volatile and Semivolatile fractions.

4.6 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

4.7 CONTINUING CALIBRATION – analytical standard run every 12 hours to verify the initial calibration of the analytical system.

4.8 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying in an oven.

4.9 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.10 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

4.11 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.12 HOLDING TIME – the elapsed time expressed in days from the date of sampling until the date of its analysis.

4.13 INTERFERENTS – substances which affect the analysis for the analyte of interest.

4.14 GAS CHROMATOGRAPH (GC) - the instrument used to separate analytes on a stationary phase within a chromatographic column. The analytes are volatized directly from the sample (VOA water and low-soil) volatized from the sample extract (VOA medium soil), or injected as extracts (SVOA and PEST). In VOA and SVOA analysis, the compounds are detected by a Mass Spectrometer (MS). In PEST analysis, the compounds are detected by an Electron Capture (EC) detector. In the screening procedure (all fractions), the Flame Ionization Detector (FID) is used as the detector.

4.15 INITIAL CALIBRATION - analysis of analytical standards for a series of different specified concentrations; used to define the linearity and dynamic range of the response of the mass spectrometer or electron capture detector to the target compounds.

4.16 INITIAL CALIBRATION VERIFICATION – analysis of a check standard from a second source (either vendor or lot) from the initial calibration standards to verify the initial calibration.

4.17 INTEGRATION TIME RANGE - the retention time at the beginning of the area of integration to the retention time at the end of the area of integration.

4.18 INSUFFICIENT QUANTITY - when there is not enough volume (water sample) or weight (soil/sediment) to perform any of the required operations: sample analysis or extraction, percent moisture, MS/MSD, etc.

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4.19 MATRIX - the predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, a sample matrix is either water or soil/sediment. Matrix is not synonymous with phase (liquid or solid).

4.20 MATRIX EFFECT - in general, the effect of a particular matrix (water or soil/sediment) on the constituents with which it contacts. This is particularly pronounced for clay particles which may adsorb chemicals and catalyze reactions. Matrix effects may prevent extraction of target analytes, and may affect surrogate recoveries. In addition, non-target analytes may be extracted from the matrix causing interferences.

4.21 MATRIX SPIKE - aliquot of a matrix (water or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

4.22 MATRIX SPIKE DUPLICATE - a second aliquot of the same matrix as the matrix spike (above) that is spiked in order to determine the precision of the method.

4.23 METHOD BLANK - an analytical control consisting of all reagents, internal standards, and surrogate standards (or SMCs for VOA), that is carried throughout the entire analytical procedure. The method blank is used to define the level of laboratory, background, and reagent contamination.

4.24 PERCENT DIFFERENCE (%D) - To compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero. (In contrast, see relative percent difference.)

4.25 PURGE AND TRAP (DEVICE) - analytical technique (device) used to isolate volatile (purgeable) organics by stripping the compounds from water or soil by a stream of inert gas, trapping the compounds on an adsorbent such as a porous polymer trap, and thermally desorbing the trapped compounds onto the gas chromatographic column.

4.26 PURGEABLES - volatile compounds.

4.27 REAGENT WATER - water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.28 RELATIVE PERCENT DIFFERENCE (RPD) - As used in this SOP to compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.29 RELATIVE RESPONSE FACTOR (RRF) - a measure of the relative mass spectral response of an analyte compared to its internal standard. Relative Response Factors are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples. RRF is determined by the following equation:

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$$RRF = \frac{A_x}{A_{is}} x \frac{C_{is}}{C_x}$$

Where,

A = area of the characteristic ion measured
C = concentration, or amount (mass)
is = internal standard
x = analyte of interest

4.30 RELATIVE RETENTION TIME (RRT) - the ratio of the retention time of a compound to that of a standard (such as an internal standard).

$$RRT = \frac{RT_c}{RT_{is}}$$

Where,

RT_c = Retention time for the volatile target or surrogate compound in continuing calibration.
RT_{is}= Retention time for the internal standard in calibration standard or in a sample.

4.31 RESPONSE - or Instrumental Response: a measurement of the output of the GC detector (MS, EC, or FID) in which the intensity of the signal is proportionate to the amount (or concentration) detected. Measured by peak area or peak height.

4.32 SOIL - used herein synonymously with soil/sediment and sediment.

4.33 SURROGATES (Surrogate Standard) – for volatiles, semivolatiles and pesticides/Aroclors, compounds added to every blank, sample, matrix spike, matrix spike duplicate, and standard; used to evaluate analytical efficiency by measuring recovery. Surrogates are brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media.

4.34 TWELVE-HOUR TIME PERIOD - The twelve (12) hour time period for GC/MS system instrument performance check, standards calibration (initial or continuing calibration), and method blank analysis begins at the moment of injection of the DFTPP or BFB analysis that the laboratory submits as documentation of instrument performance. The time period ends after 12 hours have elapsed according to the system clock. For pesticide/Aroclor analyses performed by GC/EC, the twelve hour time period in the analytical sequence begins at the moment of injection of the instrument blank that precedes sample analyses, and ends after twelve hours have elapsed according to the system clock.

4.35 VOLATILE COMPOUNDS - compounds amenable to analysis by the purge and trap technique. Used synonymously with purgeable compounds.

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4.36 RETENTION TIME (RT) - the time a target analyte is retained on a GC column before elution. The identification of a target analyte is dependent on a target compound's retention time falling within the specified retention time window established for that compound. Retention time is dependent on the nature of the column's stationary phase, column diameter, temperature, flow rate, and other parameters.

4.37 DEIONIZED WATER (DI water) - water that has passed through Accutest's deionization system. Used as reagent water (water that an interferant is not observed at or above the minimum quantitation limit of the parameters of interest).

4.38 SPIKE BLANK OR LABORATORY CONTROL SAMPLE (LCS) – A blank spiked with a known concentration of analyte (from a second source from the calibration standard) or an external quality control standard with a known concentration of analyte used to determine accuracy of the method.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

5.2 Gas cylinders must be secured at all times.

6.0 COLLECTION, PRESERVATION, & HOLDING TIMES

6.1 Samples should be collected in a 40ml VOA vial with teflon septa in duplicate. Approximately 0.25ml of a 1:1 hydrochloric acid is used to preserve samples to ph<2 to fix the gases unless CO2 is to be determined. HCl can convert inorganic carbon to CO2.

6.2 Vials must be filled to zero headspace to eliminate loss of gases and stored at 4°C ± 2°C.

6.3 Preserved samples have a 14 day holding time from time of collection. Un-preserved should be analyzed within 7 days from the time of collection.

7.0 APPARATUS AND MATERIALS

7.1 Gas Chromatograph System

7.1.1 Gas Chromatograph - Agilent 6890 series gas chromatograph with flame ionization detector (FID) and thermal conductivity detector (TCD) in series. Injection port is equipped with Electronic Pressure Control (EPC). **See table 1 for conditions.**

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7.1.2 Column – Supleco Carboxen 1006, 30m x 0.53mm

7.2 Data System

7.2.1 Hewlett Packard Enviroquant PC based chemstation software, capable of multi-point calibration technique and full instrument control.

7.2.2 Hewlett Packard "Custom Reports" using a calculation spreadsheet to convert the headspace ppmv concentrations into ug/l final results using Henry's Law constant, temperature of the sample, volume of sample vial, headspace volume, and the molecular weight of the gas.

7.3 Automatic Shaker.

7.4 Gas tight syringes

7.4.1 0.01cc, 0.05cc, 0.10cc, 0.50cc, and 1.0cc hamilton gas tight syringe with style point #5 tip for sample and standard injections.

7.4.2 5cc syringe with luer lock tip and piercing needle to measure displaced sample out of vial.

7.5 Helium delivery system with adjustable regulator and piercing needle set at a flow of approximately 5cc/min for helium delivery to displace sample out of vial and create helium headspace.

7.6 40 ml I-chem pre-certified vials with teflon septa for sampling and method blank preparation.

7.7 Thermometer (calibrated against a NIST thermometer) for ambient temperature measurement (inserted through the septa of a VOA vial filled with DI water).

8.0 STANDARDS & REAGENTS

8.1 Commercially Available Gas Standards

8.1.1 Scott Specialty Gases Calibration Standard containing acetylene, n-butane, ethane, ethylene, methane, propane, propylene, propyne, and nitrogen (all at 15 ppmv) – balance nitrogen.

8.1.2 Scott Specialty Gases Calibration Standard containing acetylene, carbon dioxide, carbon monoxide, ethane, ethylene, methane (all at 10,000 ppmv) – balance nitrogen.

8.1.3 Scott Specialty Gas Calibration Standard for Laboratory Control Sample containing carbon dioxide, carbon monoxide, hydrogen, methane, oxygen (10,000 ppmv) – balance nitrogen. This is a second source (different lot number from calibration standards).

8.2 Carrier, Detector Gas, and Headspace Gas

8.2.1 Helium
8.2.2 Hydrogen
8.2.3 Zero Air

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8.3 De-ionized, reagent grade water

9.0 INTERFERENCES

9.1 Background levels of methane and CO2 can appear from helium.

9.2 Exposure of sample to atmosphere should be avoided due to background levels of target compounds that can contaminate samples and losses of light gases to atmosphere. **Keep vials sealed at all times.**

9.3 Gas Chromatographic system needs to baked out over night after batch analysis to eliminate the buildup of water vapor on the column that can distort chromatography.

10.0 PROCEDURE

10.1 **Calibration** – Calibration is performed by external standard technique. The calibration range encompasses 15 ppmv to 10,000 ppmv for methane, ethane, ethene and CO2. At least 4 concentrations must be used in the calibration curve.

10.1.1 Standards are drawn directly from gas cylinders, which are fitted with a regulator and syringe adapter. The gas cylinder outlet pressure should be set at approximately 10psig. Insert syringe without plunger into syringe adapter and let purge for 5-10 seconds to eliminate all dead volume. Insert plunger, turn off cylinder, and adjust syringe to the injection volume needed.

10.1.2 When GC is ready, manually inject standard and immediately push the “start” button on the GC to begin acquisition.

10.1.3 Low and Medium level Calibration Points - Syringe volumes of 0.001cc(2ppmv), 0.002cc(4ppmv), 0.010cc(20ppmv), 0.050cc(100ppmv), 0.25cc(500ppmv) and 0.5cc(1000ppmv) are injected from the 1000ppmv stock standard. Select the appropriate syringe for the most accurate measurement.

10.1.4 High Level Calibration Points - Syringe volumes of 0.10cc(8000ppmv methane,10000ppmv CO,CO2), 0.25cc(20000ppmv methane, 25000ppmv CO,CO2), and 0.5cc(40000ppmv
10.1.5 methane and 50000 CO,CO2).

Vol. (ml)	10,000 ppmv stock	Conc. (ppmv)	Low Level Stock	Conc. (ppmv)
0.2	“	10000	0.20 ml 15 ppmv	15
0.05	“	2500		
0.02	“	1000		
0.005	“	250		
0.001	“	100		

10.1.6 Calibration factor is defined as peak divided by standard concentration in ppmv.

10.1.7 Initial Calibration – The linear regression coefficient must be equal to or greater than 0.995 (must be forced through zero). The low standard must have a signal/noise ratio > 5.

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10.1.8 Initial Calibration Verification (ICV) – The initial calibration must be verified using a source independent from the calibration standards (if available). Results must be within 20% (% D) of the true value. If %D criteria is not met corrective action must be taken to determine the problem and the initial calibration must be re-analyzed. The concentration of the ICV should vary from the concentration of the calibration check (section 10.1.9).

10.1.9 Calibration Check – The check level (100ppbv) is acquired every 4 hours (or 25 samples – whichever is more often) and at the end of the run (the next day's calibration check may be used for this purpose. Inject 0.05cc of the 1000ppmv stock standard.

10.1.9.1 The percent difference (%D) must be <20.

10.1.9.2 If %D criteria fails, a new minimum 4 point calibration must be performed (see section 10.1.10).

10.1.10 A calibration check may only be repeated once. If the second analysis fails, a new initial calibration must be performed (an exception to this rule is if corrective action after the first 2 calibration checks resolves the problem and 2 passing sequential calibration checks are run). In situations where the first check fails to meet criteria, the instrument logbook should have clear documented notations as to what the problem was and what the corrective actions was performed to enable the second analysis to meet criteria.

10.2 **Retention Time Windows**

10.2.1 Retention Time Windows Retention time windows must be calculated for each analyte on each GC column and whenever a new GC column is installed. The data must be retained in the laboratory.

10.2.2 Make three injections of all standard mixtures at approximately equal intervals, during the 72-hr period.

10.2.3 Calculate the standard deviation of the three absolute retention times for each single component.

10.2.4 Apply plus or minus three times the standard deviations to retention time of each standard continuing calibration. This will be used to define the retention time window for the sample.

10.2.5 The above-described procedures may be performed automatically through the LIMS. See supervisor for procedure.

10.2.6 The retention time windows must be updated daily based on the calibration check standard (ie. the RT windows produced from the above-described study are applied to the actual RTs of the compounds in the first calibration check of the day).

10.2.7 If default standard deviation of 0.01 minutes is employed, the width of the window will be 0.03 minutes.

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10.3 **Sample preparation**

10.3.1 Remove samples from storage and allow samples to reach ambient temperature.

10.3.2 Select a duplicate vial for a sample duplicate at a minimum of one per twenty.

10.3.3 Fill a blank vial with deionized, organic free water to zero headspace for a batch method blank.

10.3.4 Insert the purge needle from the helium delivery system, with a flow of approximately 5cc/min, into the septa of the sample vial.

10.3.5 Immediately insert the 5ml syringe with needle attached to collect and measure the 5ml displaced sample volume. Make sure needle tip is below the level of the purging helium needle tip. The pressure of the helium flow will force the water sample up into the collection syringe.

10.3.6 Collect 5ml of sample into the measuring syringe and simultaneously remove both needles. You have now displaced 5ml of sample with 5cc of inert helium.

10.3.7 Securely place samples, blanks, and QC on the shaker in organic prep and set timer for 5 minutes. When finished remove and place upright in vial rack for injection.

10.3.8 Place the NIST calibrated thermometer in the same rack for ambient temperature measurement.

10.4 **Analysis.**

10.4.1 The nominal sample injection volume is 0.2 cc

10.4.2 The daily sequence is as follows:

- Inject 100ppmv(0.05cc of 1000ppmv standard) daily calibration check standard
- Inject 100ppmv(0.05cc of 1000ppmv alternate standard) Laboratory Control Sample
- Inject 0.2cc of the helium blank used to prepare samples (Not required).
- Inject 0.2cc of prepared method blank, which is DI water prepared identical to samples.
- Inject 0.2cc of any samples and duplicates.

10.4.3 Quant the helium blank to determine background area of target compounds. Typically methane and CO2 have trace level hits resulting in peak areas that may be used for background peak area correction. Background correction is NOT used in this method.

10.4.4 Quant method blank and run the custom report template to ensure all compounds are below the detection limits.

10.4.5 Quant each sample following analysis to determine if a smaller volume for dilution needs to be injected. Diluted injections should be performed next after the undiluted run to minimize any losses through the septa.

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10.4.6 Measure and record the ambient temperature in degrees C (to nearest whole degree) from the NIST calibrated thermometer in the sample rack for each CCV analysis.

10.4.7 Measure and record the amount of water sample (ml) that remains in each sample, duplicate, and blank. The actual vial volume is then the remaining sample plus the displaced sample volume (5ml). Most VO vials are actually 40-44cc volume depending on the lot #s and vendors.

10.5 **Calculations.**

10.5.1 Calibration Factor (CF)

$$CF = \frac{As}{Cs}$$

Where: As = Area of the peak for the compound being measured.
Cs = Concentration of the compound being measured (μg/l).

10.5.2 Percent Relative Standard Deviation (% RSD).

$$\% RSD = \frac{SD}{Cfav} \times 100$$

Where: SD = Standard Deviation.
CFav = Average calibration factor from initial calibration.

10.5.3 Percent Difference (% D).

$$\% D = \frac{|CFav - Cfc|}{CFav} \times 100$$

Where: CFc = CF from continuing calibration (CBCHK).

10.5.4 **Sample Concentrations**

10.5.4.1 **PPMV concentration by external standard technique from calibration curve.**

$$Conc. (\mu g/l) = \frac{Ac \times D}{CFav}$$

Where: Ac = Area of peak for compound being measured.
D = Dilution factor based on volume of headspace injected = 0.5/cc inj
CFav = Average response factor from initial calibration.

10.5.4.2 **UG/L concentration conversion using Custom Reports**

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10.5.4.2.1 Open the custom reports file "natatt" under the "Custom Reports" menu. See attachment of template.

10.5.4.3 Enter headspace created from helium displacement (typically 5cc)

10.5.4.4 Enter volume of sample(ml) remaining in vial. (vial volume – sample volume remaining)

10.5.4.5 The correct ug/l concentration will automatically be calculated based on Henry's Law constant, temperature of the sample, volume of sample vial, headspace volume, Dilution Factor, and the molecular weight of the gas.

10.5.4.6 The attached template describes how all calculations are derived along with a table of Henry's Constants for each gas.

10.5.5 Percent Recovery (% R) for LCS

$$\% R = \frac{\text{Concentration found}}{\text{Concentration spiked}} \times 100$$

10.5.6 Relative Percent Difference (RPD) for sample duplicates.

$$RPD = \frac{|SR1 - SR2|}{(1/2)\,(SR1+SR2)} \times 100$$

Where: SR1 = First sample replicate concentration (ug/l).
SR2 = Duplicate sample concentration (ug/l)

11.0 QUALITY ASSURANCE

QC Requirements Summary.

Calibration Check std.	Every 4 hrs or 20 samples (whichever is more) at end of run (bracket samples)
ICV	Every initial calibration
LCS	Every 24 hrs
Helium Blank	Every 24 hrs
Batch blank	one per batch [a]
Matrix Duplicate	one per batch [a]

(a) The maximum number of samples per analytical batch is twenty.

11.1 ICV - refer to section 10.1.8.

11.2 Calibration Check – refer to section 10.1.9.

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11.3 Method blank.

11.3.1 The method blank is carried through all stages of the sample preparation and measurement.

11.3.2 An acceptable method blank must be analyzed once for each analytical batch.

11.3.3 Evaluate the method blank to the MDL. No compound can be present above ½ the reporting level which is determined after running custom reports.

11.3.4 If the method blank does not meet contamination criteria, the entire batch must be re-prepped and reanalyzed.

11.4 Blank Spike and MS/MSD. Prepare by adding 0.500 ml of 10000 ppmv standards to 5 ml headspace of the samples. This results in an aqueous concentration of 110 ug/L for methane, 223 ug/L for ethane, and 298 ug/L for ethene. The aqueous concentration of CO2 should be 100 ug/L.

11.4.1 The blank spike and MS/MSD % recoveries must be between 80-120%. The MSD agreement must be within 25% RPD.

11.4.2 If the recovery of blank spike is outside the QC limits check the calculation. Recalculate if an error is detected. If blank spike criteria is still not met, corrective action must be performed to determine the problem and a satisfactory LCS must be analyzed prior to sample analysis.

11.4.3 If the matrix spike recoveries do not meet acceptance criteria, check the blank spike recovery to verify that the method is in control. If the blank spike did not meet criteria, the method is out of control for the parameter in question and should be reanalyzed or qualified with an estimate of potential bias. Otherwise, matrix interference is assumed and the data is reportable. No further corrective action is required.

11.5 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recovery and standard deviation (of the 4 replicate percent recoveries) are compared to 80-120% (Rec) and 30 (SD). If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control. The P&A study replicates must be prepared from a source independent from the calibration standards .

11.6 Data assessment and acceptance criteria for quality control. Quality control limits are generated at least on an annual basis by QA using an in-house program. Blank spike and MS/MSD QC data are pooled for the previous year (or other specified time frame) and the data is processed and evaluated by QA. The new limits are entered into the LIMS where they can be viewed directly or by printing out a compound list (QC limits must be requested). The annual QC limit data is filed with QA.

12.0 DOCUMENTATION

IF PRINTED – this SOP may not be latest version. It is the responsibility of the user to verify the status of this SOP.
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12.1 The analytical logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

12.2 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.3 The standard preparation logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

12.4 The Accutest lot number must be cross-referenced on the gas standard cylinder.

12.5 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.6 All laboratory logbooks must be routinely reviewed and initialed or signed by the lab manager.

12.7 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, preparation and/or analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/duplicate percent recoveries and RPDs, surrogat recoveries, blank spike recoveries, and method blank results may be reported upon request of the client. Additionally, raw data including any instrument printouts (quantitation reports, chromatograms) , laboratory logbooks, etc. may be reported to the client.

14.1.1 Data may be submitted to the client in a specified electronic format (EDD).

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ACCUTEST LABORATORIES
STANDARD OPERATING PROCEDURE

Sample Manager: Scott Parsick

QA Officer: Mark Warren

TITLE: **CHAIN OF CUSTODY AND LOG-IN PROCEDURES**

REFERENCES: ACCNE,

REVISED SECTIONS: 10.9, 10.16, 12.8, 12.9

1.0 SCOPE & APPLICATION

1.1 To maintain documentation of custody of all bottle sets, samples, digestates, distillates, and extracts that fall under the responsibility of Accutest Laboratories. This procedure describes sample receipt, unique sample number assignment, electronic documentation, and chain of custody. Procedure for resolving non-conformances, with Company Sample Acceptance policy are also described.

2.0 SUMMARY

2.1 Samples are delivered to the Accutest laboratories by company courier, commercial shipper or client self-delivery.

2.2 Custody documentation is signed upon receipt at the laboratory. The sample management technician reviews the chain of custody (COC) received with the samples and verifies that the information on the form corresponds with the delivered samples. The temperature of samples are measured and documented, and the sample are then assigned a unique Accutest sample number and stored at 2 – 6 ° C or –10 to -20°C (for certain volatiles samples).

2.3 Non-compliant information and discrepancies are documented and relayed to the Accutest client services group via an email, memo, or the "Chronicle Access Application" and the client will be notified. Additionally, the Sample Manager may contact the client directly.

2.4 Completed custody documentation is forwarded to the login group for data entry into LIMS.

3.0 METHOD DETECTION LIMIT

3.1 Not applicable

4.0 DEFINITION

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 CHAIN OF CUSTODY – a custody documentation form which is provided with each client job detailing all of the required sample information (sample ID, date/time of collection, matrix, analyses requested, number of bottles, preservative added, sampler initials, client name, address, and telephone number, and any additional specific requests).

4.3 CALIBRATION BLANK - a volume of acidified deionized/distilled water.

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4.4 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.5 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

4.6 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes rinsates and equipment blanks, etc.

4.7 HOLDING TIME – the elapsed time expressed in days from the date of sampling until the date of its analysis.

4.8 LIMS – the Laboratory Information Management System.

4.9 MATRIX - the predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, a sample matrix is either water or soil/sediment. Matrix is <u>not</u> synonymous with phase (liquid or solid).

4.10 NIST CALIBRATED THERMOMETER – a thermometer which is compared with a Standard calibrated at the National Institute of Standards and Technology (NIST), and found to be within one scale division. These thermometers are checked annually against an in-house NIST calibrated thermometer (which is calibrated annually by the manufacturer (ERTCO) using NIST calibrated primary reference thermometers).

4.11 REAGENT WATER - water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.12 SUBCONTRACT ANALYSIS – sending the samples to an outside laboratory either within the Accutest system or an entirely separate laboratory. Subcontract labs are typically used for analyses which are not performed by Accutest.

4.13 SAMPLE LOGIN – the process of entering all required information from the COC into the LIMS. This process translates all information related to collection time, turnaround time, sample analysis, and deliverables into a code which enables client requirements to be electronically distributed to the various departments within the laboratory for scheduling and execution.

4.14 TURNAROUND TIME – the period of time from receipt of the samples to reporting of the results.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

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5.2 All acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact supervisor.

6.0 COLLECTION, PRESERVATION & HOLDING TIMES

6.1 Not applicable

7.0 APPARATUS

7.1 Raytek temperature gun

7.2 NIST Calibrated thermometer

7.3 pH paper (0-14)

7.4 disposable pipette

7.5 LaMotte Chlorine test kit (Model No. LP-26)

7.6 Disposable test tubes

8.0 STANDARDS & REAGENTS

8.1 Note: All applicable standard/reagent preparation information, including vendor, lot number, date of preparation, calculations, and initials must be entered in the appropriate standard/reagent preparation logbook. Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

8.2 H2SO4

8.3 NAOH solution

8.4 Hydrochloric acid

8.5 Nitric acid

8.6 Ascorbic acid

8.7 Sodium bisulfate

8.8 Purge and trap methanol

8.9 Refer to the SOP for sample preservative preparation (MSM161).

9.0 INTERFERENCES

9.1 Not applicable

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10.0 PROCEDURE

10.1 Acceptance of Samples Policy:

It is the responsibility of the client to ensure proper sampling and to forward samples to Accutest in accordance with proper preservation and storage protocol. Accutest will be responsible for sample integrity in the field only if the sampling has been performed by its personnel.

Samples must be received with proper documentation. The client may use an Accutest COC or their own chain of custody form. A fully completed Chain of Custody (COC) must be received with the samples (indicating proper relinquishing of samples to laboratory). This COC must include the following information:

- Sample identification (point of collection)
- Sample Matrix
- Date and time of collection
- Name or initial of sampler
- Preservation type
- Important comments special instructions (eg. "Sample was field filtered" or "lab to filter sample")
- Requested analysis (must be specific)
- Signature, date, and time of relinquish of samples to laboratory.

Samples must be received in good condition, in the proper sample containers, properly preserved (including temperature - **see note below**), with sufficient volume to perform sample, and adhering to method-specified holding times. The COC must be filled out in ink, and sample jars must be properly labeled in ink.

If any of the above criteria have not been met the client must be notified immediately, and provide a written request to proceed with analysis.

Accutest reserves the right to refuse acceptance of any sample which in its sole and absolute discretion and judgement is hazardous/toxic and poses or may pose a health, safety or environmental risk in handling or processing.

10.2 **External Chain of Custody Procedure** -Samples may be received via a carrier or by walk in. Upon receipt, sample management will review the custody document for the following information

10.2.1 If dictated by the project protocol, document the custody seal identification number used on the sample shipping container, and whether the seal was intact or broken. If the seal is broken upon receipt, contact the lab manager immediately.

10.2.2 The temperature of the samples in the cooler will be documented on the COC . Move packing material and ice away from the sample container or temperature blank if included. Insert an NIST calibrated thermometer into the temp. blank (if provided – refer to the Temperature Maintenance of Shipping Coolers SOP (MSM083) for details) or take the temperature of the sample container with the Raytek temperature gun (if no temperature blank provided) . If using the Raytek temperature gun, do not remove the sample from the cooler. Hold the gun a

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few inches from the sample container. Take the temperature of the outside of the sample container and record on the COC. Record temperature of a representative bottle (from the center of the cooler). Apply the applicable correction factor to the final temperature (refer to the tag on the thermometer or Raytek gun for the current correction factors). If the temperature is outside the control limits of 2-6 Deg. C. client needs to be notified and documented. Client decisions of whether to perform or forgo analysis must be documented. A Sample Receipt Temperature Non-Compliance Form must be filled out (Note – temperatures less than 2 deg. C do not have to be communicated to the client). The method of temperature reading must be recorded in the sample receipt application.

NOTE: If the samples have been collected within one hour of delivery, and the temperature of the samples have not yet reached 4°C ± 2°C – make a note of this on the COC. In this situation, sample temperature is considered acceptable since there has not been enough time for cooling to take place.

10.2.3 Verify the matrix of samples: WW-waste water, GW-ground water, DW-drinking water, SO-soil, SOL-other solid, LIQ-liquid, AIR-air, FB-field blank, TB-trip blank, etc.

10.2.4 Specific location from which the sample was taken.

10.2.5 Initials of the person who collected the samples.

10.2.6 Date and time of sample collection.

10.2.7 The volume and preservation of each bottle.

10.2.8 Signature of whom the sample was relinquished by, and to whom it was relinquished.

10.2.9 The analysis to be performed.

10.2.10 The client's name, address, and phone number.

10.2.11 Any special requirements, such as turnaround, or reporting deliverables.

10.2.12 For Army Corps Projects – the attached Cooler Receipt form must be completed (Attachment A).

10.2.13 For applicable clients, a sample receipt checklist must be completed (form number QA101).

10.3 The sample technician must document any inconsistencies between the samples received and what is stated on the COC. Any issues with the samples such as insufficient volume, incorrect or no preservatives, dates incorrect or missing, and insufficient holding times must be discussed and approved by the client before sample login can be completed. Additionally, if samples show any signs of damage or contamination, the client must be notified immediately. This notification (including any client decisions of whether to perform or forgo analysis) must be documented and attached to the project file. If, the analysis requested section of the custody is missing or ambiguous, the sample custodian may accept the samples if the needed information can be obtained before the end of the next working day. The sample custodian must make all reasonable efforts to contact the client and resolve any problems encountered on the chain of custody or with the samples. Any unclear project instructions must be clarified by the client, and this information must be documented in a telephone conversation log or a Sample Management internal memo that must be archived in the project folder.

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Any changes or additions must be verified in writing by the client. This verification is considered part of the chain of custody and will follow the original COC through the remainder of the login process.

10.4 Once the sample custodian is satisfied with the information on the chain of custody document, custody is transferred to the sample custodian by signing and dating the chain of custody. From this point the custody of the sample is the responsibility of the sample custodian.

10.5 ***Refer to Attachment B for instructions on how to enter samples into the LIMS.***

Note: If preservative is added to a sample to achieve the proper pH, the same amount of preservative must be added to the associated field blank. The amount of preservative added should be documented in the sample receipt program.

10.6 At this point, sample job numbers are assigned with the next available sample ID. Sample job ID numbers are prefixed with an 'M' followed by a 4-5-digit number assigned by the LIMS system (i.e., M4387). This sequence can be followed by an optional alpha suffix, to represent a relog. Sample numbers consist of a job number plus a second series of numbers beginning at one and continuing chronologically for each point of collection. The assigned sample ID must be written on the chain of custody form, in the Accutest ID section in black ink. If there are special circumstances regarding a sample (soluble), a Suffix may be included in the sample ID, for example , M4387-1A. The final portion of the sample ID documents the number of bottles received for each sample. For example, if there were 3 bottles provided for sample M4387-1, then the sample bottle labels on each bottle will be in the following order: M4387-1 Bot#1 , M4387-1 Bot#2 , M4387-1 Bot#3.

10.7 After custody has been accepted, the bottle set must be split. The Sample Receipt Log is completed electronically and bar code labels generated.. The information required must be documented. This includes the client, date of receipt, the sample numbers, when assigned, the number of bottles, location, type of preservation, volume of each bottle, and the pH of each **bottle (Note: the pH of volatile samples is not checked during log-in. Sample pH for these analyses are checked at the instrument level, and documented in the analysis logbook).** To determine the pH an aliquot of sample is removed using a clean disposable pipette and applied to wide-range pH paper. The preservative is noted on the electronic log-in form by documenting it with the preservative type (that is, if the pH result is correct, the appropriate preservative is checked off). If preservation or volume is incorrect for the tests required, the client must be contacted immediately and informed that the test cannot be done until additional sample can be obtained (if preservative is added to the sample – it is also noted on the COC, and may be also noted in the Chronicle). Any comments should be noted on the COC or Chronicle, such as headspace in VOA vials, leaking bottles, or broken bottles.

Note: Water samples for volatile analysis must be checked for headspace. The client must be notified of any samples exhibiting headspace greater than “pea size” (>6mm or 1/4 inch). The client must provide permission to analyze any samples with headspace greater than “pea-size”, and this permission must be documented with the project.

10.8 Samples collected for cyanide analysis must be screened for residual chlorine using the LaMotte Chlorine test kit (refer to the SOP MSM143). Follow the directions attached to the test kit. Record the results in the residual chlorine log. If a sample is determined to contain residual chlorine, the client must be notified if samples for organic analyses are included with the project. For cyanide samples, add ascorbic acid (approximately 0.5 grams). Re-test the sample to determine that no residual chlorine is present. Add additional ascorbic acid as necessary. Care must be taken to prevent contamination. An aliquot of the sample is poured into the residual chlorine test tube.

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10.8.1 Samples analyzed by EPA Method 608 (Pesticide/PCBs) that will not be extracted for 72 hours should be adjusted to a pH range of 5.0-9.0 with H_2SO_4 or a NAOH solution. Record the initial pH and adjusted pH and volume of acid or base used (if adjustment is necessary) in the "Chronicle Access Application".

10.9 The lab must wait 24 hours prior to digestion for aqueous metals samples that are preserved in the lab.

10.10 All bottles must be labeled with sample number, preservation and department which will need the bottle, and the shelf on which the sample is located.

10.11 Fast-track results. Samples that require an accelerated turnaround are handled in the following manner. The original custody must be clearly marked - red for 1 week or less. Copies must be made for each laboratory group that will be doing prep or analysis on the samples and marked the same as the original. The copies must be distributed to the lab groups as soon as possible, and no later than the end of the day in which the samples came in.

10.12 Composite Request. If the sample is to be composited, then the composite logbook must be used to document the procedure.

10.13 The original chain of custody and any other communications are then given to the administrative assistant for computer log in to the LIMS. The original COC and any other communications with the client are kept on file and available in Report Generation for reference.

10.14 **Internal Chain of Custody Procedure**

10.14.1 The purpose of an internal chain of custody is to document each date, time a sample changes hands. When a sample changes hands the recipient is responsible for the security of the sample.

10.14.2 Accutest uses an electronic internal chain of custody to document changes of custody in the laboratory.

10.14.3 When a sample(s) is received at Accutest, the external chain of custody is closed and the internal chain of custody is started for each sample bottle.

10.14.3.1 Sample management inputs the information from the COC into the LIMS, and assigns the bottles with a job and bottle number.

10.14.3.2 Administration logs the jobs and analysis information into the LIMS.

10.14.3.3 Once the analyst is ready to retrieve the sample from its proper location (as designated in the work list), the samples are removed from the refrigerator. The analyst enters his/her LIMS user name and password and scans each bottle label bar code. Once finished, the analyst scans the bottles back in, and returns them to the proper location.

10.15 Procedure for obtaining representative sub samples.

10.15.1 If it is necessary to obtain a sample to be sub-contracted to another facility or outside laboratory refer to the SOP for the Procedure for Obtaining Representative Sample Aliquot (MQA247) for details on the techniques used to obtain an appropriate sample aliquot.

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10.15.2 In general, the sample is homogenized using metal spatulas (for non-metal analyses) or other Teflon-coated or wood mixing devices - or vigorous shaking if it is an aqueous sample - prior to collecting the sub sample. Once the sample is homogenized, the sub sample may be aliquoted into the applicable sample container. Sufficient sample must be aliquoted to perform the analysis.

10.16 Treatment and handling of foreign soils.

10.16.1 Foreign soils labeling. Foreign soils must be labeled with a special label available from Quality Assurance. This label clearly indicates that the soil is from a foreign source.

10.16.2 Sample bottles, shipping containers, and applicable instrument waste must be treated prior to disposal. Refer to section 5.95 for treatment details. Large containers that can't be treated in the oven or autoclave must be thoroughly cleaned with a dilute bleach solution.

10.16.3 Any non-treated effluent from foreign sample preparation must be boiled for at least 2 minutes prior to disposal.

10.16.4 Samples shipped in non-standard sample containers (such as 5 gallon plastic buckets) must be enclosed in 2 heavy-duty plastic bags. The client must be informed of this requirement prior to shipment to the laboratory.

10.16.5 Prior to handling foreign soils, the analyst must read and sign off on the current USDA Compliance Agreement.

11.0 QUALITY ASSURANCE

11.1 Refer to the documentation section (12.0).

11.2 Internal Quality System audits of the Sample Management department will be scheduled annually. Refer to the Internal Audit SOP (MQA220) for details. Additional audits may be performed as necessary.

12.0 DOCUMENTATION

12.1 The sample receipt program must be reviewed by the Sample Manager and Quality Assurance on a periodic basis to ensure proper documentation of sample log in.

12.2 Once the job is logged into LIMS with the proper test codes, etc. they are double-checked by administration and the Laboratory Director or Laboratory Manager.

12.3 All client requests or revisions must be documented, preferably with a fax or printed email (telephone conversation log may be sufficient in certain situations). This data will be inserted in the project file as applicable. The "Chronicle Access Program" may also serve as documentation of special instruction.

12.4 External and internal sample chain of custody must be completed as described in the above sections (the internal COC may be generated directly from the LIMS).

12.7 Any hand corrections made on any laboratory document must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

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12.8 For subcontracted work - the lab must communicate in writing any samples that need special reports or handling. For example, the any samples requiring MCL exceedence reporting must be communicated (preferably on the COC) to the subcontract laboratory.

12.9 The lab must document the reason for all sample rejections. All samples should be provided with a job number to allow for proper rejection documentation.

13.0 DATA REVIEW

13.1 The COCs are reviewed by Administration and the Lab Director/Manager. Quality Assurance and/or Report Generation reviews the COCs during data package assembly or review.

14.0 DATA REPORTING

14.1 External and internal chain of custodies and/or the chronicle may be included in the deliverables on client request.

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-Hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

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14.1.2 Electronic hardcopy reports may be submitted to the client on request (e-hardcopy).

14.1.3 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.2 All data qualifiers used within the result page (sample or QC results) are defined at the bottom of the page. Refer to the Accutest Laboratories of New England , Inc. Qualifier Definitions form (QA108) for definition of all qualifiers used in Accutest Laboratories of New England result reports. This form is located on the QA server under QA forms. It may be provided to the client upon request.

14.3 Procedures for handling non-conforming data.

14.3.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.3.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 ADDITIONAL REFERENCES

UNCONTROLLED DOCUMENT

16.1 "Analysis of Dissolved Methane, Ethane, and Ethylene in Ground Water by a Standard Gas Chromatographic Technique". Published in Journal of Chromatographic Science, vol. 36 May 1998. Authored by Don H. Kampbell and Steve A. Vandegrif; RSKSOP-147, 1/14/93; RSKSOP-114, 1/15/91; US EPA Region I Technical Guidance for the Natural Attenuation Indicators: Methane, Ethane, and Ethene.

Table 1
Recommended Operating Conditions
(may change to optimize)

Carrier Gas	Helium
Detector Gas	Hydrogen, Zero Air
Injection Type	Splitless
Purge off time	0
Column Flow	EPC constant flow at 15psig @ 30c
Initial temperature	35c for 1minute
Oven Ramp	35c/min to 220c with no hold
Final Time	2 min
Injection temp	250c
FID temp	300c
TCD temp	200c

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Lab Manager: Doug Yargeau

QA Officer: Mark Warren

TITLE: **DETERMINATION OF 1,4-DIOXANE USING GC/MS SYSTEM AND SELECTIVE ION MONITORING**

TEST METHOD: SW846 8260B, Rev. 2, December 1996 ; Standard Operating Procedure for Measurement of Purgeable 1,4-Dioxane in Water by GCMS, EPA Region New England, 11/30/04.

REVISED SECTIONS: New SOP

1.0 SCOPE & APPLICATION

1.1 The following method describes the analytical procedures which are utilized by Accutest to acquire samples for the analysis of the volatile organic compound 1,4-dioxane by Selective Ion Monitoring (SIM).

1.2 This analytical method is designed for nearly all types of samples, regardless of water content, including groundwater, aqueous sludges, oily waste, sediments, and soils.

1.3 The purgeable organics can be quantitated by Gas Chromatograph/Mass Spectrometer (GC/MS) following purge and trap utilizing the internal standard technique.

1.4 The Reporting (RL) is based on the lowest calibration standard. RL'S may vary depending on matrix difficulties and sample volumes or weight and percent moisture.

2.0 SUMMARY

2.1 This method is performed in accordance with EPA methodologies 8260B and 5030B (purge and trap), from SW-846, 3rd edition.

2.2 An inert gas is bubbled through a 5 ml sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and back flushed with the inert gas to desorb the purgeables onto a gas chromatographic (GC) column.

2.3 1.4-Dioxane is separated by the temperature programmed GC column and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information.

2.4 The peak detected is qualitated by comparison to characteristic ion and retention time specific to 1,4-dioxane.

2.5 Once identified the compound is quantitated by internal standard technique with an average response factor generated from a calibration curve containing a minimum of five points. Additional points may be added to meet client requirements.

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3.0 METHOD DETECTION LIMIT

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs.

3.5 Current MDLs are entered into the LIMS, and can be viewed by printing out the compound list from the LIMS. Additionally, MDLs are reported on the result page upon client request. Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1). Refer to the MDL SOP for further detail (MQA254).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch.

4.3 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

4.4 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

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4.5 CONTINUING CALIBRATION – analytical standard run every 12 hours to verify the initial calibration of the analytical system.

4.6 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying in an oven.

4.7 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.8 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

4.9 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.10 HOLDING TIME – the elapsed time expressed in days from the date of sampling until the date of its analysis.

4.11 INTERFERENTS – substances which affect the analysis for the analyte of interest.

4.12 GAS CHROMATOGRAPH (GC) - the instrument used to separate analytes on a stationary phase within a chromatographic column. The analytes are volatized directly from the sample (VOA water and low-soil) volatized from the sample extract (VOA medium soil), or injected as extracts (SVOA and PEST). In VOA and SVOA analysis, the compounds are detected by a Mass Spectrometer (MS). In PEST analysis, the compounds are detected by an Electron Capture (EC) detector. In the screening procedure (all fractions), the Flame Ionization Detector (FID) is used as the detector.

4.13 INITIAL CALIBRATION - analysis of analytical standards for a series of different specified concentrations; used to define the linearity and dynamic range of the response of the mass spectrometer or electron capture detector to the target compounds.

4.14 INITIAL CALIBRATION VERIFICATION – analysis of a check standard from a second source (either vendor or lot) from the initial calibration standards to verify the initial calibration.

4.15 INTEGRATION TIME RANGE - the retention time at the beginning of the area of integration to the retention time at the end of the area of integration.

4.16 INSUFFICIENT QUANTITY - when there is not enough volume (water sample) or weight (soil/sediment) to perform any of the required operations: sample analysis or extraction, percent moisture, MS/MSD, etc.

4.17 MATRIX - the predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, a sample matrix is either water or soil/sediment. Matrix is <u>not</u> synonymous with phase (liquid or solid).

4.18 MATRIX EFFECT - in general, the effect of a particular matrix (water or soil/sediment) on the constituents with which it contacts. This is particularly pronounced for clay particles which may

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adsorb chemicals and catalyze reactions. Matrix effects may prevent extraction of target analytes, and may affect surrogate recoveries. In addition, non-target analytes may be extracted from the matrix causing interferences.

4.19 MATRIX SPIKE - aliquot of a matrix (water or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

4.20 MATRIX SPIKE DUPLICATE - a second aliquot of the same matrix as the matrix spike (above) that is spiked in order to determine the precision of the method.

4.21 METHOD BLANK - an analytical control consisting of all reagents, internal standards, and surrogate standards (or SMCs for VOA), that is carried throughout the entire analytical procedure. The method blank is used to define the level of laboratory, background, and reagent contamination.

4.22 PERCENT DIFFERENCE (%D) - As used in this SOW and elsewhere to compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero. (In contrast, see relative percent difference.)

4.23 PERCENT MOISTURE - an approximation of the amount of water in a soil/sediment sample made by drying an aliquot of the sample at 105 °C. The percent moisture determined in this manner also includes contributions from all compounds that may volatilize at or below 105 °C, including water. Percent moisture may be determined from decanted samples and from samples that are not decanted.

4.24 PURGE AND TRAP (DEVICE) - analytical technique (device) used to isolate volatile (purgeable) organics by stripping the compounds from water or soil by a stream of inert gas, trapping the compounds on an adsorbent such as a porous polymer trap, and thermally desorbing the trapped compounds onto the gas chromatographic column.

4.25 PURGEABLES - volatile compounds.

4.26 REAGENT WATER - water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.27 RELATIVE PERCENT DIFFERENCE (RPD) - As used in this SOP to compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.28 RELATIVE RESPONSE FACTOR (RRF) - a measure of the relative mass spectral response of an analyte compared to its internal standard. Relative Response Factors are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples. RRF is determined by the following equation:

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$$RRF = \frac{A_x}{A_{is}} x \frac{C_{is}}{C_x}$$

Where,

A = area of the characteristic ion measured
C = concentration, or amount (mass)
is = internal standard
x = analyte of interest

4.29 RELATIVE RETENTION TIME (RRT) - the ratio of the retention time of a compound to that of a standard (such as an internal standard).

$$RRT = \frac{RT_c}{RT_{is}}$$

Where,

RT_c = Retention time for the volatile target or surrogate compound in continuing calibration.
RT_{is}= Retention time for the internal standard in calibration standard or in a sample.

4.30 RESPONSE - or Instrumental Response: a measurement of the output of the GC detector (MS, EC, or FID) in which the intensity of the signal is proportionate to the amount (or concentration) detected. Measured by peak area or peak height.

4.31 SOIL - used herein synonymously with soil/sediment and sediment.

4.32 SURROGATES (Surrogate Standard) – for volatiles, semivolatiles and pesticides/Aroclors, compounds added to every blank, sample, matrix spike, matrix spike duplicate, and standard; used to evaluate analytical efficiency by measuring recovery. Surrogates are brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media.

4.33 TWELVE-HOUR TIME PERIOD - The twelve (12) hour time period for GC/MS system instrument performance check, standards calibration (initial or continuing calibration), and method blank analysis begins at the moment of injection of the DFTPP or BFB analysis that the laboratory submits as documentation of instrument performance. The time period ends after 12 hours have elapsed according to the system clock. For pesticide/Aroclor analyses performed by GC/EC, the twelve hour time period in the analytical sequence begins at the moment of injection of the instrument blank that precedes sample analyses, and ends after twelve hours have elapsed according to the system clock.

4.34 VOLATILE COMPOUNDS - compounds amenable to analysis by the purge and trap technique. Used synonymously with purgeable compounds.

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4.35 RETENTION TIME (RT) - the time a target analyte is retained on a GC column before elution. The identification of a target analyte is dependent on a target compound's retention time falling within the specified retention time window established for that compound. Retention time is dependent on the nature of the column's stationary phase, column diameter, temperature, flow rate, and other parameters.

4.36 DEIONIZED WATER (DI water) - water that has passed through Accutest's deionization system. Used as reagent water (water that an interferant is not observed at or above the minimum quantitation limit of the parameters of interest).

4.37 SPIKE BLANK OR LABORATORY CONTROL SAMPLE (LCS) – A blank spiked with a known concentration of analyte (from a second source from the calibration standard) or an external quality control standard with a known concentration of analyte used to determine accuracy of the method.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIMES

6.1 Collection and Preservation

6.1.1 Soil/Sediment: Refer to SOP MSM207 (Collection and Preservation of Solid Samples for Volatile Organics Analysis by SW846 5035 Methodology).

6.1.2 Aqueous: Samples are collected in certified pre-cleaned 40 ml VOA vials equipped with a teflon-lined silicone septum cap. Samples should not be acid preserved.

6.1.3 Volatile samples must be protected from light and stored segregated from samples for other analyses at a temperature of 4°C ± 2°C from the time of receipt to analysis.

6.2 Holding Time: Samples must be analyzed within 14 days of sampling.

7.0 APPARATUS & MATERIALS

7.1 SYRINGE

7.1.1 10, 25, 50, 100, 500 and 5000 ul graduated syringes, manually held (Hamilton or equiv.).

7.1.2 5 ml glass gas tight syringes with Luerlok end, if applicable to the purging device.

7.2 BALANCE

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7.2.1 Analytical balance capable of weighing 0.0001 gram.

7.2.2 Top-loading balance capable of weighing 0.1 g.

7.3 PURGE AND TRAP DEVICES

7.3.1 Tekmar K (VOCARB 3000) is used for purging, trapping and desorbing the sample into GC column. Alternate P&T models may be used as appropriate.

7.3.2 The sample purge vessel must be designed to accept 5 ml samples with a water column at least 3 cm deep.

7.3.3 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 inch. The trap must be packed to contain the following absorbents (3-ring):

7.3.3.1 2,6-Diphenylene oxide polymer.
7.3.3.2 Silica gel.
7.3.3.3 Charcoal packing.
7.3.3.4 Or equivalent

7.3.4 The trap should be conditioned according to manufacturer specifications by back flushing with a Helium gas flow of at least 20 ml/min prior to use.

7.3.5 The desorber should be capable of rapidly heating the trap to 250°C for desorption.

7.4 GAS CHROMATOGRAPH/MASS SPECTROMETER SYSTEM

7.4.1 Gas Chromatograph.

7.4.1.1 An alytical system complete with a temperature programmable gas chromatograph and all required accessories including syringes, analytical columns, and gases.

7.4.2 Column.

7.4.2.1 For 5890: 75 m x 0.53 mm I.D., 3 um film DB-624; J&W Scientific. Or equivalent. For 6890: 60 m x 0.25 mm I.D., 1.4 um film DB-VRX; J&W Scientific. Or equivalent.

7.4.3 Mass Spectrometer.

7.4.3.1 Capable of scanning from 35-260 amu every second or less utilizing a 70 volt (nominal) electron energy in the electron impact ionization mode.

7.4.3.2 Capable of producing a mass spectrum which meets all the criteria in Table 2 when injecting 50 ng of Bromofluorobenzene(BFB).

7.5 DATA SYSTEM

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7.5.1 A computer system is interfaced to the mass spectrometer which allows the continuous acquisition and storage on machine readable media (disc) of all mass spectra obtained throughout the duration of the chromatographic program.

7.5.2 The computer utilizes software which allows searching any GC/MS data file for target analytes which display specific fragmentation patterns.

7.5.3 The Enviroquant data system is capable of quantitation using multipoint calibration and multipoint internal standards.

7.5.4 The recent version of the EPA/NIH mass spectral library (70,000 compounds) is being used for non target peak tentative identification.

7.5.5 Data can be archived to magnetic tape for long term storage.

8.0 STANDARDS & REAGENTS

Note: All applicable standard/reagent preparation information, including vendor, lot number, date of preparation, date of expiration, calculations, and initials must be entered in the appropriate standard/reagent preparation logbook. Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

8.1 Solvent

8.1.1 Methanol: Purge and trap B&J Brand quality or equivalent. Store apart from other solvents.

8.2 Reagent water

8.2.1 Reagent water is defined as water in which an interferant is not observed at the method detection limit of the parameters of interest.

8.2.1.1 Reagent water is generated by either passing tap water through a bed of approximately one pound of activated carbon or by using the water purification system at Accutest which is a series of deionizers and carbon cartridges.

8.3 Stock standard solutions

8.3.1 Commercially prepared standards used:

8.3.1.1 Accustandard P-Dioxane App-9-10X, 1.0 mg/L in MEOH (calibration std)

8.3.1.2 Restek 1,4-Dioxane Standard, 2000 ug/ml in MEOH (Second Source)

8.3.1.3 Or equivalent standards.

8.3.2 Stock standard solutions must be replaced after 6 months or according to manufacturers expiration date if comparison with quality control check samples indicates a problem.

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8.3.2.1 Stock standard solutions should be stored according to manufacturers specifications. Opened ampules should be stored at -10°C to -20°.

8.4 Internal Standard and Surrogate Solution.

8.4.1 One internal standard (see Table 3) is used that exhibit similar analytical behavior to the compound of interest:

Internal Std: Ultra, 4-Bromofluorobenzene solution, STS-110N-1, 2000 ug/ml in MEOH.

Surrogate: Cambridge Isotope Lab (CIL), 1,4-Dioxane – D8 (P-Dioxane), (D,99%).

8.5 Working standards

8.5.1 Refer to Table 10 for standard preparation.

8.5.1.1 The blank spike and matrix spike solutions are prepared independently from the calibration standards using a different vendor or lot number.

8.5.2 Bromofluorobenzene (BFB)

8.5.2.1 The BFB is prepared at 25 ug/ml by measuring 25 ul of Ultra 4-Bromofluorobenzene Solution, (#STS-110N, 2000 ug/ml in methanol) into 1975 uls of methanol.

8.5.4 Working standard solutions should be stored at -10°C to -20°C.

9.0 INTERFERENCES

9.1 The data from all blanks, samples, and spikes must be evaluated for interferences.

9.2 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. The use of non-TFE tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

9.3 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal into the sample during shipment and storage. A field blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

9.4 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

10.0 PROCEDURE

10.1 CALIBRATION (See Section 10.1.6.4 before proceeding)

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10.1.1 The calibration range covered by the standards is 1, 5, 10, 20, 50, 100, 200 ug/l. The ICAL analyzed for Army Corps project samples must have a low standard no lower than 5 ppb. Refer to the specific Army Corps project QAPP for additional guidance for the ICAL analysis. The Analyte Reporting Limit (RL) can not be lower than the lowest calibration level utilized.

10.1.2 The linear range covered by this calibration is to the highest concentration standard (up to 200 ug/L).

10.1.3 For the Teledyne Tekmar, SOLATek 72 (AS)/Velocity XPT (P&T) instruments, internal and surrogate standards are added from a reservoir containing both at a concentration of 1.0 ug/ml (IS) and 10.0 ug/ml (SS) ug/ml. 5 ul is added to the standard, sample or blank prior to analyses.

10.1.4 1,4-Dioxane is quantitatively determined by internal standard technique using the closest eluting internal standard and the corresponding area of the major ion. See Table 5.

10.1.5 The Response Factor (RF) is defined in section 10.4.1.

10.1.6 Initial calibration

The following criteria must be met for the initial calibration to be valid.

10.1.6.1 The percent relative standard deviation (% RSD) (see section 10.4.2) of 1,4-dioxane must be $\leq$ 30

10.1.6.2 Evaluation of retention times. The relative retention time of 1,4-dioxane in each calibration standard should agree within 0.06 relative retention time units.

10.1.6.3 Internal standard area response should not drift by more than a factor of 2 (one half or 2X) as compared to the mid-level standard. All standards run during the initial calibration must pass this criteria.

10.1.6.4 The analyst is allowed to remove either a low point or a high point on a curve to meet criteria (as long as the required number of standards is maintained). Middle points may not be removed unless there is clear evidence of poor purge or an incorrect spike concentration – and this must be confirmed by a supervisor and documented in the instrument run logbook. Removal of a low point to meet criteria will raise the reporting limit, while removal of a high point will lower the calibration range.

10.1.6.5 The concentration of the calibration standard at the upper limit of the curve will be reduced if the instrument response indicates signs of detector saturation.

10.1.6.6 An initial calibration is a single event. Reanalysis of a calibration standard must occur within the same tuning period as the initial calibration – and before sample analysis occurs.

10.1.7 Initial calibration verification (ICV)

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10.1.7.1 The initial calibration is verified for accuracy immediately following the last standard with a verification standard from a source independent of the calibration standards (either a lot or vendor different from the calibration standards – preferably a different vendor).

10.1.7.2 The RF's generated for each parameter must be compared to the average RF in the Initial calibration for each analyte to determine the percent difference (% D) (see section 10.4.3). ICV acceptance criteria for percent difference is ≤30%

10.1.8 Calibration Check (CBCHK)

10.1.8.1 A continuing calibration check standard at 10 ug/ml must be acquired every 12 hrs. All continuing and initial calibration standards are prepared in volumetric flasks and transferred to 40 ml vials.

10.1.8.2 The RF's generated for each parameter must be compared to the average RF in the Initial calibration for each analyte to determine the percent difference (% D) (see section 10.4.3). CCV acceptance criteria for percent difference is ≤30%.

10.1.8.3 If the above specified criteria are met, the continuing calibration is considered valid.

10.1.8.4 If the criteria fails, corrective action must be performed. Standard data is evaluated to determine if an analytical system problem exists. If there is problem which does not require making major changes to the system, then those changes are made and the continuing calibration is re-analyzed. If a major problem exists or major changes need to be performed, then the Supervisor is notified for further instruction.

10.1.8.5 If any of the internal standard areas change by a factor of two (- 50% to + 100%) from the last mid-point initial calibration standard, the analytical system must be inspected for malfunctions and corrections will be made, as appropriate.

10.1.8.6 If the retention time for the Internal Standards change by more than 30 seconds from the most recent mid-point initial calibration standard, the system must be inspected for malfunctions. When corrections are made the sample must be reanalyzed.

10.1.8.7 A calibration check may only be repeated once. If the second analysis fails, a new initial calibration must be performed (an exception to this would be if corrective action resolves the problem as evidenced by the analysis of 2 passing sequential calibration check standards). In situations where the first check fails to meet criteria, the instrument logbook should have clear documented notations as to what the problem was and what the corrective actions was performed to enable the second analysis to meet criteria.

10.1.8.8 If the calibration verification is being performed using an autosampler for night batch analysis, two vials of standard solution may be set up for analysis. The second standard must meet calibration check criteria. The second check may be discarded due to poor purge or incorrect spike concentration – however, the first check must meet criteria. This scenario must be approved by the supervisor, and documented in the instrument run logbook.

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10.2 ANALYSIS

10.2.1 Instrument conditions.

10.2.1.1 Recommended instrument conditions are listed in Table 1 Modifications are allowed as long as criteria of calibration are met.

10.2.2 Purge and Trap Conditions.

10.2.2.1 Recommended instrument conditions are listed in Table 1.

10.2.3 Daily GC/MS performance check.

10.2.3.1 Every 12 hours, inject 2 ul (50 ng) of BFB solution directly on column.

10.2.3.2 The GC/MS system must be checked to verify acceptable performance criteria are achieved (see Table 2)

10.2.3.3 This performance test must be passed before any samples, blanks or standards are analyzed.

10.2.3.4 If all the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are met.

10.2.3.5 The injection time of the acceptable tune analysis, is considered the start of the 12 hour clock.

10.2.4 Daily calibration check

10.2.4.1 See section 10.1.8

10.2.5 Method blank (reagent water)

10.2.5.1 An acceptable method blank must be analyzed for every 12 hour time period. Run per section 10.2.6.

10.2.5.2 Surrogates must meet in-house acceptance limits (or MCP limits as applicable).

10.2.5.3 Evaluate the method blank for target compound contamination to the MDL. If the target compound is detected in the method blank above ½ the RL, the source of contamination must be identified and corrective action must be taken (and documented in the run log) before continuing with sample analysis. The method blank must be re-analyzed and evaluated before sample analysis can begin (must meet surrogate and contamination criteria).

10.2.6 Sample analysis

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10.2.6.1 Establish dilution of sample in order to fall within the upper portion of the calibration range.

10.2.6.1.1 from acquired sample data.
10.2.6.1.2 from history program.
10.2.6.1.3 sample characteristics (appearance, sheen, etc.)

10.2.6.2 Water sample

10.2.6.2.1 Tekmar SOLATek 72 Autosampler, place entire 40 ml vial into appropriate position on autosampler.
10.2.6.2.2 Record pH using 0-14 pH paper and record in logbook (After analysis).

10.2.6.3 Sediment/ soil sample

<u>Low-level soil method (Requires separate initial and continuing calibrations)</u>

10.2.6.3.1 Low level soils are collected in the field preserved in sodium bisulfate. If sample is not preserved – the analyst adds 5 mls of DI water to 5 g of sample (and a stir bar) in a 40 ml voa vial. Surrogates and IS are loaded onto the instrument (in vials) and automatically injected. The samples are heated, stirred, and purged onto the trap.
10.2.6.3.2 Alternately, accurately weigh approximately 5 g (or less) sample into clean 40 ml voa vial.
10.2.6.3.3 Add 5 ml reagent water and 1 stir bar to voa vial.
10.2.6.3.4 Place vial into Tekmar SOLATek 72 autosampler.

10.2.6.4 For analysis of low-level soils soils, heat the sample vial to 40°C while purging and stirring the sample for 11 minutes with Helium. Water samples are not heated. Sample dry purge time is 1 minute for both matrices.

10.2.6.5 Desorb the sample for 1 minute by rapidly heating the trap to 250°C while backflushing with Helium.

10.2.6.6 Bake the trap for 2 minutes at 270°C or at the manufacturers specifications to remove any residual purgeable compounds.

10.2.6.7 If the quantitation value for any analyte exceeds the working range of the GC/MS system, dilute the sample and re-analyze. Diluted results should be within the upper portion if the calibration range.

10.3 DATA INTERPRETATION

10.3.1 Qualitative identification.

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10.3.1.1 1,4-Dioxane shall be identified by analyst with competent knowledge in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. The analyst or supervisor may use professional judgement to supercede identification criteria in certain cases (especially when evaluating low-level results). The criteria required for a positive identification are:

10.3.1.2 The sample component must elute at the same relative retention time (RRT) as the daily standard. Criteria is the RRT of sample component must be within ± 0.06 RRT units of the standard.

10.3.1.3 All ions present in the standard mass spectra at a relative intensity greater than 10% (major abundant ion in the spectrum equals 100%) must be present in the sample spectrum.

10.3.1.4 The relative intensities of these ion must agree within ± 30% between the daily standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80%).

10.3.2 Quantitative analysis.

10.3.2.1 When 1,4-dioxane has been identified, concentration (see section 10.4) will be based on the integrated area of the quantitation ion, normally the base peak (see Table 5).

10.3.2.2 If the sample produces an interference for the primary ion, use a secondary ion to quantitate (primary ion 88, secondary ion 58). This is characterized by an excessive background signal of the same ion which distorts the peak shape beyond a definitive integration. Also an interference could severely inhibit the response of the internal standard ion.This secondary ion must also be used to generate new calibration response factors.

10.3.3 Library search for tentatively identified compounds.

10.3.3.1 If a library search is requested, the analyst should perform a forward library search of NBS mass spectral library to tentatively identify 15 non-reported compounds.

10.3.3.2 Guidelines for making tentative identification are:

10.3.3.2.1 These compounds should have a response greater than 10% of the nearest internal standard. The response is obtained from the integration for peak area of the Total Ion Chromatogram (TIC).

10.3.3.2.2 The search is to include a spectral printout of the 3 best library matches for a particular substance. The results are to be interpreted by analyst.

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10.3.3.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

10.3.3.2.4 Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) should be present in the sample spectrum.

10.3.3.2.5 The relative intensities the major ions should agree within ± 20%.

10.3.3.2.6 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

10.3.3.2.7 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible background subtraction from the sample spectrum because of background contamination or coeluting peaks.

10.3.3.2.8 Quantitation of the tentatively identified compounds is obtained from the total ion chromatogram based on a response factor of 1 and is to be tabulated on the library search summary data sheet.

10.3.3.2.9 Quantitation will be performed by using the nearest internal standard.

10.3.3.2.10 Report result as estimated.

10.4 CALCULATION

10.4.1 Response Factor (RF)

$$RF = \frac{As \ x \ Cis}{Ais \ x \ Cs}$$

where: As = Area of the characteristic ion for the compound being measured.
Ais = Area of the characteristic ion for the specific internal standard.
Cs = Concentration of the compound being measured (ug/l).
Cis = Concentration of the specific internal standard (ug/l).

10.4.2 Percent Relative Standard Deviation (% RSD)

$$\%RSD = \frac{SD}{RFav} \ x \ 100$$

where: SD = Standard Deviation
RFav = Average response factor from initial calibration.

10.4.3 Percent Difference (% D)

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$$\%D = \frac{|RFav - RFc|}{RFav} \times 100$$

where: RFc = RF from continuing calibration (CBCHK)

10.4.4 Concentration (Conc.)

For water:

$$Conc.\ (ug / l) = \frac{Ac \times Cis \times Vp}{Ais \times RFav \times Vi}$$

For soil/sediment (on a dry weight basis):

$$Conc.\ (ug / kg) = \frac{Ac \times Cis \times Vp}{Ais \times RFav \times Ws \times M}$$

Where: Ac = Area of characteristic ion for compound being measured.
Vp = 5 ml (Total Purge Volume)
Vi = Initial volume of water purged (ml).
Ws = Weight of sample extracted (g).
M = (100 - % moisture in sample) / 100 or % solids / 100

10.4.5 Percent Recovery (% R)

$$\%R = \frac{Concentration\ Found}{Concentration\ Spiked} \times 100$$

10.4.6 Relative Percent Difference (RPD)

$$RPD = \frac{|MSC - MSDC|}{(\frac{1}{2})(MSC + MSDC)} \times 100$$

Where: MSC = Matrix Spike Concentration
MSDC = Matrix Spike Duplicate Concentration

11.0 QUALITY ASSURANCE

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11.1 QC Requirements Summary

BFB	Every 12 hrs.
ICV	Every ICAL
Calibration Check std.	Every 12 hrs.
Method blank	Every 12 hrs. and/or every batch
Blank Spike*	Every 12 hrs. and/or every batch
Matrix Spike	one per 20 samples.*
Matrix Spike Duplicate	one per 20 samples.*
Surrogate	every sample and standard.
Internal Standard	every sample and standard.

*The maximum number of samples per analytical batch is twenty.

11.2 Daily GC/MS performance check - refer to section 10.2.3

11.3 ICV – refer to section 10.1.7

11.4 Daily calibration check - refer to section 10.1.8

11.5 Method blank (reagent water) - refer to section 10.2.5

11.6 Matrix Spike(MS)/Matrix Spike Duplicate(MSD).

11.6.1 One sample is selected at random from each analytical batch of similar matrix types and spiked in duplicate with select compounds to check precision and reproducibility.

11.6.2 Matrix spikes are prepared by spiking an actual sample at a concentration of 10 ug/l or 10 ug/kg based on 5 g dry weight. This is analyzed as outlined in 10.2.

11.6.3 Percent recovery (% R) (see section 10.4.5) is compared to 60-140%.

11.6.4 A relative percent deviation (RPD) (see section 10.4.6) is calculated and compared to RPD in-house limits (when established).

11.6.5 If matrix spikes do not meet criteria and the QC check sample (blank spike) passed acceptance criteria, a matrix interference is to be assumed and the data is reportable and must be footnoted.

11.7 Blank Spike.

11.7.1 Reagent water is used for the Blank Spike.

11.7.2 Water Blank Spikes are prepared by adding 5.0 uls of Blank Spike solution (prepared independently and from a second source as the calibration standards) to 100mls reagent water. See Table 5 for standard preparation. Soil Blank Spikes are prepared by adding 1.0 uls of Blank Spike solution (prepared independently and from a second source as the calibration standards) to 10mls reagent water.

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11.7.3 Percent recoveries are compared to 60-140%.

11.7.4 Blank spike values are used to verify results when Matrix spike/matrix spike duplicate results indicate a potential problem due to sample matrix.

11.7.5 If blank spike recoveries are biased high, and sample results are non-detected, these results may be reported without qualification. If blank spike recoveries are biased low, the samples (and blank spike) must be re-analyzed.

11.8 Surrogate

11.8.1 All blanks, samples, and standards contain surrogate compounds which are used to monitor method performance.

11.8.2 If the recovery of any surrogate compound does not meet the control limits specified by in-house acceptance limits the calculation must be checked.

11.8.3 The sample must be reanalyzed if the recovery of any one surrogate is out 60-140% (or in-house control limits if tighter).

11.8.4 Above conditions (section 11.8.3) are not required for samples having severe matrix interference problems.

11.8.5 If surrogate recoveries are acceptable upon reanalysis, the data from the reanalysis is reported. If the reanalysis date did not meet the hold time, then both sets of data have to submitted with the reanalysis reported.

11.8.6 If surrogates are still outside control limits upon reanalysis, then both sets of data should be submitted with the first analysis reported.

11.9 Internal Standard.

11.9.1 Retention time for all internal standard must be within ± 30 seconds of the corresponding internal standard in the latest continuing calibration or 100 ug/l standard of initial calibration if samples are analyzed directly following an initial calibration.

11.9.2 The area (Extracted Ion Current Profile) of the internal standard in all analyses must be within 50 to 200% of the corresponding area in the latest calibration standard (12 hr. time period).

11.9.3 If area of internal standard does not meet control limits, the calculations must be checked. If a problem is not discovered, the sample must be reanalyzed.

11.9.4 If areas are acceptable upon reanalysis, the reanalysis data is reported.

11.9.5 If areas are unacceptable upon reanalysis, then both set of data are submitted with the original analysis reported.

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11.10 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recoveries are compared to 60-140%. The standard deviation of the 4 replicate percent recoveries are compared to in-house limits. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.11 Quality control limits are generated at least on an annual basis by QA using an in-house program. Blank spike, MS/MSD, and surrogate QC data are pooled for the previous year (or other specified time frame) and the data is processed and evaluated by QA. The new limits are entered into the LIMS where they can be viewed directly or by printing out a compound list (QC limits must be requested). The annual QC limit data is filed with QA.

12.0 DOCUMENTATION

12.1 The analytical logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

12.2 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.3 The standard preparation logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

12.4 The Accutest lot number must be cross-referenced on the standard vial.

12.5 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.6 All laboratory logbooks must be reviewed and initialed or signed by the lab manager.

12.7 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

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13.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, surrogate recoveries, analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/MSD (or duplicate) percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client. Raw data may be reported to the client on request.

14.2 Data may be submitted to the client in a specified electronic format (EDD).

14.3 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.4 Procedures for handling out-of-control or unacceptable data.

14.4.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary. If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes

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15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual quality control limits generated by QA, and the annual MDL study results. Refer to section 3.5 for MDLs, and section 11.11 for QC limits.

17.0 ADDITIONAL REFERENCES

17.1 SW846 5030B, Rev. 2, December, 1996, SW846 5035 Rev. 1, December, 1996, SW846 5035A, Draft Rev. 1, December 1996, SW846 8000C, Rev. 3, March, 2003, MA

Table 1

RECOMMENDED OPERATING CONDITION

Gas Chromatograph/ Mass Spectrometer	5890/5970MSD	6890/5973
Carrier Gas(linear velocity)	Helium at 30 cm/sec	1.2 ml/min
Mass range	35 - 260 amu	"
Electron Energy	70 volts (nominal)	"
Scan time	not to exceed 7 sec. per scan	"
Injection port temperature	250degC	"
Source temperature	200 – 250degC	"
Transfer line temperature	250 – 300degC	"
Analyzer temperature	220 – 260degC	"
Initial temperature	36degC	42
Time 1	3 minutes	2 minutes

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Column temperature rate	8deg/min.	10deg/min to 80degC 14deg/min to 210degC 16deg/min to 240degC
Final temperature	200degC. 3 min. hold	80degC 2.9min hold
Total run time	30 minutes	15.44 minutes

Purge and Trap Unit

Water Samples

Purge flow	40 mls/ min.
Purge time	11 min.
Purge Temp.	80 degC
Dry Purge	1 min
Desorb preheat	245 degC
Desorb	1 min. at 250 degC
Bake	2 min. at 270 degC
Transfer line	125 degC
Valve temperature	150 degC

Purge and Trap Unit

Soil Samples

Purge flow	40 mls/ min.
Purge time	11 min.
Purge Temp.	40 degC
Dry Purge	1 min
Desorb preheat	245 degC
Desorb	1 min. at 250 degC
Bake	2 min. at 270 degC
Transfer line	125 degC
Valve temperature	125 degC
Preheat	60degC
Preheat time	1 min.

These conditions are recommendations and may be optimized as needed.

Table 2

BFB KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
50	15 - 40 of mass 95
75	30 - 60 of mass 95
95	Base peak, 100% relative abundance
96	5 - 9% of mass 95

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173	<2% of mass 174
174	50.0 – 100.0% of mass 95
175	5 - 9% of mass 174
176	95 – 101.0% of mass 174
177	5 - 9% of mass 176

Table 3

INTERNAL STANDARD

Internal Standard	Prim./Sec. Ions
BFB	174/ 176, 95

Table 4

SURROGATES

Compound	(Prim./Sec. ions)	Control Limit (%)	
		Water	Soil
1,4-Dioxane-d8	(96,64)	*60-140	*60-140

***In-house recoveries if tighter**

Table 5

Target Analyte

Compound	(Prim./Sec. ions)
1,4-Dioxane	(88,58)

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Table 6

WORKING STANDARD PREPARATION

Surrogate

Surrogate:

17.7 uls of CIL, 1,4-Dioxane-D8

9823 u/Ls of Methanol

FV = 10,000 uls

FC = 2000 ug/ml

Internal Standard and Surrogate Mixture

10.0 uls of Internal Std (2000 ug/ml) (STS-110N)

100 uls of Surrogate Std (2000 ug/ml) (1,4-Dioxane-D8)

19725 uls Methanol

FV = 20,000 uls

FC =

- BFB (IS) = 1.0 ug/ml
- D8 (SS) = 10 ug/ml

Calibration mixture

Water:

600 uls of Accustandard P-Dioxane, APP-9-096-10X (1.0 mg/ml in MEOH)

2400 uls of MEOH

FV = 3000 uls

FC = 200 ug/ml

Soil:

500 uls of 200 ug/ml std

1500 uls of MEOH
FV = 2000 uls

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FC = 50 ug/ml

Blank Spike/ Matrix Spike (2nd source)

Water:

200 uls of Restek 1,4-Dioxane std (2000 ug/ml)

1800 uls of Methanol

FV = 2000 uls

FC = 200 ug/ml

Soil:

250 uls of 200 ug/ml 2nd source std

750 uls of MEOH

FV = 1000 uls

FC = 50 ug/ml

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Lab Manager: Brad Madadian

QA Officer: Mark Warren

TITLE: ***SULFATE, TURBIDIMETRIC ANALYSIS***

TEST METHOD REFERENCE: ASTM D 516-90 -02

REVISED SECTIONS: Test Method Ref., 3.4, 4.16, 4.17, 9.2, 9.3, 10.3, 17.0, 18.0

1.0 SCOPE & APPLICATION

1.1 This method is applicable to surface and saline water, and domestic and industrial wastes and solids.

2.0 SUMMARY

2.1 In this method, sulfate ion is converted to a barium sulfate suspension under controlled conditions. The resulting turbidity is determined by a spectrophotometer and compared to a curve prepared from standard sulfate solutions.

3.0 METHOD REPORTING LIMIT AND DETECTION LIMIT

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs. For additional detail regarding MDL studies, refer to the MDL SOP MQA245.

3.5 Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

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4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH – A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20 (or 10 for certain methods), then each group of 20 samples (or 10 samples for certain methods) or less will all be handled as a separate batch.

4.3 CALIBRATION CHECK STANDARD/CONTINUING CALIBRATION VERIFICATION (CCV). The calibration check standard is a mid-range calibration standard. It is recommended that the calibration check standard or CCV must be run at a frequency of approximately 10 percent. For most methods, the mid-level calibration check standard criteria is ± 10 percent of the true value. Refer to the specific quality control section for each SOP. The exception to this rule is if the recovery on the calibration check standard is high and the samples to be reported are less than the detection limit.

4.4 CALIBRATION – the establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preparation.

4.5 CALIBRATION STANDARDS – a series of known solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve).

4.6 DRY WEIGHT – the weight of a sample based on percent solids. The weight after drying. See Percent Moisture.

4.7 CONTAMINATION - a component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other samples, sampling equipment, while in transit, from laboratory reagents, laboratory environment, or analytical instruments.

4.8 EXTERNAL CHECK STANDARD/INITIAL CALIBRATION VERIFICATION(ICV). The external check standard or ICV is a standard from a separate source than the calibration curve that is used to verify the accuracy of the calibration standards. An external check must be run a minimum of once per quarter for most analyses where a check is commercially available. The laboratory should initially assess laboratory performance of a check standard using the control limits generated by the external check supplier. Refer to the quality control section for each SOP. If the external check is outside of the control limits for a given parameter, all samples must be reanalyzed for that parameter after the problem has been resolved.

4.9 FIELD SAMPLE - a portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

4.10 FIELD BLANK – this is any sample that is submitted from the field and is identified as a blank. This includes trip blanks, rinsates, equipment blanks, etc.

4.11 HOLDING TIME – the elapsed time expressed most commonly in days from the date of sampling until the date of its analysis.

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4.12 INTERFERENTS – substances which affect the analysis for the analyte of interest.

4.13 INITIAL CALIBRATION - analysis of analytical standards for a series of different specified concentrations; used to define the linearity and dynamic range of the response of the mass spectrometer or electron capture detector to the target compounds.

4.14 INSUFFICIENT QUANTITY - when there is not enough volume (water sample) or weight (soil/sediment) to perform any of the required operations: sample analysis or extraction, percent moisture, MS/MSD, etc.

4.15 MATRIX: The component or substrate (e.g., water, soil) which contains the analyte of interest.

4.16 MATRIX DUPLICATE: A duplicate sample is digested/distilled/analyzed at a minimum of 1 in 10 samples. The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. Assess laboratory performance against the control limits. In house limits are generated once sufficient duplicate data is available to generate limits (usually a minimum of 20 to 30 analyses). If a duplicate is out of control, flag the results with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control. Note: If control limits are not specified, use default limits of ± 20% RPD.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

4.17 MATRIX SPIKE: The laboratory must add a known amount of each analyte to a minimum of 1 in 10 samples. The matrix spike recovery is calculated as shown below. Assess laboratory performance against the control limits. In house limits are generated once sufficient matrix spike data is available to generate limits (usually a minimum of 20 to 30 analyses). If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect. Note:

$$\frac{(\text{Spiked Sample Result} - \text{Sample Result})}{(\text{Amount Spiked})} \times 100 = \text{Matrix Spike Recovery}$$

4.18 METHOD BLANK. The laboratory must digest or distill (as appropriate to the method) and/or analyze a method blank with each set of samples. A minimum of one method blank is required for every 10 samples. If no digestion step is required, then the method blank is equivalent to the reagent blank. The method blank must contain the parameter of interest at levels of less that the reporting limit for that parameter. If the method blank contains levels over the reporting limits, the samples must be redigested or redistilled and reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

4.19 PERCENT DIFFERENCE (%D) - To compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero. (In contrast, see relative percent difference.)

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4.20 PERCENT MOISTURE - an approximation of the amount of water in a soil/sediment sample made by drying an aliquot of the sample at 105 °C. The percent moisture determined in this manner also includes contributions from all compounds that may volatilize at or below 105 °C, including water. Percent moisture may be determined from decanted samples and from samples that are not decanted.

4.21 RELATIVE PERCENT DIFFERENCE (RPD) - To compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.22 REAGENT BLANK: The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. (Note: for methods requiring no preparation step, the reagent blank is equivalent to the method blank.) Either a reagent blank or a method blank must be analyzed with each batch of 20 samples or less. The concentration of the analyte of interest in the reagent blank must be less than the reporting limit for that analyte. If the reagent blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the reagent blank level. In addition, if all the samples are less than a client required limit and the reagent blank is also less than that limit, then the results can be reported as less than that limit.

4.23 REAGENT GRADE: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.24 REAGENT WATER: Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water. Water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.25 REFERENCE MATERIAL: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

4.26 SPIKE BLANK OR LAB CONTROL SAMPLE. Digest and analyze a laboratory control sample or spike blank with each set of samples. A minimum of one lab control sample or spike blank is required for every 10 samples. Assess laboratory performance against the control limits. In house limits should also be generated once sufficient external check standard data is available to generate limits (usually a minimum of 20 to 30 analyses). If the lab control is outside of the control limits for a parameter, all samples must be reanalyzed for that parameter. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag. Note: If control limits are not specified, then default limits of 80 to 120 percent should be used.

4.27 STANDARD CURVE: A plot of concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by successively diluting a standard solution to produce working standards that cover the working range of the instrument. Standards should be prepared at the frequency specified in the appropriate section. The calibration standards should be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation.

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5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIMES

6.1 Collection and Preservation

6.1.1 Containers: 500 ml plastic bottle

6.1.2 Preservation: Cool to 4°C ± 2°C.

6.2 Holding Time: 28 days from the date of collection.

7.0 APPARATUS & MATERIALS

7.1 The items needed for the analysis of sulfate are listed below.

7.1.1 Magnetic stirrer.
7.1.2 Stir bars.
7.1.3 Spectrophotometer capable of measuring at 420 nm, with a 2.5 cm path length. Or Turbidometer.
7.1.4 Stopwatch for measuring reaction time.
7.1.5 Measuring spoon, 0.2 to 0.3 ml volume.

8.0 STANDARDS & REAGENTS

Note: All applicable standard/reagent preparation information, including vendor, lot number, date of preparation, date of expiration, calculations, and initials must be entered in the appropriate standard/reagent preparation logbook. Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

8.1 Conditioning reagent. Place 300 ml of DI water, 30 ml of concentrated hydrochloric acid, 100 ml of 95% ethanol or isopropanol, and 75 g of NaCl in solution in a container. Add 50 ml of glycerol and mix well.

8.2 Barium chloride crystals, 20 to 30 mesh.

8.3 Standard stock sulfate solution, 1000 mg/L: Dissolve 1.479 g of sodium sulfate (dried at 105 C°) in 1 liter of DI water. This solution is stable for 3 months.

8.4 Calibration Standards. A calibration curve containing 6 points and a blank should be analyzed with each analytical run.

8.4.1 Calibration blank. The calibration blank should be made up from DI water.

8.4.2 5.0 mg/L standard. Volumetrically pipet 0.50 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.3 10 mg/L standard. Volumetrically pipet 1.00 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.4 20.0 mg/L standard. Volumetrically pipet 2.00 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.5 30 mg/L standard. Volumetrically pipet 3.00 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.6 40.0 mg/L standard. Volumetrically pipet 4.00 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.7 Calibration Check Standard (20 mg/L). Volumetrically pipet 2.0 ml of 1000 mg/L sulfate solution into a 100 ml volumetric flask containing approximately 80 ml of DI water. Dilute to volume with DI water and mix well.

8.4.8 External Check Solution. This must be from a different lot than the stock used for the calibration curve. The external should be analyzed with each analysis, if available. If not available, a spike blank can be substituted.

9.0 INTERFERENCES

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9.1 High results may be obtained for samples containing silica. Suspended matter and color can also be interferences in this method. Either background correction or dilutions can be used to minimize interferences.

9.2 Polyphosphates and high concentration of chloride will inhibit barium sulfate precipitation.

9.3 If interferences suspected, dilute sample 1:1 with DI water, and analyze. If results agree, it is assumed that the interferences are absent.

10.0 PROCEDURE

Below is the procedure to be followed for the analysis of water samples for sulfate using the turbidimetric analysis method. Turn on the instrument and let it warm up for 30 minutes. Open the sulfate electronic logbook.

NOTE: All standards and samples should be at room temperature.

10.1 Prepare a calibration curve and analyze the curve as outlined below.

10.1.1 Place 100 ml of standard into a 250 ml beaker.

10.1.2 Add exactly 5.0 ml of conditioning reagent and mix with a stir bar on a magnetic stirring plate.

10.1.3 While the solution is being stirred, add a measuring spoonful of barium chloride crystals (0.3 g)and begin timing immediately.

10.1.4 Stir for 58 to 62 seconds. Timing is critical and the stirring period must be in this time range.

10.1.5 Immediately pour the sample into the sample cell.

10.1.6 Measure the turbidity at 30 second intervals for 4 minutes. Record all readings.

10.1.7 Calculate the calibration curve by linear regression using the maximum reading obtained in the 4 minute interval for each standard as the absorbance for that standard.

10.1.8 Make sure that the calibration curve meets all quality control limits (correlation coefficient greater than 0.995, intercept less than the detection limit, and a slope comparable to the slope normally obtained with this method) before continuing with the analysis.

10.2 Once a calibration curve is obtained, then analyze the samples following the steps outlined in 10.1.1 through 10.1.6. A calibration check standard should be analyzed after every 10 samples or less. Analyze a method blank using 100 ml of DI water. Analyze a blank spike by adding 2 ml of the 1000 mg/L stock standard solution to 100 ml of DI water. Analyze a matrix spike by adding 2 ml of 1000 mg/L stock standard solution to 100 ml of the sample. Analyze a duplicate sample.

10.3 Filter the sample if turbid. For samples with significant background color read a background correction point as follows:

10.3.1 Place 20 ml of sample in a small beaker.

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10.3.2 Add exactly 1.0 ml of conditioning reagent and mix with a stir bar, stirring for 1 minute ± 2 seconds.

10.3.3 Pour the sample into the sample cell. Read the absorbance.

10.3.4 Subtract this absorbance from the sample absorbance.

10.4 For samples greater than the highest standard, reanalyze the sample at an appropriate dilution. The diluted result should fall within the mid to upper portion of the calibration curve.

10.5 The concentration in a sample can be calculated from the sample absorbance (or background corrected absorbance) using linear regression from the calibration curve.

10.6 For soil samples mix 12 g of sample with 120 ml of DI water, mix for 1 hr ,let settle and filter with 0.45 um filter paper. Follow the procedure for waters.

10.7 CALCULATIONS

10.7.1 Calculate the sulfate concentration in water samples as follows:

SO4 (in mg/L) = Conc. in mg/L x Dilution factor

11.0 QUALITY ASSURANCE

11.1 Quality Control Sample (also referred to as Initial Calibration Verification Standard, (ICV). It is recommended that a standard from a separate source than the calibration should be run at the beginning of each run to verify the calibration curve. This ICV should be within 10 percent of the true value (or within the manufacturer's specified limits – as applicable). If it is not, the problem must be resolved before any samples can be analyzed.

11.2 Calibration Check Standard (CCV). Analyze the calibration check standard after the ICV and after every 10 samples. This standard should be within 10 percent of the true value. If it is not, the problem must be resolved before sample analysis can continue. Samples analyzed prior to the failing check standard must be reanalyzed.

11.3 Calibration Blank Standard (CCB). Analyze the calibration blank after each CCV or at the minimum after the last CCV, at the end of the run to ensure contamination was not a problem during the batch analyiss.

11.4 Method blank. A method blank must be prepared with each analytical batch of 10 samples using the same reagents to prepare samples. The method blank must be taken through all steps used to process samples. The method blank must not contain the analyte at greater than the reporting limit. If the method blank contains over that limit, the samples must be reanalyzed.

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11.5 Spike blank. The laboratory must analyze a spike blank with each set of samples. A minimum of one spike blank is required for every 10 samples. Until sufficient lab control data becomes available, the laboratory should assess the laboratory performance of the spike blank for samples against recovery limits of 80-120%. If the lab control recovery is high and the results of the samples to be reported are less than the reporting limit, then the sample results can be reported with no flag.

11.6 Matrix spike. The laboratory must add a known amount of each analyte to a minimum of 1 in 10 samples. The spike recovery should be assessed using in house limits. Until these limits can be generated, then default limits of 75-125 % recovery should be applied.

11.7 Matrix duplicate. The laboratory must analyze a duplicate sample for a minimum of 1 in 10 samples. Until in-house limits can be generated, the relative percent difference (RPD) between the duplicate and the sample should be assessed against an RPD limit of 20.

11.8 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recoveries are compared to either default limits of 80-120% or in-house control limits once established. The standard deviation of the 4 replicate percent recoveries are compared to either ±20 or to in-house limits once established. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.9 Quality Control data is generated (control charts) and reviewed on an annual basis by Quality Assurance (blank spike/ matrix spike recoveries and matrix duplicate RPDs).

12.0 DOCUMENTATION

12.1 Use the electronic Sulfate analysis logbook application.

12.2 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.3 The standard preparation electronic logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

12.4 The Accutest lot number must be cross-referenced on the standard vial/container.

12.5 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.6 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all Instrument and method quality control and progresses through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the

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authority and responsibility to perform corrective action for any out-of-control parameter of non-conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, preparation and/or analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/duplicate percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client. Additionally, raw data including any instrument printouts, laboratory logbooks, etc. may be reported to the client.

14.2 Data may be submitted to the client in a specified electronic format (EDD).

14.3 Data may be submitted to the client electronically as a PDF (e-hardcopy).

14.4 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.5 Procedures for handling non-conforming data.

14.5.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.5.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

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15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual QC limits (control charts) generated by QA, and the annual MDL study results. Refer to section 3.5 for MDLs, and section 11.9 for QC limits.

17.0 METHOD PERFORMANCE

17.1 Method performance is evaluated by the annual QC limits (control charts) generated by QA, and the annual MDL study results. Refer to section 3.0 for MDLs, and section 11 for QC limits.

18.0 ADDITIONAL REFERENCES

18.1 No additional references are required for this method.

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Lab Manager: Brad Madadian

QA Officer: Mark Warren

TITLE: TOTAL ORGANIC CARBON IN AQUEOUS SAMPLES

TEST METHOD REFERENCES: - SW846 9060A Modified,
-5310 B, Standard Methods for the Examination of Water and Wastewater 21th Edition, 2005

REVISED SECTIONS: Test Method Ref., 1.0, 4.0, 6.0, 8.0, 10.0, 11.0, 12.0

1.0 SCOPE AND APPLICATION

1.1 This method can be used to determine total organic carbon or dissolved organic carbon in any aqueous matrix. The total organic carbon is actually being determined as non-purgable organic carbon. Volatile compounds are lost during the sparging process to remove inorganic carbon.

1.2 The product for total organic carbon is TOC and the product for dissolved organic carbon is DOC. Both of these products require prep and analytical work groups.

1.3 Samples containing high levels of particulates may need to be run using the boat sampler normally used for soil samples. When analyzing these samples using the boat sampler, all steps of the soil SOP, including acidification and heating to remove inorganic carbonates, must be followed. (Acidification and sparging may also be used to remove inorganic carbonates.)

1.4 The modification to method 9060A is that water samples are not homogenzied in a blender.

2.0 SUMMARY

2.1 Total organic carbon is determined by combusting an acidified sample and quantitating the carbon dioxide released using infrared analysis. The quantitation is done by comparison to a linear calibration curve. Dissolved organic carbon is determined following the same method, but the sample is filtered through a 0.45 filter before analysis.

3.0 REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 The reporting limit (RL) is based on the lowest calibration standard. RL's may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification. The normal reporting limit for TOC and DOC in aqueous samples is 1.0 mg/l.

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3.2 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.3 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

3.4 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs. For additional detail regarding MDL studies, refer to the MDL SOP MQA245.

3.5 Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH: A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20, then each group of 20 samples or less will all be handled as a separate batch.

4.3 CALIBRATION CHECK STANDARD (CCV). The calibration check standard is a mid-range calibration standard. It is recommended that the calibration check standard be run at a frequency of approximately 10 percent. (For some methods this is mandatory and for some it is a recommendation only. Refer to individual method SOP's) For most methods, the mid-level calibration check standard criteria is $\pm$ 10 percent of the true value. The exception to this rule is if the recovery on the calibration check standard is high and the samples to be reported are less than the detection limit.

4.4 EXTERNAL CHECK STANDARD (ICV). The external check standard is a standard from a separate source than the calibration curve that is used to verify the accuracy of the calibration standards (also called an initial calibration verification – ICV). An external check must be run a minimum of once per quarter for all analyses where a check is commercially available. The laboratory should initially assess laboratory performance of a check standard using the control limits generated by the external check supplier. In house limits should also be generated once sufficient external check standard data is available to generate limits (usually a minimum of 20 to 30 analyses). If the external check is outside of the control limits for a given parameter, all samples must be reanalyzed for that parameter after the problem has been resolved.

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4.5 SPIKE BLANK OR LAB CONTROL SAMPLE. Digest and analyze a laboratory control sample or spike blank with each set of samples. A minimum of one lab control sample or spike blank is required for every 10 or 20 samples (refer to quality assurance section). Assess laboratory performance against the control limits specified in the SOP. In house limits should also be generated once sufficient external check standard data is available to generate limits (usually a minimum of 20 to 30 analyses). If the lab control is outside of the control limits for a parameter, all samples must be reanalyzed for that parameter. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag. Note: If control limits are not specified in the SOP, then default limits of 80 to 120 percent should be used.

4.6 MATRIX: The component or substrate (e.g., water, soil) which contains the analyte of interest.

4.7 MATRIX DUPLICATE: A duplicate sample is analyzed at a minimum of 1 in 10 or 20 samples (refer to quality assurance section). The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. Assess laboratory performance against the control limits that are specified in the SOP. In house limits are generated once sufficient duplicate data is available to generate limits (usually a minimum of 20 to 30 analyses). If a duplicate is out of control, flag the results with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control. Note: If control limits are not specified in the SOP, use default limits of ± 20% RPD.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2)} = \text{Duplicate RPD}$$

4.8 MATRIX SPIKE: The laboratory must add a known amount of each analyte to a minimum of 1 in 10 or 20 samples (refer to quality assurance section). The matrix spike recovery is calculated as shown below. Assess laboratory performance against the control limits that are specified in the SOP. In house limits are generated once sufficient matrix spike data is available to generate limits (usually a minimum of 20 to 30 analyses). If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect. Note: If control limits are not specified in the SOP, then default limits of 75 to 125 percent should be used.

$$\frac{(\text{Spiked Sample Result} - \text{Sample Result})}{(\text{Amount Spiked})} \times 100 = \text{Matrix Spike Recovery}$$

4.9 MATRIX SPIKE DUPLICATES: Intra-laboratory split samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. They are used to document the precision and bias of a method in a given sample matrix.

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4.10 METHOD BLANK. The laboratory must digest and analyze a method blank with each set of samples. A minimum of one method blank is required for every 10 or 20 samples (refer to quality assurance section). The method blank must contain the parameter of interest at levels of less than the reporting limit for that parameter. If the method blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

4.11 METHOD DETECTION LIMITS (MDLS). MDLs should be established for all appropriate methods, using a solution spiked at approximately 3 times the estimated detection limit. To determine the MDL values, take seven replicate aliquots of the spiked sample and process through the entire analytical method. The MDL is calculated by multiplying the standard deviation of three replicate analyses by 3.14, which is the student's t value for a 99% confidence level. MDLs should be determined approximately once per year for frequently analyzed parameters.

4.12 REAGENT BLANK: The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. The concentration of the analyte of interest in the reagent blank must be less than the reporting limit for that analyte. If the reagent blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the reagent blank level. In addition, if all the samples are less than a client required limit and the reagent blank is also less than that limit, then the results can be reported as less than that limit.

4.13 REAGENT GRADE: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.14 REAGENT WATER: Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water. For organic analyses, see the definition of organic-free reagent water. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.15 REFERENCE MATERIAL: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analyti-cal process.

4.16 STANDARD CURVE: A plot of concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by successively diluting a standard solution to produce working standards which cover the working range of the instrument. Standards should be prepared at the frequency specified in the appropriate section. The calibration standards should be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation. This is applicable to organic and inorganic chemical analyses.

4.17 TRIP BLANK: A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination

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attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.

5.0 HEALTH & SAFETY

5.1 All safety practices must be followed as outlined in the Accutest Laboratories Employee Safety Handbook and Chemical Hygiene Plan. Safety glasses, gloves, and lab coats must be worn. All samples, solutions, and extracts must be treated as unknown and potentially hazardous.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIME

6.1 Collection and Preservation

6.1.1 Containers: Samples should be collected in 40 ML VOA, zero headspace glass containers.

6.1.2 Preservation: Samples should be preserved with H_3PO_4 , H_2SO_4 or HCl to a pH of < 2. Samples should be stored at 4°C ± 2°C.

Note: Total carbon preservation is not directly addressed in the methods. Normally an unpreserved sample is used . Acid preserved sample is used for Total Organic Carbon.

6.2 Holding Time: Samples should be analyzed within 28 days from the date of collection.

7.0 APPARATUS

7.1 The following items are needed for the analysis of samples following the method outlined below:

7.2 Shimadzu TOC V analyzer with an auto-sampler.

7.2.1 Every day, the humidifier should be checked to ensure that the water level is within the two white lines on the side of the humidifier.

7.2.2 Whenever calibration check recoveries are low or blank results are high, the flow and the condition of the catalyst should be checked. Refer to the instrument manual for additional information. Never change the catalyst without first checking with the area supervisor or manager.

7.3 Analytical balance, capable or weighing to 0.1 mg. The calibration of the analytical balance should be verified each day before use.

7.4 Volumetric glassware, class A. For standards and reagent preparation.

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7.5 Filter paper, 0.45 um pore size. (For DOC only)

7.6 40 ml VOC bottles with septum.

8.0 REAGENTS

8.1 All chemicals listed below are reagent grade unless otherwise specified. Deionized water should be used whenever water is required. Make sure to properly label all reagents and record the reagent preparation in the reagent log book.

8.2 Potassium hydrogen phthalate (KHP), stock solution, 1000 mg carbon/L. Dissolve 2.125 g of potassium hydrogen phthalate (primary standard grade, dried to a constant weight, approximately 1 hour at 105^0 C) in approximately 800 ml of DI water. Add concentrated HCl or H_3PO_4 to bring the pH to less than 2 and dilute to a final volume of 1000 ml with DI water. Prepare this solution quarterly.

8.3 Carbonate-Bicarbonate Stock solution, 1000 mg/l. Weigh 0.3500 g of sodium bicarbonate and 0.4418 g of sodium carbonate into a 100 ml volumetric flask. Dissolve in DI water and dilute to a final volume of 100 ml. Prepare this solution quarterly.

8.4 Sparger Check Solution (Carbonate-Bicarbonate Standard solution, 50 mg/l). Dilute 5.00 ml of the 1000 mg/l carbonate-bicarbonate stock solution to 100 ml with DI water.
Note: Do not use Sparger for TCAR determinations.

8.5 Potassium hydrogen phthalate (KHP) calibration stock solutions. All standards should be made up in volumetric flasks using volumetric pipets.

Note: The concentrations shown below are suggested levels. Alternate calibrations may be constructed in the TOC method file and used.

8.5.1 40 PPM Calib. Std., Dilute 4.0 ml of solution 8.2, and 2 drops of conc. H_3PO_4 or HCl to 100 ml with DI water.

8.5.2 30 PPM Calib. Std., Dilute 3.0 ml of solution 8.2, and 2 drops of conc. H_3PO_4 or HCl 100 ml with DI water.

8.5.3 10 PPM Calib. Std., Dilute 1.0 ml of solution 8.2, and 2 drops of conc. H_3PO_4 or HCl to 100 ml with DI water.

8.5.4 1.0 PPM Calib. Std., Dilute 10 ml of 10 PPM solution 8.5.3, and 2 drops of H_3PO_4 or HCl 100 ml with DI water.

Place the reagent blank (DI water plus two drops of conc. HCl or H_3PO_4), and calibration stock standards 8.5.4, 8.5.1, 8.5.2 in position 1, 2, 3, 4 respectively, and the auto-sampler will dilute and make the following calibration standards: 0.0,1.0, 5.0, 10.0, 20.0, 30.0, 40.0 ppm.

Note: For pH adjustment of calibration stock standards and the reagent blanks, it recommended to use the same type of acid as was used for sample preservation.
Note: Do not add acid to calibration standards for TCAR determinations.

8.6 Continuing Calibration Verification(CCV) 20 PPM,

8.6.1 Dilute 2.0 ml of KHP stock solution 8.2 and 2 drops of conc. HCl or H_3PO_4 to 100 ml with DI water.

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8.7 2 Molar HCL solution. Add 36.5 ml of concentrated HCl in 300 ml of DI water, dilute to 500 ml with DI water. Mix.

Note: Do not use for TCAR determinations.

8.8 Sucrose Solution, 10000 Mg C /L. Weight out 4.74 gram of sucrose into 200 ml volumetric flask containing 160 m l of DI water. Add concentrated HCl (usually few drops) to bring the pH to less than 2. Mix well and bring to final volume of 200 ml. This standard may be stored under refrigeration for three month.

9.0 INTERFERENCES

9.1 High results may be obtained if the inorganic carbon is not completely removed from the sample before analysis. The sample must be acidified to a pH of less than 2 and sparged for at least 1 minute to remove the inorganic carbon.

9.2 Large particulates in the sample may not be pulled into the needle during the sample injection and may result in a low bias.

9.3 Filtration can result in loss or gain of DOC, depending on the physical properties of the carbons containing compounds and the adsorption of carbonaceous material on the filter or its desorption from it.

10.0 PROCEDURE

10.1 Below is the procedure to be followed for the analysis of aqueous samples for total organic carbon using the Shimadzu TOC V analyzer. All standards and samples must be analyzed using a minimum of duplicate injections.

Note: If SW846 9060 method is being used, all standards and samples must be analyzed in quadruple injections.

10.2 Turn on the instrument and let it warm up for at least 45 minutes. It is recommended to keep the power on for detector to be stabilized at all time.

10.3 Turn on the oxygen. The oxygen pressure at the tank must be at least 80 psi to maintain sufficient pressure at the instrument. Check to make sure that the humidifier contains sufficient water. It should be filled to within the two black lines on the side of the humidifier. (The humidifier is located inside the water analyzer at the right side of the instrument.)

10.4 Check the carrier gas control, inside the front panel and make sure it is set at 150 kpa.

10.5 Check pressure gauge next to carrier gas control and make sure it is set at 200 kpa

10.6 Check the levels in diluent and HCL bottles. Make sure that the transfer lines are well below the liquid levels.

10.7 On the desk - top double click the TOC Control V Icon, and double click on sample table editor Icon. A user name and password window will appear. Type **System** in the user space and **TOC6001** for password. Please note that this software is case sensitive. (User ; first letter is capital and the rest are lower case)

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10.8 Go to file-open and double click on the **TOCWATER upto40ppm.t32 (Tcwatersupto40ppm.t32 for TCAR)** . Go to file, "save as" , and save the file as new file name. The naming scheme must be as follows; TOC, month, day, year, matrix, and the no. of the run for that day. Example: TOC091201W1 which would be the TOC run on sep. 12 ,2001 water run # 1 for that day. TOC091201w2 would be the second run on that day.

10.9 The template contains all the information regarding the calibration curve, sparge time, etc.

10.9.1 First line of the template contains the calibration curve.

10.9.2 Enter the sample sequence starting from second line as follows:

Line 2 CCV
Line 3 CCB
Line 4 Spargerchkconf
Continue and enter the sample sequence including the quality control, ICV,etc.

10.9.3 Pour out the standards and the samples (section 10.12). Label each bottle and place on auto-sampler.

10.9.4 Remove any unused rows/lines by high lighting and cutting. Again, save the file under the proper name before starting the analysis.

10.9.5 In order to establish communication between the PC and the instrument, in the Tool Bar click on **Instrument** , then choose **connect**.(short cut for connect is the yellow lightning bolt icon on the tool bar). **Parameter Confirmation Dialog** window will open. Click on **Use Setting on PC**. Once the communication is established, go to **Instrument, Maintenance, Replace Flow Line content.** Press **START** in the flow content window. This will fill the lines from the diluent and the HCL bottles. Then, go to **Instrument, start.** (short cut for start is the traffic signal icon on the tool bar). Click **standby**. **Sparging/Acid addition** window opens. The vial position on auto sampler must be matched to samples. Placing the cursor on the appropriate row, and then, double clicking on the desired vial position in the tray diagram can enter the vial position. The sparge time and the acid addition may be confirmed for each sample at this point also. Click **OK,** to start the run and **External acid addition** window opens, leave the box checked and click **OK**. Instrument should start the analysis.

10.9.6 When all of the standards have been completed, then review the curve using the **view, sample window.** The coefficient of correlation must be at least 0.995 or greater. If this criteria is not met corrective action must be taken to correct any problems, and the curve must be reanalyzed prior to sample analysis.

10.10 After the calibration is completed, Monitor CCV, CCB, Sparger chk, and ICV standard (external check standard) made from a separate source than the calibration standards (if available). ICV standard must agree within 10 percent of the true value. If it is not within this range, determine the source of the problem before proceeding.

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10.11 After every 10 samples and at the end of the run, a continuing calibration check sample and a continuing calibration blank should be analyzed. The continuing calibration check should be a standard near the mid-range of the curve. It is recommended that a check standard at 20 mgC/l be used as the continuing calibration check standard. The continuing calibration check should agree within 10 percent of the true value. The result for the continuing calibration blank must be less than the reporting level. If either the CCV or the CCB do not meet criteria, then all samples bracketed by this QC must be reanalyzed.

10.12 Sample log and handling

10.12.1 All samples and check standards must be analyzed with duplicate injections (quadruple for SW 8469060).

10.12.2 Shake the samples well to make sure they are completely homogenized.

10.12.2.1 If a sample contains a high level of particulates, check with the lab supervisor before proceeding. The sample may need to be analyzed using the soil module.

10.12.3 With each batch of 20 samples or less, a matrix spike, matrix duplicate, method blank, and spike blank must be analyzed. All of these quality control points must be analyzed using duplicate injections (quadruple injections for SW846 9060).

10.12.3.1 Prepare the matrix spike by adding 0.500 ml of 1000 mgC/l standard solution to 50 ml of acidified sample.

10.12.3.2 The spike blank may be prepared by adding 0.500 ml of 1000 mgC/l standard solution to 50 ml of DI blank. Alternatively, the external check may be used as the spike blank.

10.12.4 Analyze continuing calibration checks and continuing calibration blanks as outlined in 10.11 above.

10.12.4.1 The software may not accept large dilution factors (>100). In that case, enter in the dilution in the column to the right of the sample ID and correct the final result in the LIMS system for the sample dilution. The instrument will dilute samples automatically, although a sample with suspected high concentration should be diluted prior to analysis to protect the instrument. The instrument will attempt a dilution by reducing the injection volume. This information could be accessed in the "Sample View Window" and on the sample report. If the TOC concentration is still too high, the sample will be diluted with dilution water. The "Auto – dilution factor" is only available in the sample view window and will not be included in the sample report.

10.12.5 Use sample window to view the peaks as the analysis is in process. With the cursor positioned on the autosampler window click on any row to be highlighted, the result for the completed samples will show in the view window.

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10.12.6 Make sure the sparger check result is less than reporting detection limit of 1 PPM and preferably less than half the reporting detection limit.

10.12.7 After the analysis is complete, check through the data to make sure that all QC is within criteria, that samples are within the curve, and that good reproducibility is obtained for all injections. If the sample injections have a coefficient of variation (CV) of greater than 2 percent, then verify the repeated analysis with additional replicate injection (Parameters for CV already programmed in the template). If, on the repeated analysis, a high rpd is still obtained, then the sample results should be reported with a flag due to possible sample non-homogeneity.

$$CV = (\text{Std Dev}_{n-1} / \text{mean}) \times 100$$

10.12.8 Review the run for completeness and data and quality control problems. Go to "File" (in the TOC-Control V sample table window, top toolbar) select "ASCII export options", and check off the "Mean Conc" box, click ok. Go back to "File" again, select "ASCII Export". The "Save As" window will now open. The location should be "programs"/Shimadzu/Data. Save the file with the appropriate name (see section 10.8). This file maybe accessed through windows explorer and transferred to LIMS. Problems encountered with auto-transfer may be related to options selected for ASCII export. These options maybe reviewed or changed from "File", "ASCII export options" in the TOC Control V sample table. Make any necessary corrections in GNAPPR such as entering the spike amounts. Approve in GNAPP and provide the supervisor with the data for additional review. See the area supervisor or manager for further details.

11.0 QUALITY ASSURANCE

11.1 Below is a summary of the quality control requirements for this method. Make sure to check with the laboratory supervisor or manager for any additional client specific quality control requirements.

11.2 **Method Blank**. The laboratory must prepare and analyze a method blank with each analysis. When using method ***SW846 9060A***, a minimum of one method blank is required for every 10 samples (20 samples if ***SM 5310B*** is used). The method blank must contain the analyte at less that the reporting limit. If the method blank contains over that limit, the samples must reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

11.3 **Spike Blank**. The laboratory must prepare and analyze a spike blank with each analysis. When using method ***SW846 9060A***, a minimum of one spike blank is required for every 10 samples (20 samples if ***SM 5310B*** is used). The laboratory should assess laboratory performance of the spike blank against recovery limits of 80 to 120 percent. If the lab control recovery is high and the results of the samples to be reported are less than the reporting

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limit, then the sample results can be reported with no flag. In all other situations, all samples associated with a spike blank outside of recovery limits must be reanalyzed.

11.4 **Matrix Spike**. The laboratory must add a known amount of analyte to a minimum of 1 in 10 samples when using method ***SW846 9060A*** (20 samples if ***SM 5310B*** is used).

11.4.1 The spike recovery should be assessed using in house limits. Until these limits can be generated, then default limits of 75 to 125 percent recovery should be applied. If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect.

11.4.2 The matrix spike recovery should be calculated as shown below.

$$\frac{\text{(Spiked Sample Result - Sample Result)}}{\text{(Amount Spiked)}} \times 100 = \text{MS Recovery}$$

11.5 **Matrix Duplicate**. The laboratory should analyze a duplicate sample for a minimum of 1 in 10 samples when using method ***SW846 9060A*** (20 samples if ***SM 5310B*** is used). The relative percent difference (rpd) between the duplicate and the sample should be assessed. Matrix spike duplicates may be used in place of matrix duplicates. The duplicate rpd is calculated as shown below.

11.5.1 The duplicate RPD should be assessed using in house limits. Until these limits can be generated, then default limits of 20 percent RPD should be applied. If a duplicate is out of control, then the results should be flagged with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of $\pm$ the reporting limit, then the duplicate is considered to be in control.

11.5.2 The duplicate RPD should be calculated as shown below.

$$\frac{\text{(Sample Result - Duplicate Result)} \times 100}{\text{Result + Duplicate Result)} \times 0.5} = \%\ \text{RPD}$$

11.6 **Quality Control Sample** (also referred to as Initial Calibration Verification Standard, (ICV). It is recommended that a standard from a separate source than the calibration should be run at the beginning of each run. This ICV should be within 10 percent of the true value. If it is not, the problem must be resolved before any samples can be analyzed.

11.7 Analyze the continuing calibration verification solution after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value, then no samples can be reported in the area bracketed by that CCV. (Note: the exception is if the CCV is biased high and the samples are less than the detection limit. In that case, the samples can be reported with no flag.) The CCV concentration should be at or near the mid-range of the calibration curve.

11.8 Analyze the continuing calibration blank solution after every CCV check (every tenth sample and at the end of the sample run). The continuing calibration blank must be less than the reporting

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limit. If the CCB solution is not less than the reporting limit, then no samples can be reported in the area bracketed by that CCB. (Note: the exception is if the CCB is biased high and the samples are less than the detection limit. In that case, the samples can be reported with no flag.)

11.9 A Precision and accuracy (P&A) study is performed as an initial determination of capability, on an annual basis (continued demonstration of capability – a successful PT result may be used in place of a P&A for continued DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recoveries are compared to either default limits of 90-110% or in-house control limits once established. The standard deviation of the 4 replicate percent recoveries are compared to either ±20 or to in-house limits once established. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.10 Quality control data are generated at least on an annual basis by QA using an in-house program. Blank spike and MS/Dup data are pooled for the previous year (or other specified time frame) and the data is processed and evaluated by QA. The annual QC data is filed with QA.

12.0 DOCUMENTATION

12.1 All sample ID's, dilution, weights and any other information should be recorded. Make sure to record any comments regarding unusual sample appearance or any other problems or observations.

12.2 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.3 All laboratory logbooks must be routinely reviewed and initialed or signed by the lab manager.

12.4 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13.0 DATA REVIEW

13.1 Primary Review. All samples should be updated to both prep (GP) and analysis (GN) batches in the LIMS system. The analyst should calculate all matrix spike, duplicate, external, and CCV recoveries and review the results of all blanks.

13.2 All documentation must be completed, including reagent references and spike amounts and spiking solution references.

13.3 A final report should be printed out from the TOC software. Make sure to check that all samples meet replication requirements (< 2% CV) and that the samples are within the range of the calibration curve.

13.4 A data file should be exported to the LIMS system and the spike amounts should be entered into the file at the GNAPP process step.

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13.5 A final data package, consisting of the raw data (TOC printout), copy of the TOC analysis runlog and workgroup printout, should be turned into the area supervisor for review.

13.6 Department managers perform a secondary review, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.7 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all-analytical requirements and specifications were executed.

13.8 Spot-check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14.0 DATA REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, preparation and/or analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/duplicate percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client. Additionally, raw data including any instrument printouts, laboratory logbooks, etc. may be reported to the client.

14.1 Data may be submitted to the client in a specified electronic format (EDD).

14.2 Data may be submitted to the client electronically (e-hardcopy) in PDF.

14.3 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.2 Procedures for handling non-conforming data.

14.2.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.2.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT.

15.1 Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

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15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the waste management SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non hazardous aqueous wastes.
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes
15.2.7 Microbiological wastes

16.0 ADDITIONAL REFERENCES

16.1 Shimadzu TOC instrument manual.

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Lab Manager: Brad Madadian

QA Officer: Mark Warren

TITLE: **TOTAL ORGANIC CARBON IN SOILS SAMPLES USING SW846 METHOD 9060 (MODIFIED), AND US EPA REGION 2 LLOYD KAHN METHOD.**

TEST METHOD REFERENCES: SW846 Method 9060, September 1986, modified, and EPA Region 2 Lloyd Kahn Method, July 1988.

REVISED SECTIONS: Added section 14.4, Deleted Section 18

1.0 SCOPE AND APPLICATION

1.1 This method can be used to determine total organic carbon in any solid matrix. It may also be used for liquid matrices containing a high level of total organic carbon. Samples that are primarily aqueous may also be analyzed using this method, but sample sizes should be limited to $\leq$ 0.10 g.

1.2 The product code for total organic carbon is TOC for the Corp. of Engineers methods and for the modified SW846 9060 method. The product code is TOCLK for total organic carbon run by the Lloyd Kahn EPA Region 2 method.

2.0 SUMMARY

2.1 Total organic carbon is determined by combusting an acidified sample and quantitating the carbon dioxide released using infrared analysis. The quantitation is done by comparison to a linear calibration curve.

3.0 REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 The Reporting Limit (RL) is based on the lowest calibration standard. RL'S may vary depending on matrix difficulties, sample volumes or weights, and percent moisture. Detected concentrations below this concentration cannot be reported without qualification.

3.2 The normal reporting limit for TOC in soils is 1000 mg/kg. This is based on a 0.1 g sample size. A minimum reporting limit of 100 mg/kg can be obtained by using a 1.0 g sample size. A reporting limit of 100 mg/kg is required for samples being analyzed for Lloyd Kahn TOC. A low level calibration standard is run at the level of this reporting limit.

3.3 The Method Detection Limit (MDL) represents the lowest reportable concentration of an individual analyte that meets the method qualitative identification criteria.

3.4 Method Detection limits (MDLs) are experimentally determined using the procedures described in 40 CFR, Part 136, Appendix B. Actual reported MDLs incorporate the sample volume analyzed and sample dilutions if needed, which may cause MDL variations from sample to sample.

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3.5 In general, MDLs are determined through the analysis of at least 7 replicate blank spikes (using the same procedures for sample analysis). The MDL is calculated by multiplying the standard deviation of the replicate concentrations by the appropriate Student's t value (3.143 for 7 replicates). If more than 7 replicates are analyzed refer to 40 CFR, Part 136, Appendix B for the appropriate student's t value. MDLs are determined initially (prior to analysis), on an annual basis, and after major maintenance to equipment. MDL data is archived with Quality Assurance. Refer to the most recent study for current MDLs.

3.6 Current MDL studies are filed with Quality Assurance. Obsolete MDL studies are archived with the QA files. Electronic MDL data is found in the annual "MDL" folder on the QA server (LINUXMA1).

4.0 DEFINITIONS

4.1 ALIQUOT - a measured portion of a sample, or solution, taken for sample preparation and/or analysis.

4.2 BATCH: A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20, then each group of 20 samples or less will all be handled as a separate batch.

4.3 CALIBRATION CHECK STANDARD. The calibration check standard is a mid-range calibration standard. The calibration check standard must be run at a frequency of 10 percent. The acceptance criteria for this standard is $\pm$ 10 percent of the true value.

4.4 EXTERNAL CHECK STANDARD. The external check standard is a standard from a separate source than the calibration curve that is used to verify the accuracy of the calibration standards. An external check must be run a minimum of once per quarter for all analyses where a check is commercially available. If the external check is outside of the control limits for a given parameter, all samples must be reanalyzed for that parameter after the problem has been resolved.

4.5 INITIAL CALIBRATION VERIFICATION – analysis of a check standard from a second source (either vendor or lot) from the initial calibration standards to verify the initial calibration.

4.6 SPIKE BLANK SAMPLE. Analyze a laboratory control sample or spike blank with each set of samples. A minimum of one lab control sample or spike blank is required for every 20 samples. Assess laboratory performance against the control limits specified in the SOP. In house limits should also be generated once sufficient data is available to generate limits (usually a minimum of 20 to 30 analysis). If the lab control is outside of control limits, all samples must be reanalyzed. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag. Note: If control limits are not specified in the SOP, then default limits of 80 to 120 percent should be used.

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4.7 LAB CONTROL SAMPLE. A solid lab control sample from an external source may be analyzed with a batch, depending on individual client requirements. The solid lab control is evaluated using manufacturer's limits. If the lab control is outside of the control limits for a parameter, all samples must be re-analyzed. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results can be reported with no flag.

4.8 MATRIX: The component or substrate (e.g., water, soil) which contains the analyte of interest.

4.9 MATRIX DUPLICATE: A duplicate sample is analyzed at a minimum of 1 in 20 samples. The relative percent difference (RPD) between the duplicate and the sample should be assessed. The duplicate RPD is calculated as shown below. Assess laboratory performance against the in house limits. In house limits are generated once sufficient duplicate data is available to generate limits (usually a minimum of 20 to 30 analyses). If a duplicate is out of control, flag the results with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of ± the reporting limit, then the duplicate is considered to be in control. Note: If control limits are not specified in the SOP, use default limits of ± 20% RPD.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

4.10 MATRIX SPIKE: The laboratory must add a known amount of analyte to a minimum of 1 in 20 samples. The matrix spike recovery is calculated as shown below. Assess laboratory performance against the in house control limits. If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect. Note: If control limits are not specified in the SOP, then default limits of 75 to 125 percent should be used.

$$\frac{(\text{Spiked Sample Result} - \text{Sample Result})}{(\text{Amount Spiked})} \times 100 = \text{Matrix Spike Recovery}$$

4.11 METHOD BLANK. The laboratory must analyze a method blank with each set of samples. A minimum of one method blank is required for every 20 samples. The method blank must contain the parameter of interest at levels of less than the reporting limit for that parameter. If the method blank contains levels over the reporting limits, the samples must be reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

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4.12 METHOD DETECTION LIMITS (MDLS). MDLs should be established for all appropriate methods, using a solution spiked at approximately 3 times the estimated detection limit. To determine the MDL values, take seven replicate aliquots of the spiked sample and process through the entire analytical method. The MDL is calculated by multiplying the standard deviation of three replicate analyses by 3.14, which is the student's t value for a 99% confidence level. If more than seven replicates are analyzed, the appropriate student's t value must be used (refer to 40 CFR pt 136, App. B). MDLs should be determined annually or after major maintenance to the instrument.

4.13 REAGENT GRADE: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.14 REAGENT WATER - water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. Accutest uses deionized water (municipal water which passes through Accutest's DI treatment system).

4.15 RELATIVE PERCENT DIFFERENCE (RPD) - As used in this SOP to compare two values, the relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero. In contrast, see percent difference.

4.16 PERCENT DIFFERENCE (%D) - As used in this SOP and elsewhere to compare two values, the percent difference indicates both the direction and the magnitude of the comparison, i.e., the percent difference may be either negative, positive, or zero. (In contrast, see relative percent difference.)

4.17 REFERENCE MATERIAL: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

4.18 STANDARD CURVE: A plot of concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by successively diluting a standard solution to produce working standards, which cover the working range of the instrument. Standards should be prepared at the frequency specified in the appropriate section. The calibration standards should be prepared using the same type of acid or solvent and at the same concentration as will result in the samples following sample preparation. This is applicable to organic and inorganic chemical analyses.

5.0 HEALTH & SAFETY

5.1 The analyst should follow normal safety procedures as outlined in the Accutest Laboratory Employee Safety Plan and Chemical Hygiene Plan, which include the use of safety glasses and lab coats. In addition, all acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

5.2 The furnace operates at high temperature and the furnace should be allowed to cool down before doing any system maintenance or troubleshooting. If there are any signs of a system

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blockage, open the sample introduction port and turn off the furnace to prevent build up of back pressure.

5.3 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level.

6.0 PRESERVATION & HOLDING TIME

6.1 Collection and Preservation

6.1.1 Containers: Samples should be collected in 2 oz glass jars with Teflon-lined lids.

6.1.2 Preservation: Samples should be stored at 4°C ± 2°C.

6.2 No holding time is outlined in the Corp. of Engineers method for TOC. EPA specifies a holding time of 28 days for aqueous samples. Unless otherwise specified, this 28-day holding time will also be applied to solid samples analyzed using this SOP.

6.3 A 14 day holding time should be followed when analyzing TOC soils following the EPA Region II Lloyd Kahn method.

7.0 INTERFERENCES

7.1 High results may be obtained if the inorganic carbon is not completely removed from the sample before analysis. To ensure that all of the inorganic carbon is removed, heat an acidified sample at least 10 minutes at 75°C before starting the analysis. Some volatile organics may be lost in this heating step, resulting in a low bias in the TOC result.

8.0 APPARATUS

The following items are needed for the analysis of samples following the method outlined below:

8.1 Shimadzu TOC-V analyzer with soil analysis module or equivalent.

8.1.1 Each day of analysis, the humidifier/water trap should be checked to ensure that the water level is within 1 inch of the top of the humidifier.

8.1.2 Each day of analysis, the baseline should be checked to make sure that it is stable and near zero.

8.1.3 Whenever calibration check recoveries or blanks are out of compliance, the flow and the condition of the catalyst should be checked. If the catalyst appears bad (contains many small fines), it should be cleaned and replaced. Refer to the instrument manuals for additional information on system maintenance.

8.2 Syringes, 0.100, or 0.250 ml size.

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8.3 Analytical balance, capable or weighing to 0.1 mg. The calibration of the analytical balance should be verified each day before use.

8.4 Volumetric glassware, class A. for standards preparation.

8.5 Ceramic boats. Ceramic Fiber

8.6 Drying oven, capable of being set to 75°C

8.7 Desiccator with metallic shelf

9.0 REAGENTS

All chemicals listed below are reagent grade unless otherwise specified. Deionized water taken from the DI taps in the organics lab should be used whenever water is required. Make sure to properly label all reagents and record the reagent preparation in the reagent logbook (including vendor, lot number, date of preparation, any calculations, and initials). Vendors typically used by Accutest include Fisher Scientific, VWR, Accustandard, Supelco, Chemservices, Ultra, and ERA. Additional vendors may be utilized as necessary.

9.1 Sucrose Stock Solution, 200000 mgC/l (20% C from sucrose): Dry sucrose in desicctor. Weigh out 47.5 grams into a 100 ml volumetric flask containing approximately 80 ml of DI water. Add concentrated hydrochloric acid to bring the pH to less than 2. Mix well and bring to a final volume of 100 ml. Note: This stock should be replaced whenever crystallization of the sucrose is apparent. It can be held for a maximum of 6 months. Refrigeration is not required.

9.2 Sucrose Standard Solutions: Dilute the above stock solution (200000 mC/l) as shown below to make the suggested calibration standards. Add concentrated hydrochloric acid to bring the pH to less than 2 before diluting each standard to the final volume. (Note: If needed, two sets of calibration standards may be prepared , low range , and high range)

9.2.1 **Low range standards(ACCUTESTSOLID CAL CURVE.CAL)**

Standard Level	ml of stock	Final volume (ml)
15000 mgC/l	7.5	100
10000 mgC/l	5.0	100
8000 mgC/l	4.0	100
5000 mgC/l	2.5	100
2000 mgC/l	1.0	100
1000 mgC/l	0.50	100
500 mgC/l	0.25	100
Blank	0.000	100

9.2.2 **High range standards(ACCUTESTSOLID CAL CURVE2.CAL)**

Standard Level	ml of stock	Final volume (ml)

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50000 mgC/l	25	100
40000 mgC/l	20	100
30000 mgC/l	15	100
25000 mgC/l	12.5	100
20000 mgC/l	10	100
15000 mgC/l	7.5	100
Blank	0.000	100

9.3 Glucose Stock External Solution, 20000 mgC/l (2% C from glucose): Dry glucose in dessicator. Weigh out 5.0 grams into a 100 ml volumetric flask containing approximately 80 ml of DI water. Add concentrated hydrochloric acid to bring the pH to less than 2. Mix well and bring to a final volume of 100 ml. Note: This stock should be replaced whenever crystallization of the glucose is apparent. It can be held for a maximum of 6 months. Refrigeration is not required.

9.4 Nitric Acid, reagent grade. Used for acidifying samples to remove inorganic carbon.

9.5 Oxygen Gas, high purity.

9.6 2 M HCl Solution, Add 36.5 ml of concentrated HCl in 300 ml of DI water, dilute to 500 ml with DI water.

10.0 PROCEDURE

Below is the procedure to be followed for the analysis of soil samples for total organic carbon using the Shimadzu TOC soil analyzer.

10.1 Turn on the oxygen. The pressure in the soil module should be set at 300 kPa and the carrier gas should be set as marked on the dial (0.5 l/min). The oxygen pressure at the tank must be at least 80 psi to maintain sufficient pressure at the instrument. Check to make sure that the water trap contains sufficient water. It should be filled to within approximately 1 inch of the top of the humidifier/water trap. (The humidifier is located under the magnetic plate on the right side of the instrument)

10.2 If the power is off, then turn on the power at the side of the soil and water modules and for the computer. Note: It is recommended to leave the TOC water module and PC on at all times, and prior to using the instrument follow the following sequences. Shut down the modules(water and soil), and PC. Turn back on the modules and PC. This would insure that the communication between all three is established. <u>One sign of communication problem is when the green and amber lights in front panel of the TOC water module are blinking</u>.

10.3 Go into the TOC software by double clicking the TOC-Control V icon on windows desk top. Double click on sample table editor, enter "**System**" for name, and "**TOC6001**" for password. Note: software is case sensitive. Right click on TOC-Solids in the left border of the window and click connect, and click on "use setting on PC" in parameter confirmation dialog window. Wait for the software to connect with the TOC analyzer.

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10.4 Right click on the TOC Solids and scroll down to properties. In the instrument properties window go to SSM tab and click SSM TC Furnace On, then click OK. The SSM module furnace will now begin to heat. Temperature must reach at 900 Deg.C of the led display on the SSM module to begin analysis.

10.5 Prepare and store in desiccator with metallic shelf, at least 7 ceramic boats and load approximately 40-60 mg of ceramic fiber following the procedure outlined in glassware cleaning section.

10.6 **Calibration**

If the instrument has not been calibrated within the last 3 month, then the instrument must be calibrated at this point (A new calibration is required at least once per quarter). Confirm the temperature of SSM has reached 900 Deg. C and stabilized. Two calibration curves may used for this analysis. Both calibration curves should be analyzed on the same day, if possible. See section 9.2.1 and 9.2.2 for the calibration standards used for each curve. Templates for the curves are titled as "**Accutestsolidcalcuve2.cal**" for the high level and, "**Accutestsolidcurve.cal**" for the low level. Notes, each calibration curve must be analyzed separately and without any attached samples.(this will enable the calibration curves to be printed out and included with future analysis run packages).

10.6.1 In the "**Toc-Control V Sample Table** " window go to File and click on New, and double click sample run.

10.6.2 In the "**General information**" window select Toc-Solids under system, and click OK.

10.6.3 Save the file by clicking on file, save as, in the following format; TOC day month year S (for solid) and the number of the analysis for that day. Example: **TOC101801S1** or **TOC101801S2**(if it's a second run for that day).

10.6.3.1 **<u>If a new calibration curve is to be run:</u>**
On the top toolbar , go to "insert", then click on "calibration curve" . A window will now open to browse for the calibration curve templates. Choose the appropriate template as discussed in section 10.6., and click open. On the toolbar click on the lightning bolt icon and then click on the traffic light icon. The "TOC measurement " window will now open, click start. The "Enter Sample Amount" window will now open. Enter in the appropriate volume for STD's and place the loaded ceramic boat with the standard into the SSM. Click on start in the "Enter Sample Amount" window.

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10.6.4 A dialog box will appear to instruct the user to push the sample to the measurement position marked on SSM. Meanwhile the measurement peaks may be viewed during the analysis with the sample window which must be accessed from the "view" on the top toolbar. The software will indicate when to move sample back to cooling position. After staying in cool position, software will instruct the analyst to move sample to the preparation position. **The dialog box MUST BE CLOSED PRIOR to moving the lever. If not the software will freeze**

10.6.5 The "Toc Measurement" window now will be displayed and the previously analyzed sample results can be viewed. In this box you may also "Repeat", "Excluded", "Stop" or go to " Next" sample..

10.6.6 Select the option to repeat the injection and repeat the steps outlined above (Minimum of two injection with CV less than 15% or RPD less than 20%. In TOC Measurement window you may also "Exclude", "Stop".

10.6.7 When the last replicate of the last STD has been completed, click stop in the "TOC measurement" window.

10.6.8 If a correlation coefficient of greater than 0.995 is obtained, then save the curve using the file, save option. Check to make sure that the intercept, calculated using a weight of 1.0 g for Lloyd Kahn or using a weight of 0.1 g for other TOC analyses, is less than the reporting limit for each method (100 mg/kg for Lloyd Kahn or 1000 mg/kg for other TOC soils.) Note: If either the correlation coefficient or the intercept does not meet the above criteria, than recalibrate before proceeding with the samples.

10.6.9 To run the next calibration curve, close the sample window and the spreadsheet and refer to section 10.6.1 to repeat the procedure using the next set of standards for that level.

10.7 **Sample Preparation**

10.7.1 Begin preparing the samples following the procedure outlined below.

Weigh out from 100 to 1000 mg of sample (wet weight) into a ceramic boat using a 4-place analytical balance. For samples that contain high levels of TOC smaller sample sizes may be needed. For unknown samples, start with a sample size of 100 mg. (All method blanks and spike blanks should be calculated assuming a 100 mg sample size.) Samples that contain non-homogeneous particulates should be homogenized with a mortar and pestle before weighing out the sample aliquot. All samples must be homogenized prior to preparation (refer to the Procedure for Representative Aliquots SOP MQA247). If a client is requiring a detection limit lower than 1000 mg/kg, then larger sample sizes are required. A detection limit of 100 mg/kg requires a weight of 1000 mg. A smaller sample size may be used only to bring the sample to within the range of the calibration curve.

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10.7.2 Add nitric acid dropwise to the sample until no additional effervescence is observed and the surface of the sample is covered with the acid. Heat the acidified sample in an oven at 75°C for a minimum of 10 minutes.

10.7.3 With each batch of 20 samples or less, a matrix spike and a duplicate should be analyzed. On each analysis day, a method blank and spike blank must be analyzed. All of these quality control points must be analyzed in duplicate.Prepare the method blank by treating a small amount (approximately 100 mg) of pre-baked Ottawa with nitric acid and heating at 75 º C for a minimum of 10 minutes.

10.7.4 Prepare the spike blank in the same manner as the method blank, but spike it with 100 ul of a 20000 mgC/l standard or external solution before adding the acid.

10.7.5 Prepare the duplicate in the same manner as a sample.

10.7.6 Prepare the matrix spike by adding 100 ul of a 20000 mgC/l standard or external solution to a sample aliquot before adding the acid and heating the sample.

10.8 **Sample Analysis**

10.8.1 Refer to section 10.1 through 10.5.

10.8.2 In the "**TOC-Control V Sample Table**" window go to file and click on new, and double click sample run. In the "General Information" window select Toc-Solids under system, and click OK. Save the file by clicking on file(see section 10.6.3).

10.8.3 Go to "Insert" on the top toolbar and click on Auto Generate. A wizard will now open. On page one at the "Sample Group Wizard" click on calibration curve, then click on the gray box to attach the latest curve that was analyzed within the last three month. The date of the last calibration curve can be found in the TOC instrument log book or the analysis book. The high level calibration curve is always attached to the run at this point. The format of the curve is as follows :

Example: "Accutestsolidcalcurve2.2002_10_18_07_54_30.cal"

Notice that the original template name is followed by the year, month, day, hour, min, Sec. , that the calibration curve was analyzed. Double click on the appropriate calibration curve to be used. Press "Next" to move to page two at the wizard.

10.8.4 On second page of the wizard, enter the number of samples including all QC, and CCV's. It is a good practice to choose more samples than needed as the run may be stopped at any time and more samples added to the analysis sequence for that day. Next delete any name that appears in the sample name window. Click "Next".

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10.8.5 Skip page 3 of the wizard by clicking "Next" , then click "Finish" on page 4 of the wizard.

10.8.6 Type in the sequence and on the toolbar click on the lightning bolt icon and then click on the traffic light icon. The "TOC measurement " window will now open, click start. The "Enter Sample Amount" window will now open. Enter in the appropriate weight for sample and place the loaded ceramic boat with the sample into the SSM. Click on start in the "Enter Sample Amount" window.

10.8.7 Follow section 10.6.4 , 10.6.5 , 10.6.6 .

10.9 **Changing calibration curves for samples less than 15000 ppm**

10.9.1 If two curves (Hi and Low) were used, for samples less than 15000 ppm, the low level curve must be used. Initially all samples and checks are analyzed based on the high level curve. After both replicates of the sample have been analyzed, click on stop in the "Toc measurement " window. Then in sample view window, right click in the " SP1.No." box next to the sample. The "update" parameter box is now open. Click on calibration curve and be sure to check box to include subsequent replicates. Click on the gray box to the right of the curve description box. This will open a window to browse for the calibration curve. The most recent level curve should now be attached by double clicking on it. The curve will be in the format of the template name first, then the year, month, day, hour, min, sec. that the calibration curve was analyzed see example below:

"Accutestsolidcalcurve,2002_10_18_07_54_20. cal"

The software will now ask to recalculate, click "OK".

10.9.2 Now in the spreadsheet that contains the sample sequence, highlight the row that contains the sample. On the left side of the computer screen there is a window that lists the samples. In this window, right click on the box next the sample being evaluated, and click on recalculate . The software will ask to recalculate, click "OK", and then the data will reflect the change in calibration curves.

10.9.3 Calibration curves must be verified with a low and a high standard and a blank (method blank can be used as blank) before proceeding on each analysis day. The low standard must be within 30 percent and the high within 10 percent of the true value. Make sure to use duplicate injections for all analyses.

10.9.4 After the calibration checks are completed, then analyze the continuing calibration verification standard (CCV). CCV should be a standard near the mid range of the curve. CCV results should agree within 10 percent of the true value. If the CCV is not within 10% of the true value, then no sample can be reported in the area bracketed by this CCV, unless the CCV is biased high (110 to 150%) and the sample results to be reported are less than the reporting limit. Analyze this standard after every 10 samples.

10.9.5 Analyze an external check standard (ICV). This standard must agree within 10 percent

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of the true value. If it is not within this range, determine the source of the problem, correct the problem, and recalibrate.

10.9.6 If the duplicate sample injections have a coefficient of variation (CV) of greater than 15 percent or an RPD of greater than 20%, then repeat the analysis with 2 additional duplicate injections (unless the two injections are less than RL).If on the repeated analysis, a high CV or RPD is still obtained, then report the average of 4 injections. The sample results should be reported with a flag due to possible sample non-homogeneity.

$$CV = (\text{Std Dev}_{n-1} / \text{mean}) \times 100$$

$$RPD = (\text{Result1} - \text{Result 2})) \times 100/\text{mean}$$

10.9.7 The final sample results are calculated using the equation shown below. The calculation is done automatically in the Shimadzu TOC software except for the percent solids correction. The percent solids correction is added when the data is transferred in the LIMS system. See area supervisor or manager for further details.

Organic Carbon, Total (mg/kg) =

$$\frac{\text{Conc. from curve}}{\text{\%sol}/100}$$

10.10 **GLASSWARE CLEANING**

10.10.1 Brush any adhering material from the boat and wash with soap and water and then Well rinsed with DI water. Soak in 2 M HCl solution for few minutes and rinse with DI water several times. Place the boats in muffle furnace at 900 Deg. C for 15 min.Cool, and store in desiccator.
Note: it is recommended to prepare the boats at the end of each analysis for next analysis date to conserve time.

11.0 QUALITY CONTROL

Below is a summary of the quality control requirements for this method. Make sure to check with the laboratory supervisor or manager for any additional client specific quality control requirements.

11.1 Calibration Curve. The instrument must be calibrated a minimum of once per quarter. It is recommended that the instrument be calibrated at least once per month. If the instrument is not calibrated on a given day, then the curve must be verified using a low and a high standard and a blank before proceeding on each analysis day. The low standard must be within 30 percent of the true value. All other check standards must be within 10 percent of the true value. The blank must contain less than the reporting limit for TOC.

11.2 Method Blank. The laboratory must prepare and analyze a method blank with each set of samples. A minimum of one method blank is required for every 20 samples. The method

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blank must contain the analyte at less that the reporting limit. If the method blank contains over that limit, the samples must reanalyzed. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit.

11.3 Spike Blank. The laboratory must prepare and analyze a spike blank with each set of 20 or less samples. For a running batch, a new spike blank is required for each different analysis day. The laboratory should assess laboratory performance of the spike blank against recovery limits of 80 to 120 percent. (If the spike blank is used in place of the external, then it must be within recovery limits of 90 to 110 percent.) If the lab control recovery is high and the results of the samples to be reported are less than the reporting limit, then the sample results can be reported with no flag. In all other situations, all samples associated with a spike blank outside of recovery limits must be reanalyzed.

11.4 Matrix Spike. The laboratory must add a known amount of each analyte to a minimum of 1 in 20 samples. (Note: For Florida samples, spikes should be prepared for 1 in 10 samples.)

11.4.1 The spike recovery should be assessed using in house limits. Until these limits can be generated, then default limits of 75 to 125 percent recovery should be applied. If a matrix spike is out of control, then the results should be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and should be footnoted to that effect.

11.4.2 The matrix spike recovery should be calculated as shown below.

$$\frac{\text{(Spiked Sample Result - Sample Result)}}{\text{(Amount Spiked)}} \times 100 = \text{MS Recovery}$$

11.5 Matrix Duplicate. The laboratory must prepare and analyze a duplicate sample for a minimum of 1 in 20 samples. The relative percent difference (rpd) between the duplicate and the sample should be assessed. Matrix spike duplicates may be used in place of matrix duplicates. The duplicate rpd is calculated as shown below.

11.5.1 The duplicate RPD should be assessed using in house limits. Until these limits can be generated, then default limits of 20 percent RPD should be applied. If a duplicate is out of control, then the results should be flagged with the appropriate footnote. If the sample and the duplicate are less than 5 times the reporting limits and are within a range of $\pm$ the reporting limit, then the duplicate is considered to be in control.

11.5.2 This duplicate fills the requirement for quadruplicate injections for one sample in 20 for the TOCLK method.

11.5.3 The duplicate RPD should be calculated as shown below.

$$\frac{\text{(Sample Result - Duplicate Result)} \times 100}{\text{(Sample Result + Duplicate Result)} \times 0.5} = \text{\% RPD}$$

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11.6 Quality Control Sample (also referred to as Initial Calibration Verification Standard, (ICV). A standard from a separate source than the calibration should be run at the beginning of each run to verify the initial calibration. This ICV should be within 10 percent of the true value. If it is not, the problem must be resolved before any samples can be analyzed. Note: The spike blank may be used in place of the ICV as long as a separate source standard is used and the 10 percent criterion is met.

11.7 Continuing Calibration Verification (CCV). Analyze the continuing calibration verification solution after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value, then no samples can be reported in the area bracketed by that CCV. (Note: the exception is if the CCV is biased high (111 to 150%) and the samples are less than the detection limit. In that case, the samples can be reported with no flag.) The CCV concentration should be at or near the mid-range of the calibration curve.

11.8 Continuing Calibration Blank (CCB). For some clients, a continuing calibration blank (CCB) may be required. This is not required as part of the normal TOC protocol. If it is required, than it should be run after each CCV check. The results of the CCB must be less than the reporting limit for TOC. If the CCB is not less than the reporting limit, then no samples can be reported in the area bracketed by this CCB unless the sample results to be reported are less than the reporting limit.

11.9 A Precision and accuracy (P&A) study is performed as an initial determination of capability and on an annual basis (continuing demonstration of capability – a successful PT result may be used in place of a P&A for continuing DOC), and if any significant changes have been made to the instrument. In general, 4 replicates or blank spikes are analyzed using the same procedures and conditions for sample analysis. The percent recovery is compared to the blank spike acceptance criteria. The standard deviation of the 4 replicate percent recoveries are compared to either ±20 or to in-house limits once established. If percent recovery or standard deviation criteria are not met, corrective action must be taken to bring the system back into control.

11.10 Quality Control data is generated (control charts) and reviewed on an annual basis by Quality Assurance (blank spike/ matrix spike recoveries and matrix duplicate RPDs).

12.0 DOCUMENTATION

12.1 All analytical data should be labeled with the sample ID and any dilutions made. The analyst should double check to make sure that all comments dealing with the run are recorded on the raw data.

12.2 The analytical logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

12.3 If samples require reanalysis, a brief explanation of the reason should be documented in this log.

12.4 The standard preparation logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the

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respective person.

12.5 The Accutest lot number must be cross-referenced on the standard vial/container.

12.6 The instrument Maintenance logbook must be completed when any type of maintenance is performed on the instrument. Each instrument will have a separate log.

12.7 All laboratory logbooks must be routinely reviewed and initialed or signed by the lab manager.

12.8 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

13 DATA REVIEW

13.1 The analyst conducts the primary review of all data. This review begins with a check of all method quality control and processes through sample quality control concluding with a check to assure that the client's requirements have been executed. The analyst has the authority and responsibility to perform corrective action for any out-of-control parameter of non- conformance.

13.2 A secondary review is performed by department managers, and it includes review of the data produced by their department. All manual calculations, QC criteria, and a comparison of the data package to client specified requirements are checked. The department manager may reject data, initiate reanalysis, take additional corrective action, or reprocess data.

13.3 The laboratory director performs a full tertiary review of the data package following its assembly. This review includes an evaluation of QC data against acceptance criteria and a check of the data package contents to assure that all analytical requirements and specifications were executed.

13.4 Spot check reviews are performed by the Quality Assurance Officer focusing on all elements of the deliverable including the client's specifications and requirements, analytical quality control, sample custody documentation and sample identification.

14 REPORTING

14.1 A results page including positive results and/or RLs, units, methodology, analysis dates, and data qualifiers are reported. Additional quality control data including calibration summaries, MS/duplicate percent recoveries and RPDs, blank spike recoveries, and method blank results may be reported upon request of the client.

14.2 Data may be submitted to the client in a specified electronic format (EDD). Lab result are also available electronically via e-hardcopy upon request of the client.

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14.3 Once the data is approved by the laboratory manager, it may be accessed by clients via LabLink™.

14.4 Procedures for handling non-conforming data.

14.4.1 If quality control data does not meet criteria the non-conformance must be discussed in a case narrative and footnoted on the applicable quality control report summary.

14.4.2 If preservation or holding time criteria is not met and the samples are analyzed the result page must be footnoted with this information, and the non-conformance must be discussed in a case narrative or other suitable communication (telephone conversation log or email). Client notification documentation should be included with the data (telephone conversation log, fax, or email).

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT.

15.1 Pollution Prevention. Users of this method must perform all procedural steps that controls the creation and/or escape of wastes of hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids, or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 15.2.

15.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the Sample and Waste Disposal SOP. This document describes the proper disposal of all waste materials generated during the testing of samples as follows:

15.2.1 Non-hazardous aqueous wastes
15.2.2 Hazardous aqueous wastes
15.2.3 Chlorinated organic solvents
15.2.4 Non-chlorinated organic solvents
15.2.5 Hazardous solid wastes
15.2.6 Non-hazardous solid wastes

16.0 METHOD PERFORMANCE

16.1 Method performance is evaluated by the annual QC limits (control charts) generated by QA, and the annual MDL study results. Refer to section 3.5 for MDLs, and section 11.10 for QC limits.

17.0 ADDITIONAL REFERENCES

17.1 There are no additional references for this SOP.

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ATTACHMENT D

Waste Management Plan Addendum

WORK PLAN REVISION

REVISION NO: 01

CONTRACT NO: N62470-08-D-1006

PROJECT NAME:	Naval Air Station (NAS) Brunswick Brunswick, Maine	TO NO:	WE01 & WE09
SITE/TASK:	Mere Brook and Merriconeag Stream Groundwater-Surface Water Interface Investigation	WORK PLAN DATE:	September 2009
WORK PLAN NAME:	Remedial Action Work Plan, Naval Exchange (NEX) Service Station Site Revision No. 00	DATE OF REVISION:	September 2010
REVISION PREPARED BY:	Monica Martin		

Purpose: The purpose of this Work Plan Revision is to; 1) Amend the Waste Management Plan of the Final Remedial Action Work Plan, Naval Exchange Service Station Site so that it is specific to the Mere Brook and Merriconeag Stream Groundwater-Surface Water Interaction Investigation and 2) Include the waste characterization sampling and analysis to be conducted as part of this investigation.

Modifications/Revisions:

Item No.	Description of Modifications/Revisions
01	Refer to attached summary for amendments to the Waste Management Plan and waste characterization sampling and analysis for the Mere Brook and Merriconeag Stream Groundwater-Surface Water Interface Investigation. All Waste Management requirements not amended in this work plan revision will comply with the requirements set forth in the Final Remedial Action Work Plan, Naval Exchange Service Station Site (AGVIQ-CH2M HILL, 2009).

Reasons for the Modifications/Revisions:

Item No.	Reasons for the Modifications/Revisions
01	The Waste Management Plan of the Final Remedial Action Work Plan, Naval Exchange Service Station Site requires amendments for it to be applicable to the Mere Brook and Merriconeag Stream Groundwater-Surface Water Interface Investigation and the waste characterization sampling and analysis required for this investigation differs from the waste characterization sampling and analysis related to the Waste Management Plan of the Final Remedial Action Work Plan, Naval Exchange Service Station Site.

Venky Venkatesh TO Project Manager	Signature	September 1, 2010 Date
Michael Halil Deputy Program Manager	Signature	September 1, 1020 Date
U.S. Navy Responsible Authority	Signature	Date

Document Control Distribution

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Work Plan Addendum No. 01
Waste Management and Characterization for the Mere Brook and Merriconeag Stream Groundwater-Surface Water Investigation
Brunswick, Maine
September 2010

Introduction

AGVIQ-CH2M HILL will be installing monitoring wells and performing groundwater, pore water, surface water, and sediment sampling in accordance with this UFP-SAP. This addendum, Attachment D of the UFP-SAP, includes amendments to the Waste Management Plan of the Final Remedial Action Work Plan for the Naval Exchange Service Station Site (AGVIQ-CH2M HILL, 2009); it is specific to the Mere Brook and Merriconeag Stream Groundwater-Surface Water Interaction Investigation at NAS Brunswick and the sampling and analysis that will be performed to characterize the waste generated during this investigation.

The following wastes may be generated during these activities:

- Potentially contaminated soil generated during monitoring well installation
- Aqueous wastes, including:
  - Potentially contaminated purge water (groundwater or pore water)
  - Decontamination water

Exemptions or Exclusions

There are no known exemptions or exclusions for the potentially contaminated waste that will be generated during this investigation.

Waste Characterization

Environmental media will be characterized through sampling and laboratory analysis. Soil and aqueous waste will be sampled and analyzed in accordance with Table 1 below. All waste will be characterized in accordance with Title 40 Code of Federal Regulations (40 CFR) Part 261 Subpart C. Uncontaminated wastes and debris such as office trash will be classified as municipal solid waste.

Waste Profile

The waste profile typically requires the information included (but not limited to) that described in the *Final Remedial Action Work Plan for the Naval Exchange Service Station Site* (AGVIQ-CH2M HILL, 2009). Examples of this information for waste generated during this investigation include:

- Generator information including name, address, contact, and phone number
- Site name including street/mailing address
- Process generating waste (e.g., Mere Brook and Merriconeag Stream Investigation)
- Source of contamination (e.g., Eastern Plume)
- Historical use for area (e.g., industrial)
- Waste composition (e.g., 95 percent soil, 5 percent debris or 100 percent water)
- Physical state of waste (e.g., solid, liquid)

- Hazardous waste codes (if applicable)

General Waste Management Requirements

Containment

Soil and aqueous wastes will be stored in approved 55-gallon drums. The guidelines related to drums and small containers are defined in the *Final Remedial Action Work Plan for the Naval Exchange Service Station Site* (AGVIQ-CH2M HILL 2009).

References

AGVIQ-CH2M HILL 2009. *Final Remedial Action Work Plan for the Naval Exchange (NEX) Service Station Site, Brunswick, Maine*. September.

Sampling Task	Sample Point	Sample Collection Method	Matrix	Analysis	Method	Normal Samples	Trip Blanks	Total Samples	Preservation	Containers
Characterization of Soil Cuttings	Drums	Grab (TCLP Volatiles) 4-point Composite	Soil	TCLP Volatiles	SW-846 Method 1311, 8260B	1	--	1	Cool to 4°C +/- 2°C; sealed zero headspace in containers	(1) 4 oz. amber glass
				TCLP Semi-volatiles	SW-846 Method 1311, 8270C	1	--	1	Cool to 4°C +/- 2°C	(4) 8 oz. amber glass
				TCLP Pesticides	SW-846 Method 1311, 8081A	1	--	1		
				TCLP Herbicides	SW-846 Method 1311, 8151A	1	--	1		
				PCBs	8082	1	--	1		
				TCLP Metals	SW-846 Method 1311, 6010, 7040/7471	1	--	1		
				pH	9045D	1	--	1		
Liquid Characterization Sampling	Drums	Grab	Water	TCL Volatiles	8260B	1	1	2	HCl pH<2; Cool to 4°C+/- 2°C	(3) 40 ml vial
				TCL Semi-volatiles	8270C	1	--	1	Cool to 4°C +/- 2°C	(6) 1L amber glass
				TCL Pesticides	8081A	1	--	1		
				TCL Herbicides	8151A	1	--	1		
				TCL Metals	6010B/7470A	1	--	1	HNO_3 pH<2; Cool to 4°C+/- 2°C	(1) 500 mL HDPE
				PCBs	8082	1	--	1	Cool to 4°C +/- 2°C	(2) 1L amber glass
				Ignitability	1010	1	--	1		(1) 250 mL amber glass
				Corrosivity	9040B	1	--	1		(1) 250 mL amber glass

ATTACHMENT E

IAVI Screening Levels

Attachment -E1
Groundwater Screening Levels for Protection of Indoor Air
Naval Air Station Brunswick, Maine

CAS#	Chemical	MCL	EPA VI Screening Values (EPA, 2002)(1)	Target Groundwater Concentration Corresponding to Target Indoor Air Concentration where the Soil Gas to Indoor Air Attenuation Factor (α) = 0.001 and Partitioning across the Water Table Obeys Henry's Law (4)	Final Groundwater SL for VI
Volatile Organic Compounds					
71-55-6	1,1,1-Trichloroethane	2.0E+02	3.1E+03		3.1E+03
79-34-5	1,1,2,2-Tetrachloroethane		3.0E+00		3.0E+00
79-00-5	1,1,2-Trichloroethane	5.0E+00	(2)	4.1E+00	4.1E+00
75-34-3	1,1-Dichloroethane		2.2E+03		2.2E+03
75-35-4	1,1-Dichloroethene	7.0E+00	1.9E+02		1.9E+02
540-59-0	1,2-Dichloroethene		NA		NA
107-06-2	1,2-Dichloroethane	5.0E+00	(2)	2.3E+00	2.3E+00
78-87-5	1,2-Dichloropropane	5.0E+00	3.5E+01		3.5E+01
78-93-3	2-Butanone (MEK)		4.4E+05		4.4E+05
591-78-6	2-Hexanone		NA		NA
108-10-1	4-Methyl-2-pentanone (MIBK)		1.4E+04		1.4E+04
67-64-1	Acetone		2.2E+05		2.2E+05
71-43-2	Benzene	5.0E+00	(2)	1.4E+00	1.4E+00
75-27-4	Bromodichloromethane	8.0E+01	2.1E+00		2.1E+00
75-25-2	Bromoform	8.0E+01	8.3E-03		8.3E-03
74-83-9	Bromomethane		2.0E+01		2.0E+01
75-15-0	Carbon disulfide		5.6E+02		5.6E+02
56-23-5	Carbon tetrachloride	5.0E+00	(2)	3.4E-01	3.4E-01
108-90-7	Chlorobenzene	1.0E+02	3.9E+02		3.9E+02
75-00-3	Chloroethane		2.8E+04		2.8E+04
67-66-3	Chloroform	8.0E+01	(2)	7.1E-01	7.1E-01
74-87-3	Chloromethane		6.7E+00		6.7E+00
156-59-2	cis-1,2-Dichloroethene	7.0E+01	2.1E+02		2.1E+02
542-75-6	cis-1,3-Dichloropropene		8.4E-01		8.4E-01
124-48-1	Dibromochloromethane	8.0E+01	3.2E+00		3.2E+00
100-41-4	Ethylbenzene	7.0E+02	(2)	3.0E+00	3.0E+00
75-09-2	Methylene chloride	5.0E+00	5.8E+01		5.8E+01
100-42-5	Styrene	1.0E+02	8.9E+03		8.9E+03
127-18-4	Tetrachloroethene	5.0E+00	(2)	5.5E-01	5.5E-01
108-88-3	Toluene	1.0E+03	1.5E+03		1.5E+03
156-60-5	trans-1,2-Dichloroethene	1.0E+02	1.8E+02		1.8E+02
542-75-6	trans-1,3-Dichloropropene		8.4E-01		8.4E-01
79-01-6	Trichloroethene	5.0E+00	(2)	2.9E+00	2.9E+00
75-01-4	Vinyl chloride	2.0E+00	(2)	1.5E-01	1.5E-01
1330-20-7	Xylene (total)	1.0E+04	2.2E+04		2.2E+04
Semi-Volatile Organic Compounds					
123-91-1	1,4-Dioxane		(3)		NA

Notes:
Units are presented in ug/L.

(1) EPA. 2002. Draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance).
The VI screening levels are based on an excess lifetime cancer risk of $1x10^{-6}$ and hazard quotient of 1.
p-Xylene value used for Xylene (total)
(2) The target concentration is lower than MCL.
(3) The constituent is not sufficiently volatile to be a constituent of potential concern for the vapor intrusion pathway
Henry's law constant is less than 10^{-5} atm m^3/mol
(4) The risk-based groundwater VI SLs were calculated using the most recent toxicity values.

Attachment -E2

Table 1: Comparative Generic Vapor Intrusion Screening Criteria Corresponding to Target Indoor Air Concentrations and Target Groundwater Concentrations for Chemicals Truncated at the MCL, Target Risk = 1E-06

								Target Indoor Air Concentration to Satisfy the Prescribed Risk Level (TR=1E-06 or THQ=1)		Target Soil Gas Concentration Corresponding to Target Indoor Air Concentration where the Soil Gas to Indoor Air Attenuation Factor (α) = 0.1			Target Groundwater Concentration Corresponding to Target Indoor Air Concentration where the Soil Gas to Indoor Air Attenuation Factor (α) = 0.001 and Partitioning across the Water Table Obeys Henry's Law	MCL	VI Risk at MCL
CAS No.	Chemical	Molecular Weight	Basis of Target Concentration C=Cancer Risk; N/C=Non cancer Risk	InhalationUnit Risk $(\mu g/m^3)^{-1}$		Reference Concentration $(\mu g/m^3)$		$\mu g/m^3$	ppbv	$\mu g/m^3$	ppbv	Dimensionless Henry's Law Constant (unitless)	µg/L	µg/L	unitless
71432	Benzene	78	C	7.80E-06	I	3.00E+01	I	3.12E-01	9.8E-02	3.12E+00	9.8E-01	2.30E-01	1.36E+00	5.00E+00	3.70E-06
56235	Carbon tetrachloride	154	C	6.00E-06	I	1.00E+02	I	4.06E-01	6.5E-02	4.06E+00	6.5E-01	1.20E+00	3.38E-01	5.00E+00	3.70E-05
67663	Chloroform	119	C	2.30E-05	I	9.80E+01	A	1.06E-01	2.2E-02	1.06E+00	2.2E-01	1.50E-01	7.05E-01	8.00E+01	1.10E-04
107062	1,2-Dichloroethane	99	C	2.60E-05	I	2.40E+03	A	9.36E-02	2.3E-02	9.36E-01	2.3E-01	4.00E-02	2.34E+00	5.00E+00	2.10E-06
100414	Ethylbenzene	106	C	2.50E-06	C	1.00E+03	I	9.73E-01	2.2E-01	9.73E+00	2.2E+00	3.20E-01	3.04E+00	7.00E+02	2.30E-04
127184	Tetrachloroethylene (PCE)	166	C	5.90E-06	C	2.70E+02	A	4.12E-01	6.1E-02	4.12E+00	6.1E-01	7.50E-01	5.50E-01	5.00E+00	9.10E-06
79005	1,1,2-Trichloroethane	133	C	1.60E-05	I	NA		1.52E-01	2.8E-02	1.52E+00	2.8E-01	3.70E-02	4.11E+00	5.00E+00	1.20E-06
79016	Trichloroethylene (TCE)	132	C	2.00E-06	C			1.22E+00	2.3E-01	1.22E+01	2.3E+00	4.21E-01	2.89E+00	5.00E+00	1.70E-06
79016	Trichloroethylene (TCE)	132	N/C			1.00E+01	N	1.00E+00	1.9E+00	1.00E+02	1.9E+01	4.21E-01	2.50E+01	5.00E+00	1.70E-06
75014	Vinyl chloride*	63	C	4.40E-06	I	1.00E+02	I	1.60E-01	6.3E-02	1.60E+00	6.3E-01	1.10E+00	1.45E-01	2.00E+00	4.00E-06

Notes: I = IRIS, A = ATSDR, C = CalEPA, N = NYSDOH

Carcinogenic Target Indoor Air $(\mu g/m^3)$ = Target Cancer Risk x AT_c / (EF x ED x IUR)

where:

Target Cancer Risk = 1E-06, 1E-05, or 1E-04

AT_c = averaging time, carcinogens (25,550 days)

EF = exposure frequency for a resident (350 days/year)

ED = exposure duration for a resident (30 years)

IUR = inhalation unit risk $(ug/m^3)^{-1}$

Non-cancer Target Indoor Air $(\mu g/m^3)$ =Target Hazard Quotient (THQ) x RfC

where:

THQ = 1

RfC = Reference Concentration $(\mu g/m^3)$

Concentrations in ppbv (conversion from $\mu g/m^3$ to ppbv) = $C(\mu g/m^3) \times 10^9 (ppb/atm) \times 10^{-3} (m^3/L) \times R \times T/(MW \times 10^6 [\mu g/g])$

where:

R = gas constant (0.0821 L-atm/mole-K)

T = absolute temperature (298K)

MW = molecular weight (g/mole)

Target Soil Gas $(\mu g/m^3)$ = Target Indoor Air / α

where α = soil gas to indoor air attenuation factor (0.1 for target soil gas)

The soil gas to indoor air attenuation factor of α = 0.1 is used for all soil gas. Hence, screening values are for all soil gas.

Target Groundwater (µg/L) = Target Indoor Air x 10^3 m^3/L / (H x α)

where α = soil gas to indoor air attenuation factor (0.001 and partitioning across the water table obeys Henry's Law)

*Early-life exposure is accounted for in this calculation

Equation can be found on the RSL User's Guide.